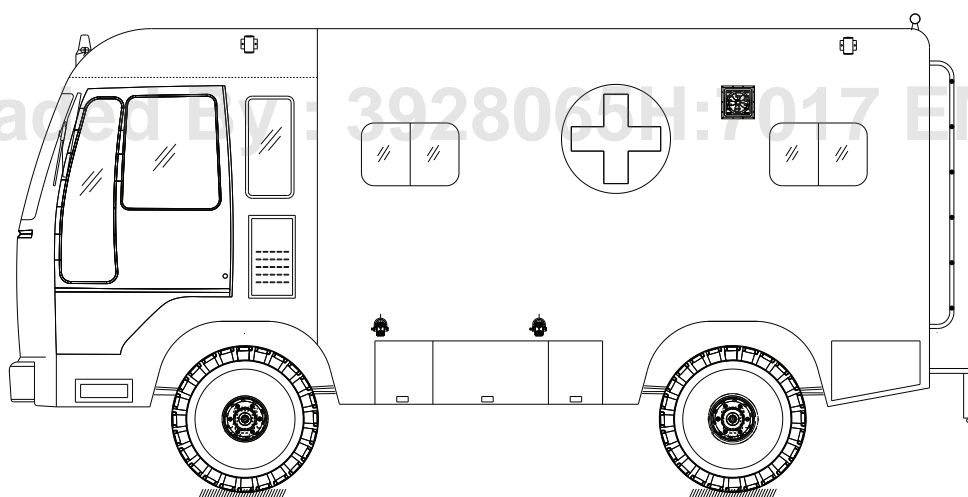


# RESTRICTED

The information given in this document is not to be communicated either directly or indirectly to the press or to any person not authorised to receive it.

## WORKSHOP MAINTENANCE MANUAL

For



### MEDIUM AMBULANCE 4 X 2 (BS III NORMS)

Manufactured by



**ASHOK LEYLAND**

No. 1 Sardar Patel Road, Guindy, Chennai - 600 032.





# INTRODUCTION

This manual has been prepared to provide the operators with necessary information on the maintenance and repair of **MEDIUM AMBULANCE 4 X 2 (BS III NORMS)**.

The manual not only serves as a ready reference book for Service Supervision, but also as a guide to the mechanics. Ashok Leyland Ltd (the company) reserve the right to change the procedures, material, specifications, dimensions or design of the vehicle shown, described, referred to herein at any time and without prior notice in accordance with the Company's Policy of constant product improvement. Every reasonable effort has been made to ensure that the service manual is accurate.

Proper tools and parts contribute largely to efficient and economic repairs, Operators are advised to use only genuine Ashok Leyland Parts "LEYPARTS" manufactured exactly to original specification.

## GENERAL MANAGER - DEFENCE

**ASHOK LEYLAND LIMITED**  
MARKETING DIVISION,

No.1, Sardar Patel Road,

Guindy, Chennai - 600 032.

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**MEDIUM AMBULANCE 4 X 2  
FRONT LH VIEW**



**MEDIUM AMBULANCE 4 X 2  
FRONT RH VIEW**



**MEDIUM AMBULANCE 4 X 2  
REAR RH VIEW**



**MEDIUM AMBULANCE 4 X 2  
REAR LH VIEW**

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## PRECAUTIONS

1. Always use “**Ashok Leyland Genuine Parts**”. Guarantee does not cover failure or accidents caused by the use of non-genuine parts or consequential failures arising out of the use of non-genuine parts.

### 2. **STARTING THE ENGINE AFTER PROLONGED VEHICLE STORAGE**

#### **De-preservation procedure**

1. Clean external parts thoroughly.
2. Uncover all openings previously covered during preservation and appropriate connections should be made.
3. Remove fuel filters and fit new ones.
4. Remove injectors and check opening pressure and refit.
5. The procedure for starting as recommended below should be followed.
  - a. Engine has been properly depreserved.
  - b. Air cleaner is fitted properly.
  - c. Radiator is properly mounted in the vehicle and leak proof piping connections are made. Check coolant level in the De-aeration tank.
  - d. Engine oil is filled in the sump up to the high level on the dipstick.
  - e. Fuel system has been primed.
  - f. Electrical connections are properly made and fully tightened.
  - g. Fill engine oil through the priming plug of turbo charger to wet the turbo charger bearings.
  - h. Check oil level and top up if necessary in the gear box, rear axle, power steering and clutch master cylinder.
  - i. Crank engine by operating starter for ten seconds to circulate oil to engine components.
3. Keep the engine at idling speed for minimum 2 minutes before moving the vehicle, and shutting off, this will ensure trouble free performance from the turbocharger.
4. Ensure that the thermostat and pressure cap fitted are in good working condition.
5. The FIP is adjusted and sealed to provide optimum performance from the engine. Breaking the seal and tampering with the standard adjustment can adversely affect engine performance and result in engine damage.
6. Use recommended low sulphur diesel (BS III fuel) as per IS 1460-2000 (Amendment - 1, January 2003).

## STORAGE OF VEHICLES

Whenever vehicles are kept off-road or in storage, proper care should be taken, as detailed below:

1. If stored for a short period:
  - (a) The vehicle should be thoroughly washed, including the under chassis, to remove any deposits of mud which may be salt-laden.
  - (b) The vehicle should be parked in a covered area, on plain hard surface.
  - (c) Disconnect battery terminals.
  - (d) Once a week the engine should be started and run for a few minutes. It is advisable that the vehicle is jacked up to engage the gears so that complete circulation of oil is effected in the gear-box and the differential.
2. If stored for longer periods:
  - (a) The batteries should be removed and prepared for storage in a dry place. Top up with distilled water and charge fully before storage. Check and charge at regular intervals during storage.
  - (b) Remove the injectors and spray 20 cc of engine inhibiting oil (Shell Ensio oil SAE 10, Castrol storage oil 301, Servo preserve 30) through injector hole. Crank the engine for about 30 seconds. Then fit back the injectors.
  - (c) Spray liberally anti-corrosive oil over rocker levers, push rods, plunger springs and tappets of fuel injection pump.
  - (d) Drain the lubricating system and replenish the same with engine inhibiting oils.
  - (e) It is advisable to drain the cooling system. A board is to be hung on the engine indicating that cooling system has been drained out to avoid accidental starting of the engine.
  - (f) It is advisable to drain the fuel tank as well as the fuel filters to avoid formation of gum deposits and the possibility of difficult starting later.
  - (g) Completely seal with masking tape the engine intake, exhaust tail pipe and the vent hole of the fuel tank.

## PRESERVATION PROCEDURE FOR ENGINE

The engine after testing should be prepared for preservation as follows:

1. Drain the fuel from the filter bowls by removing the drain plugs.
2. Run the engine for 15 minutes with the following rust preventive agents.
  - a) Fill water jacket with water containing 1% shell Bocut cutting compound or any water soluble cutting compound.
  - b) Connect fuel feed pump to a mixture of diesel and 10% flushing oil such as Lubrex or equivalent.
  - c) Fill engine sump with Servo Preserve - 40 or equivalent.
  - d) After 15 minutes disconnect the fuel line and allow the engine to run so that the fuel in the filter and pump are exhausted.
3. Stop engine and remove:
  - a) Cylinder head cover and air intake piping.
  - b) InjectorsCrank engine with starter motor.  
During cranking spray 10 cc of rust preventive oil (Servo Preserve - 40) into each injector hole and turbo inlet.  
Stop cranking after spraying oil into the cylinders and manifold.  
Spray oil (Servo Preserve - 40) through the push rod holes to reach the tappets.  
Spray oil (Servo Preserve - 40) on:
  - a) Rocker Assembly
  - b) Fit new injector washers and leave the injector in hand tight condition. (Do not torque).
4. Refit all components and seal all openings:
  - a) Air intake pipe
  - b) Water - inlet and outlet
  - c) Fuel Inlet
5. Drain:
  - a) Water from water jacket
  - b) Oil from sumpAttach a label showing 'NO-OIL' and date of preservation.
6. Paint all exterior ferrous parts of engine like block, sump, cylinder head etc., with one coat of PFU Priming GS, Brushing redoxide of Iron (IHA) - 0648 (IND/SL/3142) and paint PFU heat resisting olive green scamic 314 to specification No. IND/SL/3119.

## ABBREVIATIONS

A/F	-	Across Flat
AL	-	Ashok Leyland
Approx.	-	Approximate
Assy.	-	Assembly
Aux.	-	Auxiliary
BSF	-	British Standard Fine thread
CO <sub>2</sub>	-	Carbon-dioxide
DE	-	Double End
Dia	-	Diameter
Diff.	-	Differential
Fig	-	Figure
FIP	-	Fuel Injection Pump
GTW	-	Gross Train Weight
GVW	-	Gross Vehicle Weight
H x W x T	-	Height x Width x Thickness
ITTAC	-	Indian Tyre Technical Advisory Committee
km/ℓ.	-	Kilometre per litre
L x W x H	-	Length x Width x Height
LH	-	Left Hand
LTD	-	Limited
Max.	-	Maximum
Min.	-	Minimum
mtg.	-	Mounting
PCD	-	Pitch Circle Diameter
PR.	-	Ply-rating
PVC	-	Polyvinyl Chloride
Pvt.	-	Private
Qty.	-	Quantity
RH	-	Right Hand
rev/min	-	Revolutions Per Minute (RPM)
S/A.	-	Sub Assembly
SWC	-	Spare Wheel Carrier
TDC	-	Top Dead Centre
ZF	-	Zahnradfabrik-Friedrichshafen, Germany.

## UNITS

SYMBOL	NAME	UNIT - SYSTEM*
° C	Degree Celsius	SI
° F	Degree Fahrenheit	UK
A	Ampere	SI
Ah	Ampere hour	SI
bhp	Brake Horse Power	UK
h	Hour	SI
kg	Kilogram	SI
kg/cm²	Kilogram / Square centimetre	SI
kgm	Kilogram metre	SI
km	Kilometre	SI
lb.ft.	Pound Foot	UK
ℓ	Litre	UK
mm	Millimetre	SI
Nm	Newton Metre	SI
PS	Pferdestarke = metric horsepower	DIN 66036
psi	Pounds per square inch	UK
t	Tonne (metric)	SI
V	Volt	SI
W	Watt	SI

### Multiplication factor for conversion from other units to SI Unit

$$^{\circ}\text{F to }^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$$

$$\text{bhp to kW} = 0.74570$$

$$\text{lb.ft. to Nm} = 1.46$$

$$\ell \text{ to m}^3 = 0.001$$

$$\text{PS to kW} = 0.735499$$

$$\text{psi to kpa} = 2.89$$

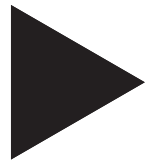
\* SI - System International,

UK - United Kingdom,

DIN 66036 - German Institute for Standardisation)

# **CHAPTER 1**

## **GENERAL**



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## ENGINE

- |                                     |   |
|-------------------------------------|---|
| 1. Model                            | : "H-Series 4 stroke DI<br>Turbocharged Intercooled<br>Diesel Engine"                 |
| 2. No of cylinders and arrangement  | : 4 cylinder Inline   |
| 3. Bore & Stroke                    | : 104 x 113 mm  |
| 4. Displacement                     | : 3.8 l   |
| 5. Compression ratio                | : 17.7 : 1  |
| 6. Power (As per ISO 1585)          | : 88 kW @ 2400 rpm  |
| 7. Max. Torque (As per ISO 1585)    | : 400 Nm @ 1600 rpm   |
| 8. Engine oil Capacity              | : 8.5 liters  |
| 9. Fuel Injection Equipment Details |   |
| a) Make                             | : Bosch   |
| b) Model                            | : VP-37 EDC   |
| c) Type                             | : Electronic Rotary Distributor type VP-37 EDC  |
| d) FIP Part No                      | : X7477800  |
| e) Injection Nozzle Part No.        | : X7473500 and X7473600 (1 <sup>st</sup> Injectors)                                   |
| 10. Tappet Clearance Inlet (cold)   | : 0.30 mm   |
| 11. Tappet Clearance Exhaust (cold) | : 0.45 mm   |
| 12. Injection Timing                | : 0.3 mm (+- 0.02 mm) plunger lift at TDC with no.1<br>cylinder at compression stroke |
| 13. Cold Starting aids              | : Grid Heater (Flange Heater)   |
| 14. Dry weight                      | : 400 kg  |

## CLUTCH

- |                                    |                       |
|------------------------------------|-----------------------|
| 1. Make                            | : CLUTCH AUTO LIMITED |
| 2. Type                            | : Diaphragm           |
| 3. Outside diameter                | : 310mm               |
| 4. Inside diameter                 | : 175mm               |
| 5. Clutch face thickness with load | : 10mm                |
| 6. Clutch release bearing grease   | : Hytec 2/EP 2        |
| 7. Lining thickness                | : 10mm                |

## GEAR BOX

- |                          |  |
|--------------------------|--|
| 1. Make                  | : AL   |
| 2. Model                 | : ZF S5 - 36 -OD   |
| 3. Type                  | : Synchromesh  |
| 4. Forward gear ratios   | : 1st - 5.96:1<br>: 2nd - 3.05:1<br>: 3rd - 1.62:1<br>: 4th - 1.00:1<br>: 5th - 0.78:1<br>: Reverse - 6.67:1 |
| 5. Shift lever locations | : LH side of Driver  |
| 6. Oil capacity          | : 6 liters   |
| 7. Level plug location   | : LH side  |

## PROPELLER SHAFT

Gearbox to Rear Axle	: 1510 Series
Quantity	: 2

## AXLES - FRONT & REAR

1. Make	: Ashok Leyland
2. Model	: FA85 - Front
	: C100 - Rear
3. Type	- Front : Reverse Elliot - Forged I Beam
	- Rear : Fully Floating Single Speed
4. Live/Dead	- Front : Dead
	- Rear : Live
5. Capacity	- Front : 3.8T
	- Rear : 7.95T
6. Under slung/over slung	: Over Slung
7. Differential ratio	: 3.7:1
8. Oil capacity	: 6 liters

## SUSPENSION

### a) Front Spring

1. Type	: Parabolic
2. Make	: Jai parabolic Springs Ltd.
3. Number of leaves	: 2
4. Width x Thickness	: 76.2x22.5 mm
5. Material specification	: 50CrV4/SUP11A
6. Length between spring eyes	: 1448 mm
7. Spring Rate	:
Main first stage	: 22.05kg/mm

### b) Rear Spring

1. Type	: Parabolic
2. Make	: Jai parabolic Springs Ltd.
3. Number of leaves	: 3
4. Width x Thickness	: 76.2x22.5 mm
5. Material specification	: 50CrV4/SUP11A
6. Length between spring eyes	: 1524 mm
7. Spring Rate	: 23.94kg/mm

### c) Shock Absorbers - Front & Rear

1. Make	: Gabriel / Hydraulics
2. Type	: Double acting telescopic

## WHEELS

### a) Rim

1. Make	: Wheels India Ltd.
2. Rim Offset	: 123.5 mm
3. Mounting hole PCD	: 203 mm
4. Rim size	: 6.00G x 16



**b) Bolts & Nuts**

- |  |   |  |
|--|---|--|
| 1. Number per wheel                    | : | 6  |
| 2. Surface finish                      | : | IS 1367 XII BS 3189                          |
| 3. Make                                | : | Sundaram Fasteners / Sterling Tools / Caparo |
| 4. Size of bolt (D x p x L)            | : | M18 x 2.5                                    |
| 5. Size of Nut (D x p)                 | : | M18x 2.5                                     |
| 6. Pitch circle diameter of bolt (PCD) | : | 203 mm                                       |

**c) Dual wheel or single**

- |               |   |        |
|---------------|---|--------|
| 1. Front axle | : | Single |
| 2. Rear axle  | : | Single |

**d) Spare Wheel**

- |             |   |                                 |
|-------------|---|---------------------------------|
| 1. Size     | : | 9.00x16 - 16PR - SCH (Michigan) |
| 2. Quantity | : | One                             |
| 3. Mounting | : | On Spare wheel carrier          |

**e) Tyres**

- |                                |   |                      |
|--------------------------------|---|----------------------|
| 1. Make                        | : | MICHIGAN             |
| 2. Size and ply rating         | : | 9.00x16 - 16PR - SCH |
| 3. Quantity                    | : | 4                    |
| 4. Type of tread pattern       | : | SCH                  |
| 5. Valve                       | : | As per Michigan      |
| 6. Specifications              | : | As per Michigan      |
| 7. Tyre Pressure Data (in psi) | : | 70                   |

**BRAKES****a) Service brake**

- |                       |   |                                      |
|-----------------------|---|--------------------------------------|
| Type                  | : | Air Brake Dual Line                  |
| Make                  | : |                                      |
| Front                 | : | Meritor HVS India / Brakes India Ltd |
| Rear                  | : | Meritor HVS India / Brakes India Ltd |
| Brake Size            | : |                                      |
| Front                 | : | 323 x 119 x 15.65 mm                 |
| Rear                  | : | 323 x 119 x 15.65 mm                 |
| Drum diameter x Width | : |                                      |
| Front                 | : | 325 x 130 mm                         |
| Rear                  | : | 325 x 130 mm                         |

**b) Parking brake**

- |             |   |              |
|-------------|---|--------------|
| 1. Type     | : | Pneumatic    |
| 2. Location | : | In Rear Axle |

**c) Exhaust brake**

- |             |   |  |
|-------------|---|--|
| 1. Make     | : | Wabco                                  |
| 2. Model    | : | Butterfly Type                         |
| 3. Location | : | On Exhaust pipe after exhaust manifold |

## STEERING SYSTEM

- |                              |                           |
|------------------------------|---------------------------|
| 1. Make                      | : ZF Power Steering       |
| 2. Model                     | : 8033 955 814 (ZF)       |
| 3. Type                      | : Intergal Power Steering |
| 4. Ratio                     | : 18.8:1                  |
| 5. System pressure           | : 130 ± 10 bar            |
| 6. Oil filling capacity      | : 4 liters                |
| 7. Diameter (Steering wheel) | : 476 mm                  |
| 8. Location                  | : RH Frame                |
| 9. Toe in                    | : 0 to 1.6 mm             |
| 10. Castor                   | : 3.5 mm                  |
| 11. Camber                   | : 0.6°                    |
| 12. King pin inclination     | : 7°                      |

## ELECTRICAL SYSTEM

### a) Battery

- |                     |   |
|---------------------|---|
| 1. Make             | : Chloride Industries Ltd (Exide) / AMCO Batteries Ltd / Amarraja Batteries |
| 2. Type             | : Lead acid accumulator   |
| 3. Capacity         | : 100Ah - 20hr rating   |
| 4. Size (l x w x h) | : 408mm x 233mm x 174mm   |
| 5. Voltage          | : 12 V x 2  |
| 6. Location         | : Inside Driver's cabin   |
| 7. Terminal earthed | : Negative  |

### b) Alternator

- |             |         |
|-------------|---------|
| 1. Make     | : LTVS  |
| 2. Model    | : SA45  |
| 3. Capacity | : 100 A |
| 4. Voltage  | : 24V   |

### c) Starter Motor

- |                             |                           |
|-----------------------------|---------------------------|
| 1. Make                     | : LTVS                    |
| 2. Model                    | : M14- 24 V Starter Motor |
| 3. Voltage                  | : 24 V                    |
| 4. Lock Torque              | : 33N-m (Min.)            |
| 5. Running Torque           | : 15 N-m (Min.)           |
| 6. Lock current required    | : 720 A (Max.)            |
| 7. Running current required | : 370 A (Max.)            |
| 8. Type of engagement       | : Pre-Engaged             |

**d) Lamps and bulbs**

- |                            |                             |
|----------------------------|-----------------------------|
| 1. Head lamps              | : 75/ W, 2 nos.             |
| 2. Side indicators         | : 21 W, 2 nos.              |
| 3. Reversing lamp          | : 21 W, 2 nos.              |
| 4. Warning lamp            | : 2 W, 17 nos.              |
| 5. Black out head lamp     | : 21 W, 2 nos.              |
| 6. Combined stop tail lamp | : 21 W - 3 nos, 10 W - 1 no |
| 7. Black out stop lamp     | : 2W, 2nos.                 |
| 8. Black out tail lamp     | : 2W, 2nos.                 |
| 9. Inspection lamp         | : 10 W, 1 nos.              |
| 10. Axle flood lamp        | : 2 W, 1 nos.               |
| 11. Fog lamp               | : 55 W, 2 nos.              |
| 12. Roof marker lamp       | : 5 W, 2 no.                |
| 13. Repeater lamp          | : 4 W, 2 no.                |
| 14. Map reading lamp       | : 2 W, 1 no.                |

**ADDITIONAL FITMENTS**

1. Cab heater / demister
2. Fog lamps and Blockout equipment
3. HVAC for Patient compartment
4. Glove box with lock
5. Fire extinguisher
6. Socket inspection lamp
7. Two nos palm coupling at front
8. Map reading lamp
9. Interior Lamps
10. Invertor
11. Batteries for Invertor
12. Rotary light with geneva cross in red colour
13. Siren
14. Fire extinguisher (ABC Type 2 Kg)
15. D - Shackle in vehicle Front
16. Lashing points / hooks for para drop
17. Lashing points for comouflage nets / pads

## GENERAL DATA

### a) Weights

1.	Front Axle Capacity (Max)	: 3800 kg
2.	Rear Axle Capacity (Max)	: 4950 kg
3.	Unladen Weight	
4.	Front Axle	: 2790 kg
5.	Rear Axle	: 2460 kg
6.	Total Unladen weight	: 5250 kg
7.	Laden Weight (with pay load)	
8.	Front Axle	: 3320 kg
9.	Rear Axle	: 2930 kg
10.	Gross Vehicle Weight	: 6250 kg

### b) Dimensional Data

1.	Wheel Base	: 3000 mm
2.	Wheel Track - Front	: 1745 mm
3.	Wheel track - Rear	: 1864 mm
4.	Front Overhang	: 1450 mm
5.	Rear Overhang	: 1210 mm
6.	Front Overhang	: 1225 mm
7.	Rear Over hang	: 1210 mm
8.	Ground clearance	: 230 mm

### c) Overall Dimensions

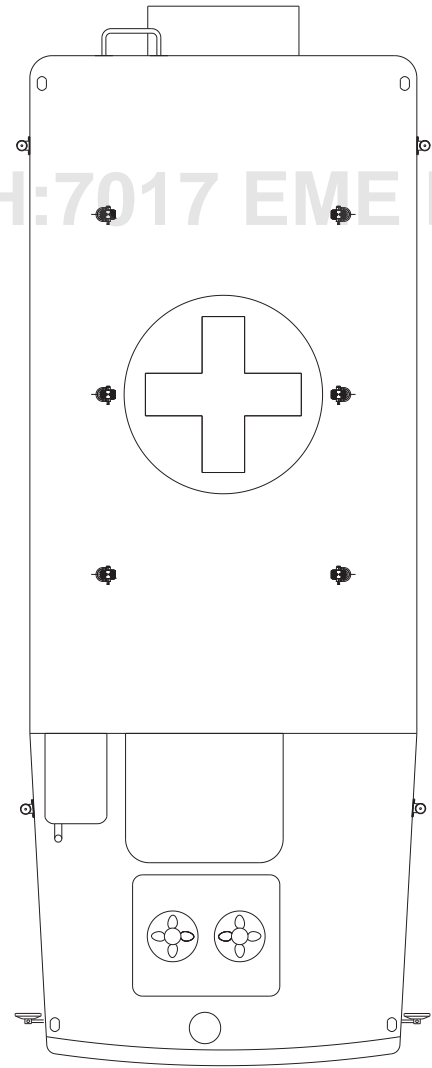
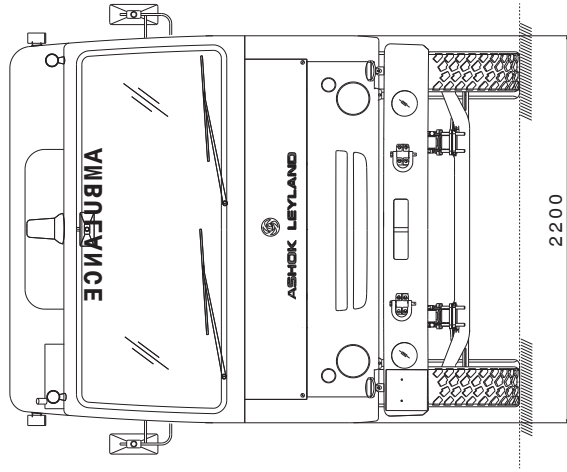
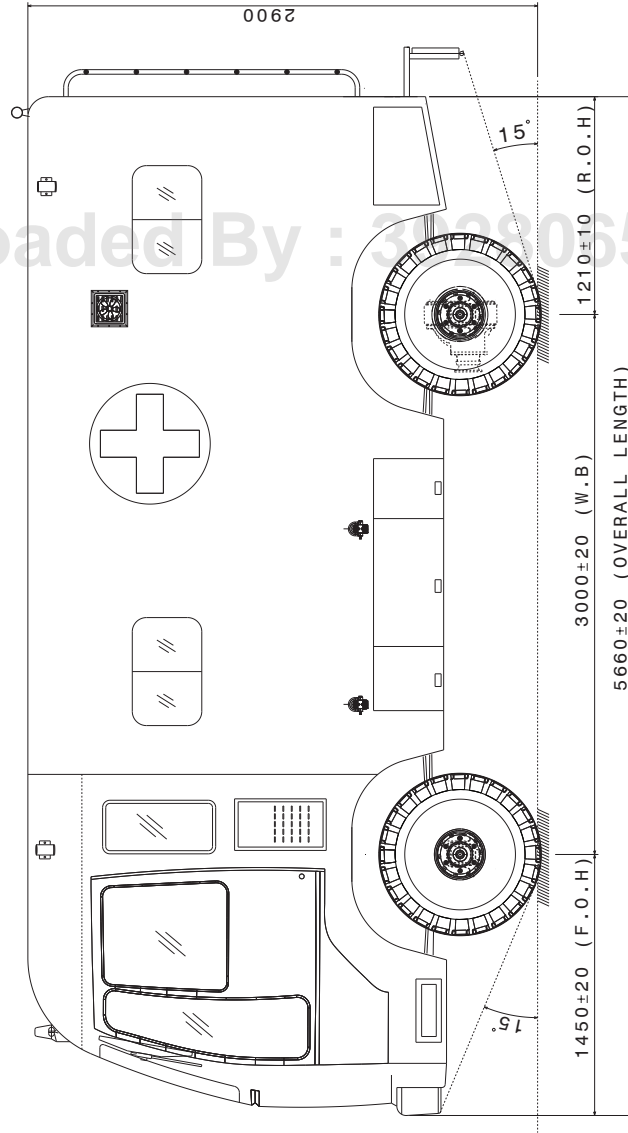
1.	Overall Length (max)	: 5660 mm
2.	Overall Width (max)	: 2200 mm
3.	Overall Height (max Unladen)	: 2900 mm
4.	Angle of Approach	: 15°
5.	Angle of Departure	: 15°

**d) Vehicle Performance**

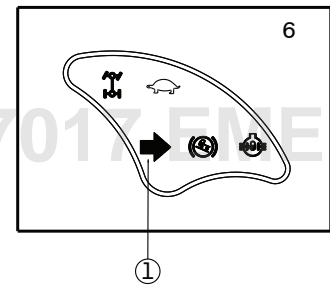
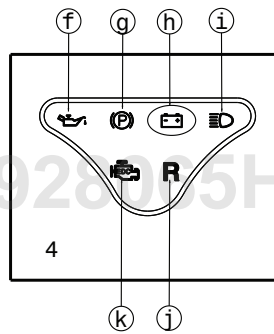
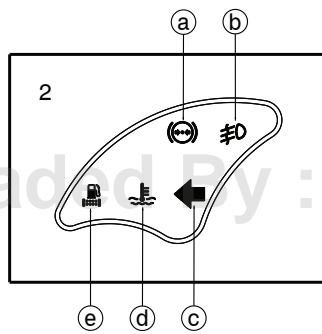
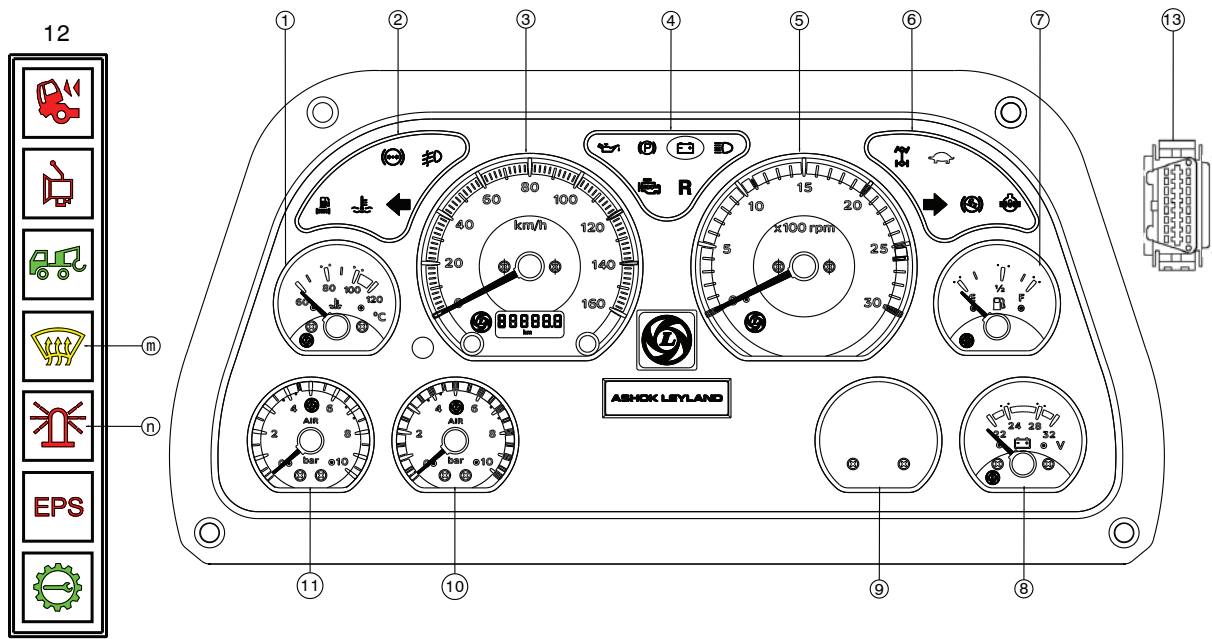
First Gear Speed	: 17 kmph
Second Gear Speed	: 35 kmph
Third Gear Speed	: 65 kmph
Fourth Gear Speed	: 79 kmph
Fifth Gear Speed	: 90 kmph
Reverse Gear Speed	: 16 kmph
Turning 'Circle Diameter	: 12.1 m
Braking Efficiency	: To meet IS11852-1987
Max Gradeability	: 15°
Parking Brake Performance	: 15°
Maximum Draw Bar Pull	: 4T
Calibration of Speedo/Odometer	: +10%
Fuel Consumption	: 5 - 5.5Km/l (Highway)
Crusing Range	: 575Km (Highway)
Cross Country Towing	: 4T max
Max Noise Level	: 82dB
Over Turning Angle	: 15°
Mud Tracking	: 200 mm
Water Wading	: 200 mm

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# GENERAL ARRANGEMENT DRAWING



## INSTRUMENT PANEL

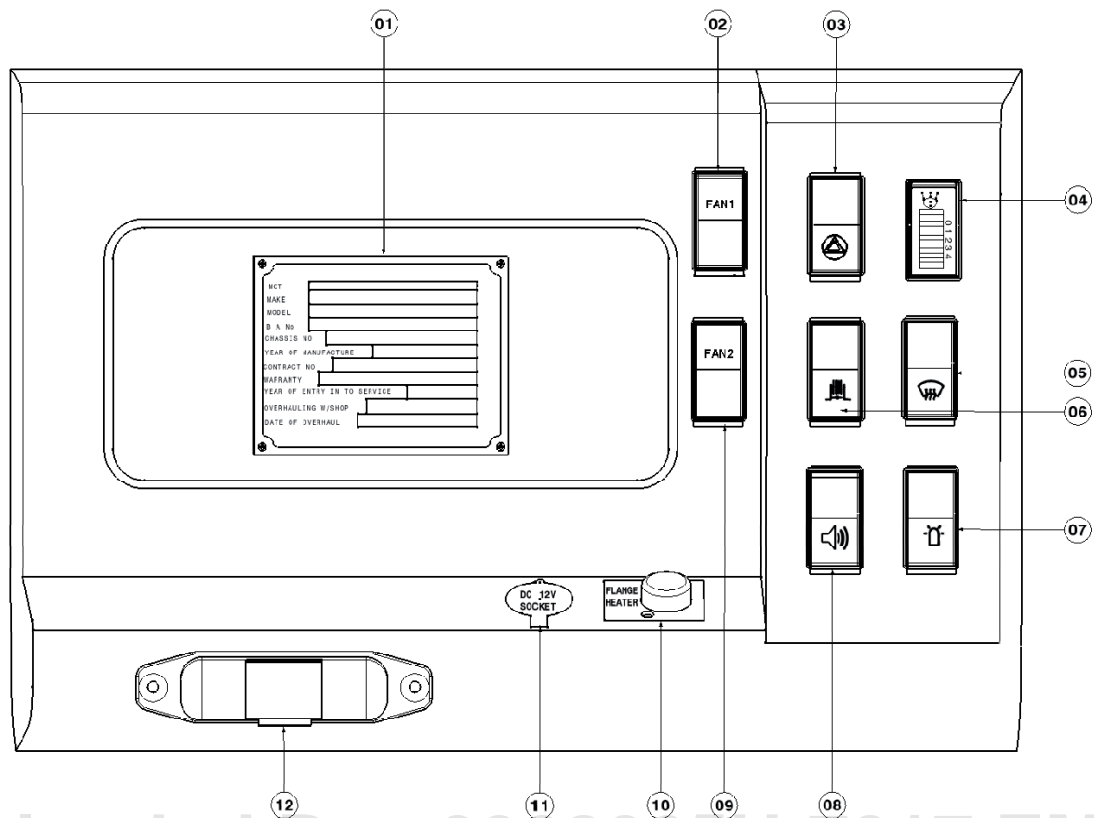


ILL NO	Description
1	Temperature Gauge
2	Warning lamp
a	Low air Pressure
b	Fog lamp front
c	Turn left
d	High Temperature
e	Water in fuel
3	Speedometer
4	Warning lamp
f	Low oil Pressure
g	Parking brake

ILL NO	Description
h	Battery Charge
i	High Beam
j	Reverse
k	Diagonistic Lamp
5	RPM Meter
6	Warning lamp
l	Turn Right
7	Fuel Guage
8	Volt Meter
9	Dummy
10	Air guage 1

ILL NO	Description
11	Air guage 2
12	Combined Warning lamp
m	Demister Lamp
n	Beacon Lamp
13	Diagnostic Gauge

## CENTRE CONSOLE



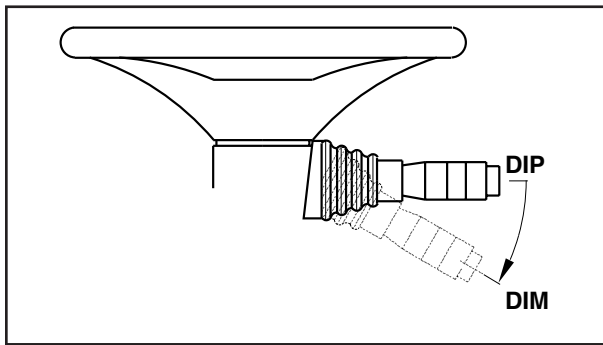
01. VEHICLE IDENTIFICAION PLATE
02. FAN1
03. HAZARD SWITCH
04. HEAD LAMP LEVELLER
05. DEMISTER SWITCH
06. EXHAUST BRAKE SWITCH
07. BEACON LAMP
08. SIREN SWITCH
09. FAN2
10. FLANGE HEATER
11. SOCKET INSPECTION LAMP
12. MAP READING LAMP

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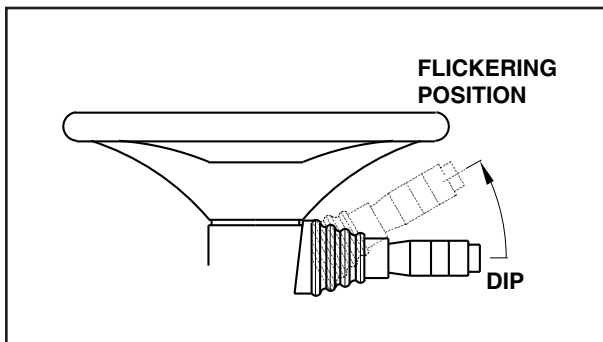
## 1. COMBINATION SWITCH

This switch mounted on the steering column has multifunctions. Following lights and accessories are connected.



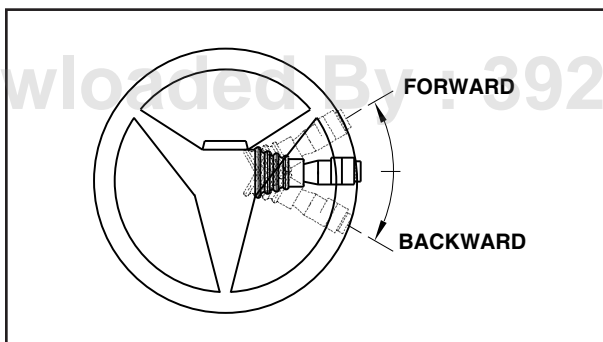
### a) HIGH BEAM AND LOW BEAM (DIP & DIM)

Position	Function
Neutral	Low beam
Down	High beam



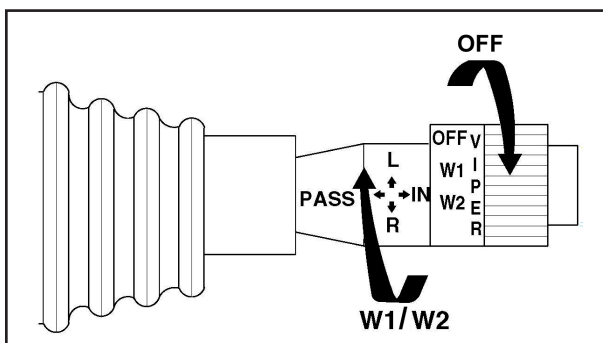
### b) PASSBY BEAM

Position	Function
Up	Passby beam will glow continuously as long as the arm is held in 'up' position.



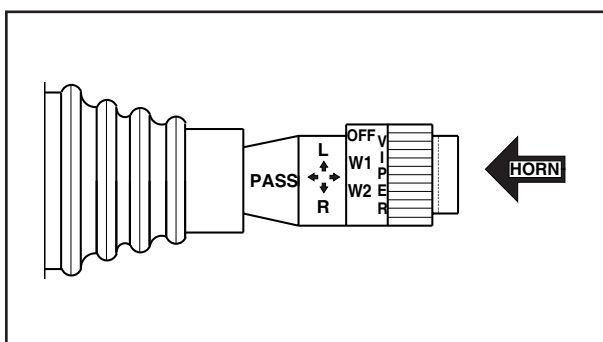
### c) DIRECTIONAL INDICATOR

Position	Function
Forward	Left direction
Neutral	Off
Backward	Right direction.



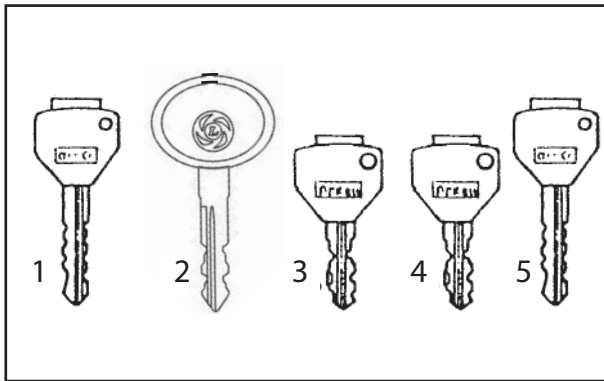
### d) WIPER SWITCH (Rotary Motion)

Position	Function
OFF	NIL
W1	Wiper Low Speed
W2	Wiper High Speed



### e) HORN SWITCH

Press in as shown in figure



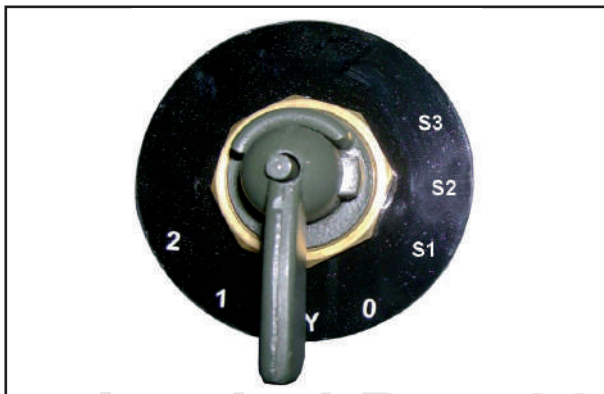
## KEYS

Keys: Following keys are supplied with the vehicle

Details of Keys:

ILL.NO	Key type
1	Door Lock
2	Ignition
3	Glove Box
4	Key Patient compartment
5	Key fuel tank

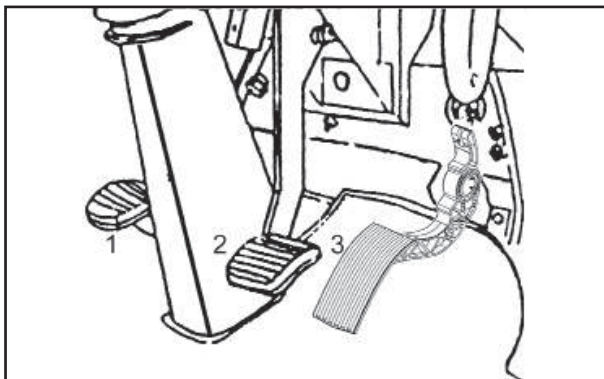
\* Preserve the duplicate keys separately for emergency requirement.



## BLACK OUT SWITCH

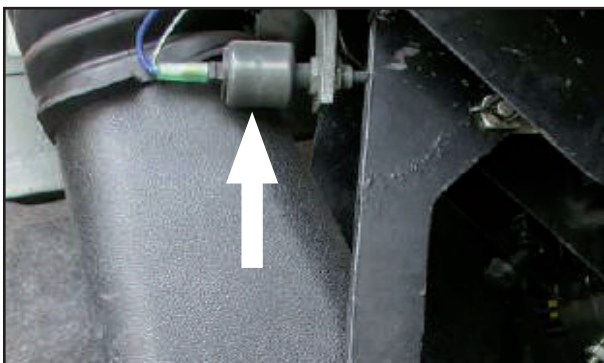
Position	Lamps Operated
Day	Flasher, Stop
0	Only instrument panel lamps
1	Stop, Flasher, Side & Tail
2	Stop, Flasher, Side, Tail & Head
S1	Axle flood, Black out stop
S2	Black out head
S3	Black out tail, head, stop and axle flood.

Press pin at centre and shift horizontal lock to LH side for operating black out mode.



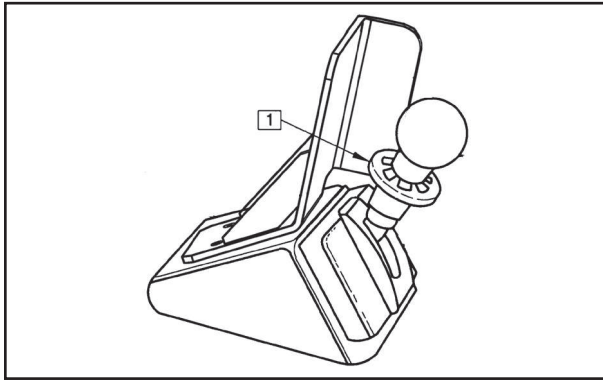
## PEDALS AND CONTROLS

1. Clutch pedal
2. Brake pedal
3. Accelerator pedal



## EXHAUST BRAKE MICRO SWITCH.

A micro switch is located on the brake pedal. This gets activated at the beginning of the pedal stroke and energises the solenoid to release air pressure to exhaust brake.

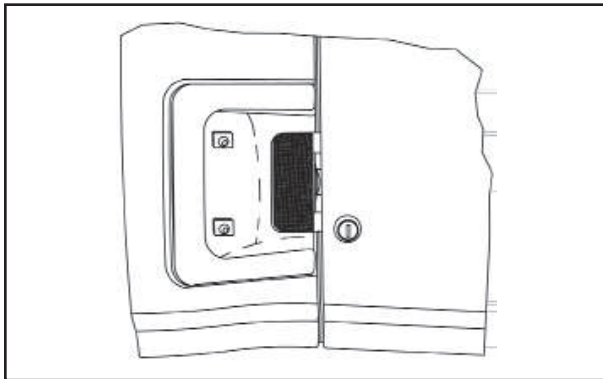


### PARKING BRAKE CONTROL

**To apply rear parking brake:** Move the control upwards and the locking collar will engage automatically

**To release rear parking brake:** Lift the locking collar (1) and move the control downwards then release the locking collar.

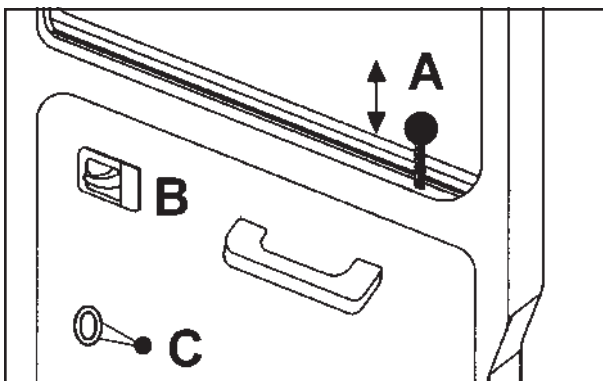
**1. Highway parking** - Apply flick valve to engage the rear parking brakes.



### DOOR LOCKS

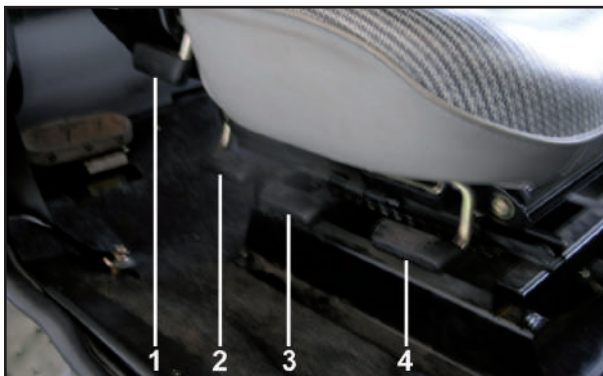
To lock the door from the outside, insert the key into the lock and turn rearward until a click is heard. Return the key to the upright position and withdraw. To unlock insert the key and turn forward until a click is heard. Return the key to upright-position and withdraw. To open the door, hold the handle and pull open.

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### DOOR INTERIOR - RH DOOR

- A. To lock the door from inside, move the control knob downwards and pull up to unlock.
- B. To open the door from inside pull trigger type latch and push the door open.
- C. Rotate handle to raise and lower the door glass.



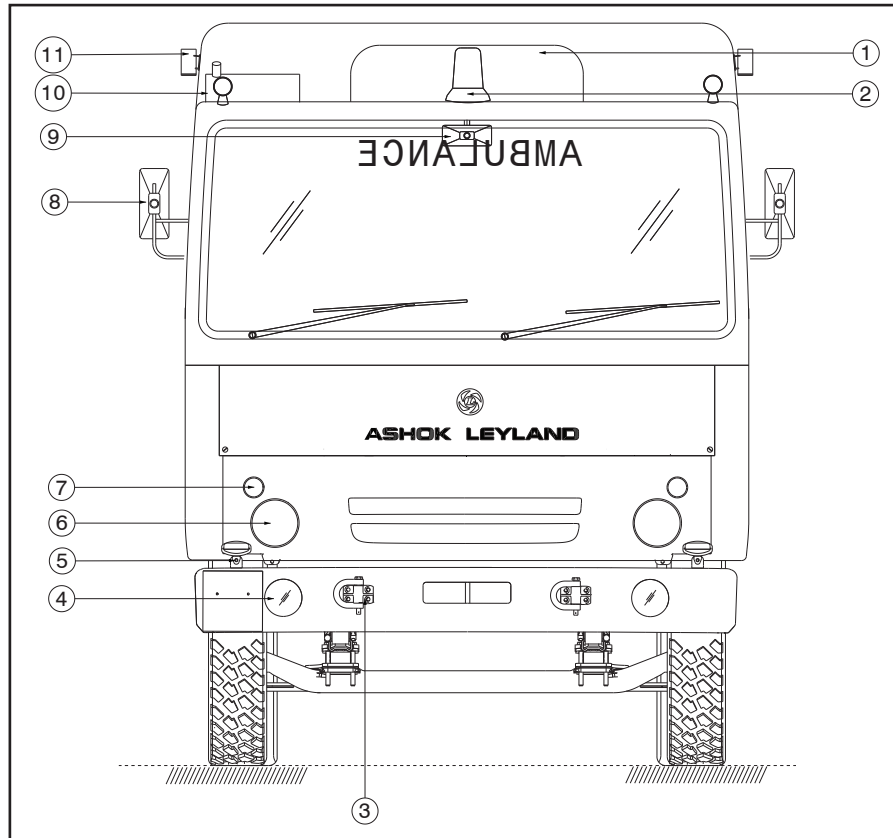
### SEAT CONTROLS

To adjust the seat front and back - move the lever (3) upward, slide seat to the desired position and release the lever to lock.

To adjust the rake of the seat back, lift lever (1) and adjust until the desired position is reached.

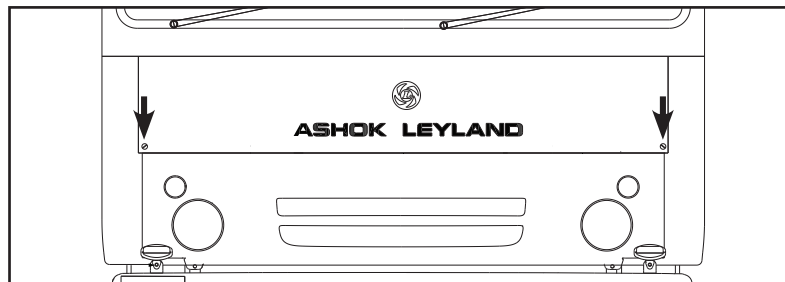
The front and rear of the cushion may be adjusted independently. To raise the front lift latch (4) and set in the desired position by releasing the latch. Lift latch (2) to adjust the rear of the seat.

## VEHICLE MIRRORS



The vehicle is fitted with three mirrors one each on LH and RH side and a rear view mirror at centre of the windscreen glass. The rear view mirror at center of windscreen can be set with two positions for day and night vision, ensure all three mirrors are checked and adjusted to give the best possible vision.

## HOOD



The front hood must be opened to access the radiator and other aggregate adjacent to radiator. Rotate the two FOP lock which hold the front panel.

The deaeration tank cap and engine oil dip stick can be accessed after removing the front hood.

## **RECOMMENDED LUBRICANTS**

The recommended lub chart gives the minimum performance / viscosity requirements of lubricants, relating to ambient temperature for all units. The equivalent proprietary brands of lubricants shown are recommended by the linked oil companies to meet these requirements.

Where different grades of lubricant are shown for various atmospheric temperature ranges, the grade chosen should be that applicable to the temperature range which is operative for a significant period.

Ashok Leyland will not accept any responsibility for negligence in maintenance arising from any of the following causes:

1. The use of oils lower viscosity than the recommended grade
2. The use of oils of lower performance level with regard to characteristics specified in the lubrication chart.
3. The continued use of oils after the recommended oil change period.

## **GREASING**

Chassis has to be lubricated at regular intervals with the recommended grease. A high pressure grease gun or a pneumatically operated grease gun to be used.

The purpose of greasing is to drive away mud and old grease from a particular place and new grease is introduced for better operation. Improper greasing will always cause deterioration in the life of the units.

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FOLLOWING ARE THE IMPORTANT PLACES WHERE GREASING HAS TO BE DONE:

**LUBRICATE WITH GREASE**

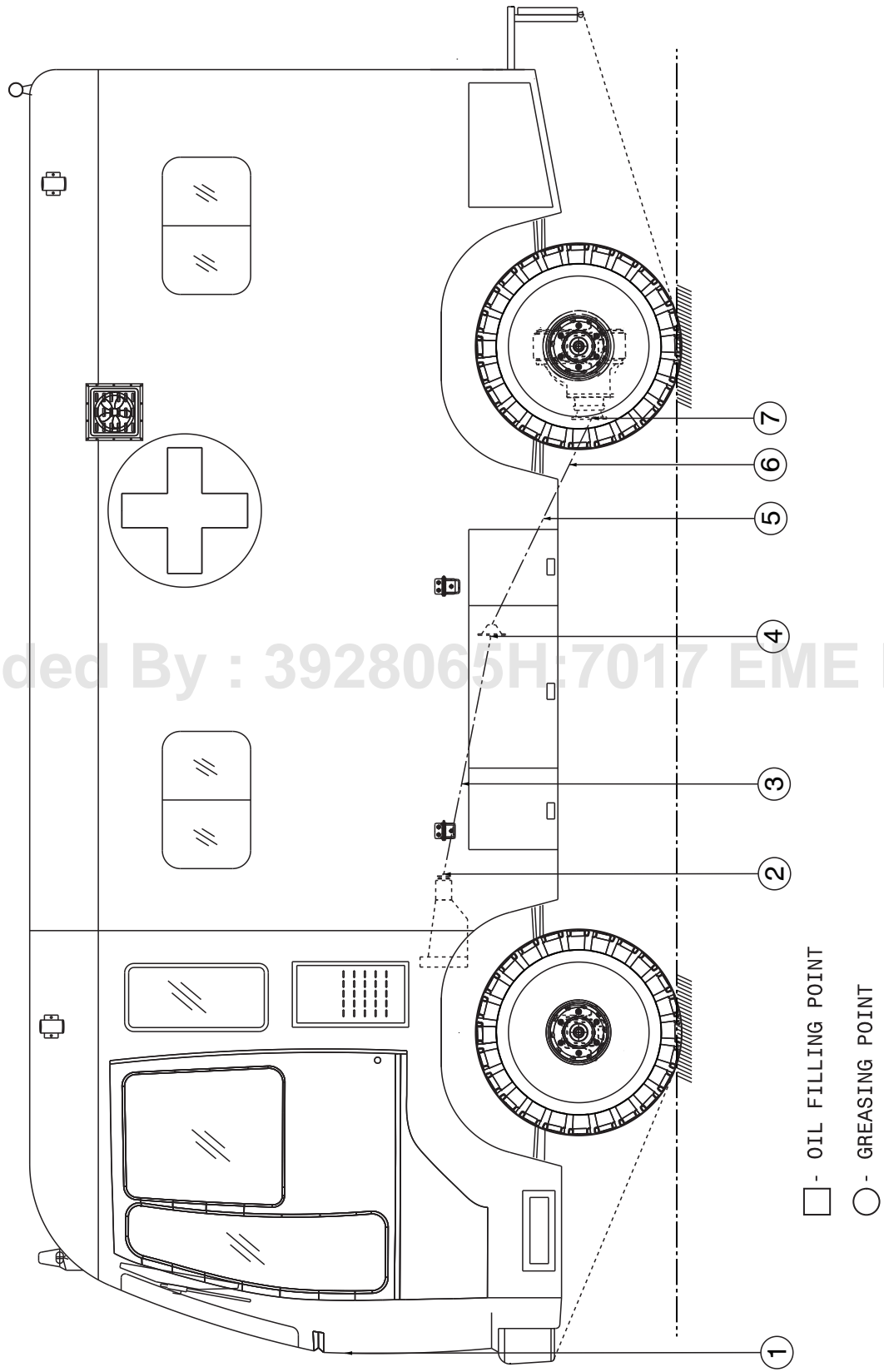
SL. NO.	COMPONENTS
2,4,5,7	PROP. SHAFT UJ CROSS JOINT
3,6	PROP. SHAFT SPLINES
9,27	SPRING PIN FRONT
8,10	DRAG LINK BALL JOINT
11,28	KING PIN TOP AND BOTTOM
12,25	TRACK ROD BALL JOINT
13	CLUTCH WITHDRAWAL LEVER
14,22	SPRING PIN REAR
15,23	SPRING SHACKLE PIN
16,19	'S' CAM SHAFT
17,20	SLACK ADJUSTER
18	REAR HUB
21	SWC PIVOT PIN
24	CLUTCH WITHDRAWAL SLEEVE
26	FRONT HUB

**AGGREGATES FILLED WITH OIL**

ILL. NO.	COMPONENTS	OIL FILLING CAPACITY (ℓ)	CHANGE PERIOD (kms)
1	CLUTCH MASTER CYLINDER	0.3	-
29	POWER STEERING	4.0	30,000
30	GEAR BOX	6.0	20,000
31	REAR AXLE	6.0	20,000
32	ENGINE	8.5	10,000**

**\*\* - FOR HAA AND DESERT OPERATION OIL / FILTER TO BE CHANGED AT 5000 km INTERVAL.**

# LUBRICATION POINTS CHART

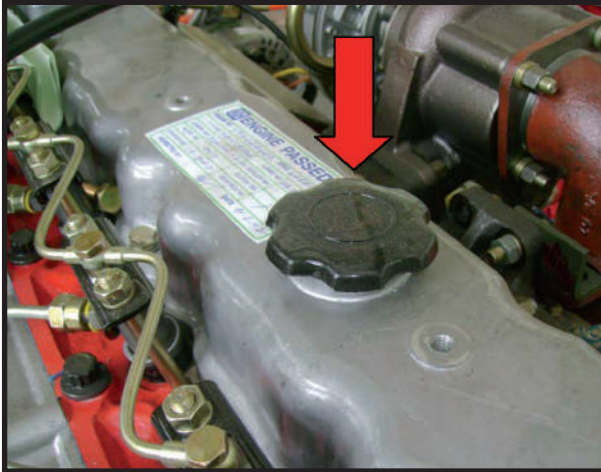


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## OIL FILLING POINTS



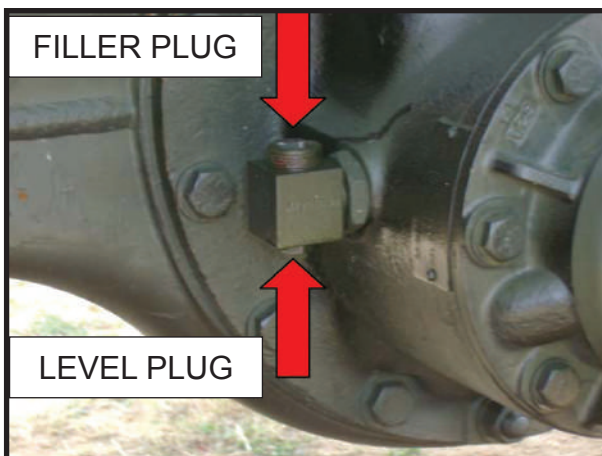
### ENGINE

1. **Filler Cap** - Remove by Hand.
2. **Drain Plug** - Use 12 mm Allen Key.
3. **Filter Bolt** - Use 22 mm Ring Spanner.



### GEAR BOX

1. **Filler Plug** - Use 17 mm DE Spanner
2. **Drain Plug** - Use 17 mm Ring Spanner



### AXLES (Rear)

1. **Filler Plug** - Use 1/2" Sliding T Handle.
2. **Drain Plug** - Use 1/2" Sliding T Handle.
3. **Level Plug** - Use 17 mm Ring Spanner.



### CLUTCH

1. **Filler Cap** - Remove by Hand
2. **Drain** - Remove Hose on Slave Cylinder



### STEERING

1. **Filler Cap cum Dipstick** - Remove by Hand
2. **Drain** - Remove pipe in steering box

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## RECOMMENDED LUBRICANTS CHART

UNIT	Ashok Leyland Specification	Ambient Temp °C	AL Recommended Companies		Equivalent products from other Companies			
			Indian oil Corporation	Gulf oil	Hindustan Petroleum	Bharat Petroleum	Elf Lubricants	SAH Petroleum IPOL
Engine BS III Norms	API CH4+ MB228.3	- 15 °C and above (Viscosity grade 15W40)	Servo Pride XL 15W40	Gulf Super Fleet LE 15W40	HP No. 1 15W40	MAK CH4 15W40	Elf Performance 3-D 15W40	IPOL MCH Diesel XL SAE 15W40
		- 30 °C and above (Viscosity grade 10W40)	Servo Pride XL 10W40	Gulf Super Fleet LE 10W40	NA	MAK CH4 10W40	Elf Performance Exerty 10W40	IPOL MCH Diesel XL SAE 10W40
Gear Box Synchronmesh	API GL4 (or) MIL-L-2105 (or) IS 1118 -EP Type GL4	< 0°C @	Sevo Gear HP 80W	Gulf Gear EP 80	HP Gear Oil EP 80	MAK Spirol EP 80W	Gear Elf 4 EP 80W	Syncro EP 80W
		> 0°C @	Sevo Gear HP 90(T)	Gulf Gear EP 90	HP Gear Oil EP 90	MAK Spirol EP 90	Gear Elf 4 EP 90	Syncro EP 90
Power Steering	General Motors Type A Suffix A	****	Servo Transfluid A	Gulf ATF Type A	ATF - A	MAK ATF - A	Trans-O-matic	Syncro TQX
Hydraulic Jack	IS 10522	****	Servo System 68	Gulf Harmony AW68	Enklo 68	MAK Hydrol	Acantis HM68	****
Axles	API GL-5 (or) MIL-L-2105 D (or) IS 1118 -EP Type GL5	< 4°C	Sevo Gear Super 80W90	Gulf Gear MP 80W90	HP Gear Oil XP 80W90	MAK Spirol HD 80W90	Gear Elf 5 EP 80W90	Syncro Premium 90
		> 4°C	Sevo Gear Super 85W140	Gulf Gear MP 85W140	HP Gear Oil XP 85W140	MAK Spirol HD 850W140	Gear Elf 5 EP 85W140	Syncro Premium 140
General Chassis lubrication\$	IS 12203 *	****	Servo Grease MP	Gulf Crown MP 2	MP Grease No.2	MAK Univex A	Lex 2	IPOL MP Grease No.2
Clutch Master Cylinder	FM VSS 116 - Dot3 (or) IS 8654	****	Servo Brake Fluid Super HD	Gulf Brake Fluid Dot 3	Super Duty Brake Fluid Dot3	MAK HDBF	Heavy Duty Brake Fluid	IPOL Halt X Dot3

@ - Gear Box (Synchronmesh) oil: For wider ambient temperature range the following multigrade oils can also be used.

For -15° C and above, SAE 80W140 viscosity grade oil can be used.

For -30°C to +30°C, SAE 75W90 viscosity grade oil can be used.

\* - Balmer Lawrie grease Balmerol Multi grease No. 2 can also be used.

\$ - Servo Gem RR3 (IOC) and Lithon RR3 (HP) can be used for wheel bearings for longer wheel greasing intervals.

Note:- When repacking bearings, completely remove old grease and wash the bearings in solvent and air dry before applying new grease. Never mix two different types of grease.

### Recommended grease specification for other units.

1. Starter motor drive assy - OKS 475 HS grease of OKS Speciality Lubricants, Bangalore
2. Gear shift linkage ball joint - Castrol LMM Grease
3. Brake valves - use silicone grease supplied along with repair kits.

### FUEL ADDITIVES

Following additives are recommended for enhancing lubricity of fuel (Additive to be mixed in the ratio of 4cc per litre).

NONOX from M/S GOCL, Hitec 580 from Afton Chemicals, VAL 2S 1750 from ELF Lubricants. (Pecton India pvt ltd)



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# **H SERIES HA4CTI3N BS III ENGINE**



**ASHOK LEYLAND**





## 16.0 GENERAL

### 16.0.0 Engine Type and Number



Fig. 1

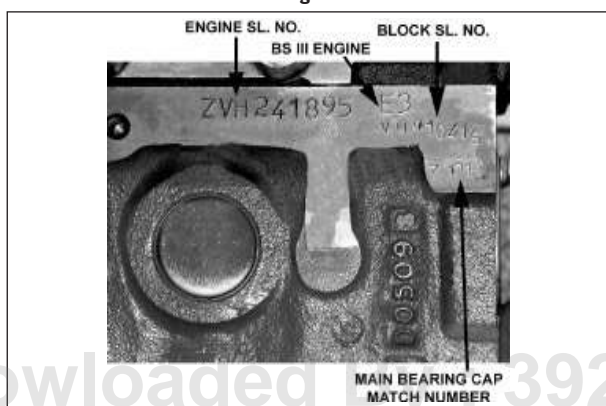


Fig. 2

The engine serial number is punched on the Left hand side top rear of crankcase, behind Fuel Injection Pump. **Fig. 1 & 2**

#### 16.0.1 Design and Operation

4 cylinder, water cooled 4 stroke Diesel Engine with direct fuel injection into a shallow combustion chamber arranged in the piston crown .

Another characteristics is the special shape and arrangement of the intake ducts in the cylinder head which allows the air to enter only from one direction. Upon entering, the air is given a swirling motion causing the fuel to mix, which is injected through a multi hole nozzle into the combustion chamber. Combustion is initiated at the end of compression stroke.

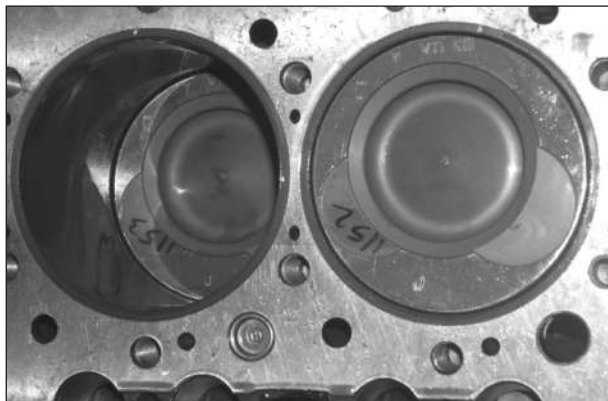


Fig. 3

The Engine employs a shallow combustion chamber which features a specially shaped combustion chamber in the piston crown. **Fig. 3**

The shape of the combustion chamber allows full use of the energy contained in the fuel, because the cooling surfaces are comparatively small in relation to the volume of the combustion chamber whilst the air swirls ensures that air and fuel are mixed uniformly.

Electronic fuel injection equipment is used alongwith sensors for precise control of injected fuel quantity and injection begin thereby achieving stringent BS III emission norms.

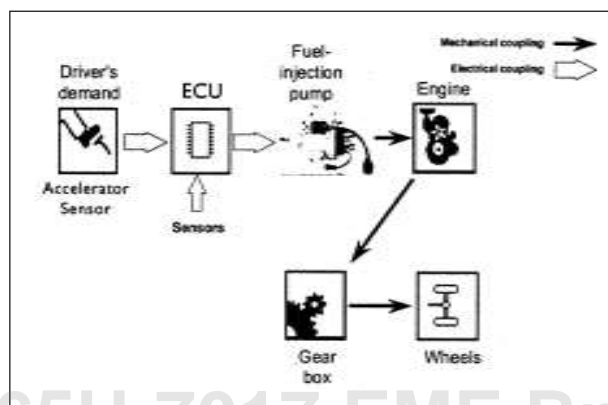


Fig. 4

The electronic fuel injection equipment is controlled by an **Electronic Control Unit (ECU)** and there are no control lever and mechanical linkages to FIE. Hence called "**Drive by Wire Technology**". **Fig. 4**

#### Major components of EDC system

Electronic Diesel Control system comprises of the following.

- Distributor type VP37 Fuel injection pump.
- Engine driven feed pump with hand primer.
- Instrumented Injector for 1st cylinder
- Normal Injector for other cylinders
- Electronic Control Unit (ECU)
- Engine speed sensor
- Coolant temperature sensor
- Boost pressure sensor
- Accelerator pedal position module
- Brake switch
- Clutch pedal switch
- Vehicle speed sensor and DC-DC converter (power source)





## 16.0.2 General Data

Description	HA4CTI3N (BS III)
Type	Diesel four stroke, 4 cylinder, Water cooled direct injection, in-line overhead valve
Aspiration	Turbocharged with inter cooled
Max output	88.25 kw (120 ps) @ 2400 rpm
Max torque	40.8 kgm @ 1600 rpm
Bore and Stroke	104 x 113 mm
Piston displacement	3.839 ℓ
Compression Ratio	17.7 : 1
Firing order	1-3-4-2
Direction of rotation	Counter clockwise viewed from flywheel.
Compression pressure	29 - 32 kg/cm <sup>2</sup> @ 280 rpm (Limit - 24 kg/cm <sup>2</sup> )
Idling revolution	600 rpm
Engine weight (with oil)	375 kg
Fuel Injection Equipment	VP37 EDC - Electronic Rotary Distributor type injection pump.
Injection Nozzle	
Type	Multi hole nozzle type (6 Holes - 6 x 0.18 x 146)
Opening pressure	248 - 260 bar
Injection timing	0.3 mm (± 0.02 mm) plunger lift at TDC with no. 1 cylinder on compression stroke
Injector high pressure pipe (mm) (OD x ID x Length)	6.35 x 1.8 x 750
Valve Timing	
Intake opens	18° Before Top Dead Centre
Intake closes	30° After Bottom Dead Centre
Exhaust opens	57° Before Bottom Dead Centre
Exhaust closes	15° After Top Dead Centre
Valve clearance (when cold)	
Intake	0.30 mm
Exhaust	0.45 mm
Engine Oil Pump	
Type	Full forced Pressure feed by gear pump
Drive	By timing gear
Engine oil cooler	Multi plates type (no of plates - 5) water cooled
Coolant Pump	
Type	Forced circulation by volute pump
Drive	By Poly V-belt
Impeller dia	85 mm
Pump bearing dia	55 mm
Thermostat	
Type	Wax type, Bottom bypass system
Turbo wastegate	Yes
Electrical	
Starter motor	12V/24V, Pre-engaged
Alternator	12V - 65 Amps, 24V - 100 Amps



**16.0.3 Repair Data**

DESCRIPTION	SPECIFICATION (Measurements in mm)	MEASURING DEVICE AND REMARKS
	HA4CTI3N (BS III)	
Crankcase		
Cylinder block flatness	0.05 (limit 0.1)	Straight edge rule and feeler gauge
Crankcase bore for cylinder liner fitment	Refer section 16.0.8	W,X,Y,Z, punch marked on crank case LH side adjacent to each bore
Cylinder liner outside diameter	Refer section 16.0.8	W,X,Y,Z, paint mark given on cylinder liner OD for identification
Fitment of cylinder liner in crankcase bore	Mild Interference Fit Liner	Selective assembly (Only MLS gasket to be used).
Cylinder liner bore	104.008 - 104.040 (limit 104.15)	Bore dial gauge (To be measured at 80 mm from top)
Liner projection	0.01 - 0.08	Dial gauge with magnetic stand
Block Top Surface to Crankshaft Centre	299.95 - 300.00	
Block Top Surface to sump face height	370	
Main parent bore dia	77.985 - 78.00	Micro meter & bore dial gauge
Cylinder counter bore depth	8.020 - 7.980	Vernier depth gauge
Cylinder counter bore dia	112.00 (+0.290 to 0.150)	Micro meter & bore dial gauge
Piston and Connecting Rod Assembly		
Piston diameter Standard size	103.860 – 103.875 / 103.827 – 103.843	Micrometer (measure at skirt area perpendicular to piston axis)
Diametral piston clearance (at skirt)	0.140 - 0.172	Micro meter and bore dial gauge
Piston ring Groove Width		
Top	—	Vernier calipre
Second	2.53-2.55 (limit 2.70)	
Oil Ring	3.015-3.035 (limit 3.08)	
Piston ring width		
Top	—	Micrometer
Second	2.47 - 2.49 (limit 2.32)	
Oil Ring	2.97 - 2.99 (limit 2.95)	
Piston ring side clearance in groove		
Top	0.08 - 0.12 (limit 0.7)	Feeler gauge
Second	0.04 - 0.08 (limit 0.2)	
Oil Ring	0.025 - 0.065 (limit 0.1)	
Piston Ring gap		
Top	0.30 - 0.45 (limit 1.2)	Feeler gauge
2nd	0.30 - 0.45 (limit 1.2)	
Oil	0.20 - 0.40 (limit 1.2)	
Maximum permissible piston weight difference per set	5 gms	No need to check weight difference as pistons are serviced as set
Piston pin hole inside diameter	36.998 - 37.003 (limit 37.030)	Bore dial gauge
Gudgeon pin outside diameter	36.989 - 37.00 (limit 36.980)	Micrometer (Push fit in piston heated to 80°C)
Clearance between Piston pin and Piston pin hole	– 0.002 - 0.014 (limit 0.04)	
Small end bush bore	37.015 - 37.025 (limit 37.07)	Bore dial gauge



DESCRIPTION	SPECIFICATION (Measurements in mm)	MEASURING DEVICE AND REMARKS
	HA4CTI3N (BS III)	
Diametral clearance between gudgeon pin and con. rod small end bush bore Max. permissible clearance	0.015 - 0.036 (limit 0.08)	Bore dial gauge and micrometer
Interference fit of small end bush in connecting rod	0.035 - 0.092	Bore dial gauge and micrometer
Connecting rod centre to centre distance	181.480 - 181.520	
Connecting rod bend / twist limit	0.1 per 200	
Connecting rod big end dia	65.985 - 66	
Max. permissible connecting rod weight (gms) Grading	A : 1790 - 1830 B : 1830 - 1870 C : 1870 - 1910 D : 1910 - 1950 E : 1950 - 1990	Grades A, B, C, D, E are punched on big end of the connecting rod. An engine should have connecting rods of same grade.
<b>Crankshaft</b>		
Crankshaft journals and crankpin grinding dimensions	Refer section 16.0.6	Micrometer
Surface hardness of journals and crankpins	269-311 BHN	Hardness Tester. No further heat treatment recommended
Maximum permissible bend at 3rd journal	Refer section 16.0.5 (limit 0.04)	V-Blocks and dial gauge
Journals and crankpins	Refer section 16.0.5	Micrometer
Crankshaft Main Bearing Cap roundness	0.06	
Main and connecting journal sizes	Refer section 16.0.6	(Standard and undersizes)
Crankshaft end play Maximum permissible clearance	0.05 - 0.22 0.4 (limit)	Dial gauge with magnetic stand
Diametral clearance between main journal and bearing Maximum permissible clearance	0.039 - 0.09 0.13 (limit)	Bore dial gauge and micrometer
Main bearing spread	79.00 - 79.60	Vernier Calliper
Connecting rod big end bearings	Refer section 16.0.7	(Standard and undersize)
Connecting rod side clearance	0.20 - 0.52 (limit 0.6)	Feeler gauge
Diametral clearance between Connecting Rod Big End Bearing & Crank pin	0.031 - 0.082 (limit 0.12)	Bore dial gauge and micrometer
Connecting rod Big end ovality/taper	0.06	Bore Dial gauge & Micrometer.
Connecting rod big end bearing spread	67.05 - 67.55	Vernier caliper
Flywheel face out	limit 0.15	Dial gauge with magnetic stand
<b>Cylinder Heads and Valves</b>		
Cylinder head flatness	0.05 (limit 0.1)	Straight edge and feeler gauge
Cylinder head height	87.0 (limit 86.8)	Vernier caliper
Nozzle protrusion from cylinder head surface	2.1 - 2.5	Depth Gauge
Valve sink (Valve head depth below cylinder head face)		Dial gauge
Inlet	0.05 - 0.35	
Exhaust	(-) 0.47 - (-) 0.77	
Valve stem diameter		
Inlet	8.95 - 8.97 (limit 8.9)	Micrometer
Exhaust	8.93 - 8.95 (limit 8.8)	
Intake and Exhaust Valve Guide inner dia	9.000 - 9.015	Internal micro meter



DESCRIPTION	SPECIFICATION (Measurements in mm)	MEASURING DEVICE AND REMARKS
	HA4CTI3N (BS III)	
Diametral valve stem clearance in guide Intake Exhaust	0.035 - 0.068 0.050 - 0.083	Plug gauge and Micrometer
Valve seat angle Intake Exhaust	30° - 30° 15' 45° - 45° 15'	Bevel Protractor (for both inlet and exhaust)
Valve seat seating depth on cylinder head Inlet Exhaust	8.9 ± 0.1 7.3 ± 0.1	
Valve seat thickness Inlet Exhaust	7.5 - 7.7 6.0 - 6.2	
Valve seat seating dia on cylinder head Inlet Exhaust	46.5 (+0.016, - 0.0) 41.0 (+0.10, - 0.0)	
Outer dia of valve seat Inlet Exhaust	46.5 (+0.145 to +0.130) 41.0 (+0.145 to 0.130)	
Valve angle Intake Exhaust	29° 45' - 30° 15' 44° 45' - 45° 15'	Protractor (for both inlet and exhaust)
Valve head diameter: Inlet Exhaust	45.3 - 45.5 39.8 - 40.0	Micrometer.
Maximum permissible out of true head face head to stem	0.03	Lathe and dial gauge
Interference fit of valve guide in cylinder head	0.010 - 0.039	Plug gauge and micrometer
Height of valve guide above spring seat	14.5	
Maximum permissible out of true of valve seat to guide	0.030	
Valve spring straightness	2.0 (limit)	Tri Square
Valve Spring load	26.5 kg @ 45.5 mm (limit 24.6 kg)	Valve spring scale (inlet and exhaust)
Valve lift Intake Exhaust	11.74 mm 13.02 mm	Depth gauge (inlet and exhaust)
<b>Timing</b>		
Rocker arm shaft diameter	18.966 - 18.984	Micro meter
Diametral clearance between rocker lever on rocker shaft	0.036 - 0.079 (limit 0.15)	Micro meter and bore gauge
Push Rod Bend	0.3	Centres and dial gauge
Tappet Diameter	26.95 - 26.97	Micro meter
Tappet guide inside diameter	27.00 - 27.02	Internal micro meter
Diametral tappet clearance in crankcase bore Maximum permissible limit	0.025 - 0.071 0.1 (limit)	Bore dial gauge and micrometer
Camshaft Bend	0.05 (limit)	Dial gauge and V blocks
Camshaft Cam lift (Intake)	6.5213	Vernier height gauge & V blocks
Camshaft Cam lift (Exhaust)	7.2352	Vernier height gauge & V blocks
Camshaft end play	0.10 - 0.18 (limit 0.3)	Dial gauge with magnetic base



DESCRIPTION	SPECIFICATION (Measurements in mm)	MEASURING DEVICE AND REMARKS
	HA4CTI3N (BS III)	
Camshaft Journal Diameter		Micro meter
Journal 1	56.95 - 56.97 (limit 56.85)	
Journal 2	56.75 - 56.77 (limit 56.65)	
Journal 3	56.55 - 56.57 (limit 56.45)	
Camshaft Journal Bearing inside Diameter after pressing the bushes.		Bore dial gauge
Journal 1	57.0 (limit 57.070)	
Journal 2	56.8 (limit 56.870)	
Journal 3	56.6 (limit 56.670)	
Diametral camshaft clearance in bushes Max. permissible clearance	0.03 - 0.12 0.15 (limit)	Internal measuring gauge and micrometer
Idle Shaft Diameter	49.95 - 49.975 (limit 49.94)	Micrometer
Idle Gear bushing inside Diameter	50.00 - 50.025 (limit 50.05)	Internal micro meter
Diametral clearance between Idle Gear shaft and Bush	0.03 to 0.08 (limit 0.1)	Internal measuring gauge and micrometer
Idle Gear end play	0.04 - 0.10 (limit 0.15)	Dial gauge
Tooth Backlash between Crank gear & Idle gear	0.068 - 0.194	Feeler gauge or dial gauge
Tooth Backlash between Idle gear & Oil Pump gear	0.065 - 0.182 (limit 0.3)	Feeler gauge or dial gauge
Tooth Backlash between Injection Pump gear & Idle gear	0.065 - 0.232	Feeler gauge or dial gauge
Tooth Backlash between Cam gear & Oil Pump gear	0.065 - 0.182 (limit 0.3)	Feeler gauge or dial gauge
<b>Engine lubrication</b>		
Max. oil pressure:		
Full-load	4.5 / 4.8 kg/cm <sup>2</sup>	Pressure gauge
Idling	1.2 - 1.6 kg/cm <sup>2</sup>	Pressure gauge
Minimum oil pressure	1.0 kg/cm <sup>2</sup>	
Oil flow rate	21 - 24 ℓ per minute at 4 kg/cm <sup>2</sup> at 1000 rpm	
Valve opening pressure: (Oil filter)		
Release valve	3.7 - 4.3 kg/cm <sup>2</sup>	Hydraulic pump with pressure gauge
By-pass valve for paper element	1.5 kg/cm <sup>2</sup>	
By-pass valve for heat exchanger	1.4 kg/cm <sup>2</sup>	
Oil Pump Gear Height	27.02 to 27.04	
Oil Pump Gear Outer Diameter	49-49.05	
Oil Pump Gear Backlash (Drive & Driven)	0.09 - 0.21 (limit 0.30)	Feeler gauge
Drive Gear shaft Diameter	18.088 - 18.106 (limit 18.060)	Micro meter
Drive shaft Bushing inside Diameter	18.146 - 18.173 (limit 18.20)	Internal micro meter
Clearance between Drive Shaft & Bushing	0.040 - 0.085 (limit 0.1)	Bore dial gauge/Micro meter
Driven Gear shaft Diameter	17.979 - 17.997 (limit 17.970)	Micro meter
Driven Gear Inside Diameter	18.037 - 18.054 (limit 18.070)	Bore dial gauge/Internal micro meter
Clearance between driven gear and shaft	0.040 - 0.075 (limit 0.1)	Dial gauge



DESCRIPTION	SPECIFICATION (Measurements in mm)	MEASURING DEVICE AND REMARKS
	HA4CTI3N (BS III)	
Oil Cooler air pressure testing	6 kg/cm <sup>2</sup>	
<b>Cooling System</b>		
Maximum Permissible coolant temp.	95°C	Temperature gauge
Maximum water pump output	216 lpm @ 0.5 kg/cm <sup>2</sup>	Test tank
Commencement of thermostat opening	82°C ± 2°C	Test tank thermometer & dial gauge
Thermostat working stroke at 95°C	10 mm or more	Test tank thermometer & dial gauge
Cooling System - Capacity (l)	14.5	

<b>16.0.4 Tightening Torques</b>	<b>Kgm</b>	<b>lb.ft</b>	<b>Nm</b>
Liner Pressing Special Tool	5 - 6	36 - 42	49 - 59
Main Bearing Cap Bolts	14 - 16	102 - 115	137 - 157
Flywheel Housing Fitting Bolts	1.9 - 2.6	14 - 18	19 - 26
	11 - 13	80 - 94	108 - 128
Flywheel Fitting Bolts	18 - 20	131 - 144	177 - 196
Connecting Rod Cap Bolts	4 + 68° Angle	29 + 68° Angle	39 + 68° Angle
Timing Gear Plate Bolts	1.9 - 2.6	14 - 18	19 - 26
Oil Pump Assembly Fitting Bolts	1.9 - 2.6	14 - 18	19 - 26
Camshaft Drive Gear Fitting Bolt	11 - 13	80 - 94	108 - 128
Camshaft Thrust Plate Fitting Bolts	1.9 - 2.6	14 - 18	19 - 26
Idler Gear Fitting Bolt	4 + 60° - 65°	30 + 60° - 65°	40 + 60° - 65°
Timing Gear Cover Fitting Bolts	1.9 - 2.6	14 - 18	19 - 26
Crankshaft Pulley Fitting Nut	48 - 57	348 - 412	471 - 559
Oil Strainer Fitting Bolts	1.9 - 2.6	14 - 18	19 - 26
Oil Pan Fitting Bolts	1.9 - 2.6	14 - 18	19 - 26
Oil Pan Drain Plug	4 - 5	29 - 32	39 - 49
FIP Drive gear bolt	3.7 - 4.5	26 - 32	36 - 44
FIP Mounting on Timing Casing	1.9 - 2.6	14 - 18	19 - 26
FIP Fuel Injector Banjo	2.0 - 2.5	15 - 18	20 - 25
Fuel Outlet Orifice Adaptor	2.5 - 3.0	18 - 22	25 - 30
High Pressure Pipe Cap Nut	2.0 - 2.5	15 - 18	20 - 25
Injector Leak of Pipe Screws	0.5 - 0.7	3.7 - 5	5 - 7
Air Compressor Fitting Bolts	4.5 - 5.0	33 - 36	44 - 49
Alternator Bracket	4.5 - 5.0	33 - 36	44 - 49
Alternator Supporting Bolt & Nut.	4.5 - 5.0	33 - 36	44 - 49
Fan Belt Adjusting Bracket	4.5 - 5.0	33 - 36	44 - 49
Water Jacket Elbow	4.5 - 5.0	33 - 36	44 - 49



Tightening Torques	Spanner Size	Kgm	lb.ft	Nm
Water Drain Plug on Elbow		4.5 - 5.0	33 - 36	44 - 49
Oil filter Drain Plug		5.5 - 6.2	40 - 45	54 - 61
Centre Bolt - Oil Filter		4 - 5	29 - 32	39 - 49
Oil Cooler Element Fitting Nuts		1 - 1.5	8 - 10	10 - 15
Oil Cooler Assembly Fitting Bolts		1.9 - 2.6	14 - 18	19 - 26
Water Pump Assembly Fitting Bolts		1.9 - 2.6	14 - 18	19 - 26
Water Pump Pulley Bolt		1.9 - 2.6	14 - 18	19 - 26
Fan to Spacer Bolts		2.0 - 3.0	15 - 21	20 - 29
Cooling Fan Fitting Bolts		1.5 - 2.2	11 - 16	15 - 22
Cylinder Head Bolts (M12 – IMF side)	7.14-7.34+86°-88°angle	51.66-53.136+86°-88°angle	70-72+86°-88° angle	
Cylinder Head Bolts (M12 – EMF side)	7.14-7.34+92°-94°angle	51.66-53.136+92°-94°angle	70-72+92°-94° angle	
Cylinder Head Bolts (M10)		4.5 - 5.0	33 - 36	44 - 49
Rocker Shaft Locking Bolts		0.6 - 0.7	4 - 5	6 - 7
Rocker Shaft Assembly Fitting Bolts		1.9 - 2.6	14 - 18	19 - 26
Rocker Shaft Assembly Main Bolts		13 - 14	94 - 102	128 - 137
Rocker Arm Adjusting Screw Nuts		1.9 - 2.6	14 - 18	19 - 26
Thermostat Case & Cover	4.5 - 5.0 1.9 - 2.6	33 - 36 14 - 18	44 - 49 19 - 26	
Injector Holder Fitting Nuts		1.3 - 1.9	10 - 13	13 - 19
Glow Plugs Fitting Nuts		2.25 - 2.75	17 - 19	22 - 27
Flare Nuts on Injector Pipes		1.5 - 2.5	11 - 18	15 - 25
Injector Pipe Clip fasteners		0.5 - 1.0	3.7 - 7.2	5 - 10
Exhaust Manifold		4.5 - 5.0	33 - 36	44 - 49
Inlet Manifold Fitting Bolts		1.9 - 2.6	14 - 18	19 - 26
Cylinder Head Cover Bolts		1.3 - 1.8	10 - 13	13 - 18
Boost Sensor Screw		0.25 - 0.35	1.8 - 2.6	2.5 - 3.5
Speed Sensor Screw		0.6 1.0	4 - 7.2	6 - 10
Water Temperature Sensor		2.0 - 2.4	15 - 17.7	20 - 24
Speed Sensor Holder		1.3 - 1.9	10 - 13	13 - 19

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### 16.0.5 Crank Shaft Main Journals and Crank Journals Dimensions.

DESCRIPTION	mm
1. Std diameter of main journals	72.94 - 72.96
2. Std diameter of conrod journals	61.94 - 61.96
3. Fillet Radius main journal	3.00 - 3.50
4. Con. rod journal fillet radius	3.75 - 4.2.5
5. Wear limits	
Taper (across total width)	0.1
Ovality	0.1
Bend	0.04
Wear limit	0.2
Concentricity	0.03
Maximum permissible out of round	0.02
6. Available under sizes (only 4 under sizes)	0.25/0.50/0.75/1.00

### 16.0.6 Main and Crank Journals Grinding Sizes

Under size mm	Crank pin mm	Main Journal mm
0.25	61.69 - 61.71	72.69 - 72.71
0.50	61.44 - 61.46	72.44 - 72.46
0.75	61.19 - 61.21	72.19 - 72.21
1.00	60.94 - 60.96	71.94 - 71.96



Correct by regrinding if worn unevenly more than 0.10 mm  
Regrind if the wear is more than 0.2 mm  
Replace crankshaft if wear is more than 1.2 mm

### 16.0.7 Connecting Rod Big End Bearing Shell Sizes (Thickness)

Under size (mm)	Thickness (mm)	Tolerance
STANDARD	2.00	-0.003 To -0.013
0.25	2.125	- do -
0.50	2.250	- do -
0.75	2.375	- do -
1.00	2.500	- do -

### 16.0.8 Crankcase Parent Bore and Cylinder Liner Outer Dia

Crankcase Parent Bore		Cylinder Liner Outer Dia	
Grade	Size (mm)	Grade	Size (mm)
W	107 + 0.0060 + 0	W	107 + 0.011 + 0.005
X	107 + 0.0125 + 0.0060	X	107 + 0.011 + 0.018
Y	107 + 0.0190 + 0.0125	Y	107 + 0.024 + 0.018
Z	107 + 0.0250 + 0.0190	Z	107 + 0.030 + 0.024



Interchangeability is allowed w.r.t. next oversize or undersize liners.

Only Multi Layered Gasket (MLS) should be used along with Mild Interference Liners (MIF).

**16.0.9 Fuel Oil (High Speed Diesel)**

Users are recommended to obtain their fuel supplies from a source which can be depended upon to maintain a consistent standard of quality and service.

Fuel should be free from water and dirt, care should be taken by the user to protect fuel from contamination.

**16.0.9.0 Fuel Specifications - as per IS 1460 : 2000 - Bharat Stage III**

i).	Acidity, inorganic	...	Nil
ii).	Acidity, total mg.of KOH/g (Max.)	...	0.20
iii).	Ash, percent by Mass (Max.)	...	0.01
iv).	Carbon residue (Ramsbottom) on 10 percent residue, percent by Mass, Max	...	0.30
v).	Cetane Number (Minimum)	...	51
vi)	Cetane index (Minimum)	...	46
vii).	Pour point (Max.)	...	3°C for Winter & 15°C for Summer
viii).	Copper Strip Corrosion for 3 hours @ 100°C., Max., rating	...	Not worse than No.1
ix).	Distillation, percent v/v, recovered:		
	a) at 350°C, Min	...	85
	b) at 370°C, Min	...	95
x).	Flash point (Min.)		
	a) Abel, °C, Min	...	35
	b) Pensky-Martens, °C, Min	...	66
xi.	Kinematic viscosity, cSt, @ 40°C	...	2.0 to 4.5
xii.	Sediment, percent by mass (Max.)	...	0.05
xiii.	Density; at 15°C., kg/m <sup>3</sup>	...	820 - 845
xiv.	Total Sulphur, percent by mass (Max.)	...	0.035
xv.	Water content percent by mass (Max.)	...	0.020
xvi.	Cold Filter Plugging Point (CFPP) max	...	6°C for Winter and 18°C for Summer
xvii.	Total Sediments mg per 100 ml. (max)	...	1.6
xviii.	Total contaminations (Particulate matter) mg/kg. (max)	...	24
xix.	Oxidation stability, g/m <sup>3</sup> , (max)	...	25
xx.	Polycyclic Aromatic Hydrocarbon (PAH), percent by mass, Max	...	11
xxi.	Lubricity, corrected wear scar diameter (wsd) 1.4) at 60°C, microns, Max	...	460





## 16.0.10 Recommended coolant & Lubricants

### 16.0.10.0 Recommended Coolant

Ashok Leyland Specification	Ambient Temp.	Gulf Oil India	Indian Oil Corporation	Change Period (kms)
JIS K 2234 -94 Class 2 and Plus	>-35°C	Eurocool LL MAX 50	Servo Kool ALT 50	Every 200000 kms or 2 years whichever is earlier



For topping up use only Gulf Eurocool LL Max 50 or Servo Kool ALT 50 directly. Do not dilute with plain or demineralised water for top up.

### 16.0.10.1 Recommended Lubricants

Use of correct grades of lubrication is most important to prevent the wear and tear of components. The chart shows the oil grade recommended by AL.

Aggregate	Ashok Leyland Specification	Ambient Temp. °C	Co-branded Lubricant	Approved Lubricant	Change Period (Every km)
			Gulf Oil India	Indian Oil Corporation	
Bharat Stage III Diesel Engines	API CH-4 + MB 228.3 + VDS 2	-15 and above	Superfleet LE Max SAE 15W-40	Servo Pride ALT 15W-40	For longhaul operation - Oil change at every 16000 km For Tipper - 10000 km or 250 hrs. of operation whichever is earlier.

### 16.0.11 Filling Capacity

Aggregates	Qty (l)
Engine (Including Oil Filter)	12.5



### 16.0.12 Liquid Gasket and Application Points

Use liquid gasket (Anabond 673/Loctite 587) instead of conventional sheet gaskets. The following are the liquid gasket application points.

#### Liquid gasket application points and coating width

Parts Name	Application	Coating width
a) Oil pan	Flange face which mate with cylinder block, timing gear cover and flywheel housing	1.5 - 2.5 mm
b) Timing gear cover	Faces which mates with timing gear plate (flange face, boss face)	1.5 - 2.5 mm
c) Flywheel housing	Faces which mate with cylinder block (flange face, boss face)	1.5 - 2.5 mm
d) Coolant pump	Flange face which mates with timing gear cover	1.5 - 2.5 mm
e) Thermostat case	Flange face which mates with cylinder head	1.5 - 2.5 mm
f) Intake manifold	Flange face which mates with cylinder head	1.5 - 2.5 mm
f) Turbo oil drain pipe	Flange face which mates with cylinder block	1.5 - 2.5 mm
g) Camshaft end plate	Flange face which mates with cylinder block	1.5 - 2.5 mm

#### Coating Liquid Gasket and parts Assembly Procedure

1. Completely remove old liquid gasket from each part and the respective mating part, and remove oil, water, and dirt using cloth.
2. Be careful not to apply excessive or insufficient liquid gasket. Also, be sure to overlap the start and end of each coating.
3. When assembling coated parts, be careful that there is no misalignment between mating parts. If there is any misalignment, coat the parts again.
4. Assemble the various parts within 20 minutes after applying liquid gasket. If more than 20 minutes have elapsed, remove the liquid gasket and apply it again.
5. After assembling the various parts wait for at least 15 minutes before starting the engine.

#### Applicator Gun

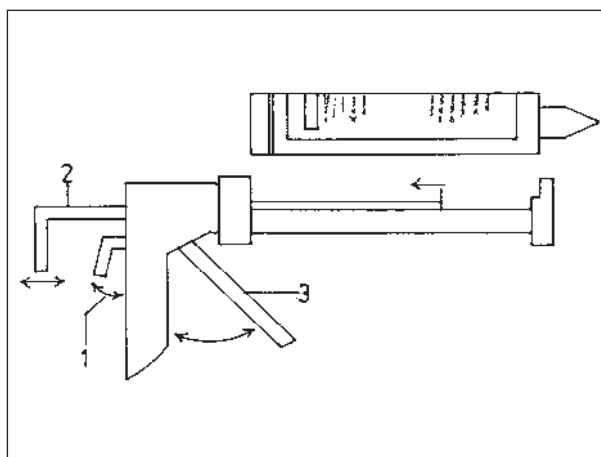


Fig. 2

#### Loading Cartridge

Press lever 1 and simultaneously pull lever 2 back completely. Insert the cartridge. The open cartridge can be dispensed by pressing lever 3.

#### Unloading Cartridge

Press lever 1 and simultaneously pull lever 2 back completely - Remove cartridge from the gun.



### 16.0.13 Description of Leading Engine Components

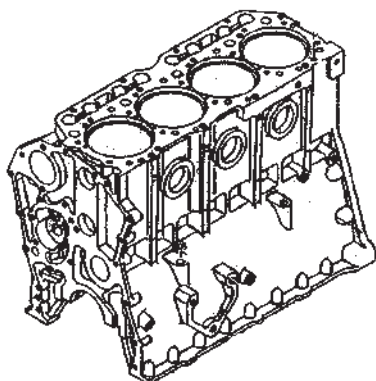


Fig. 1

**Cylinder Block** - Made of high grade cast iron. Cylinders and the crankcase form an integral casting. The crankcase is enclosed from below by the oil sump. **Fig. 1**

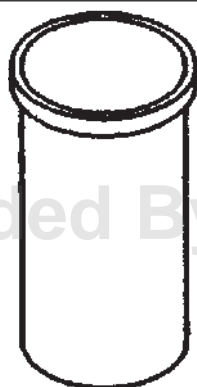


Fig. 1A

**Cylinder Liners** (dry, pre finished, hard, easy fit type) - Mild Interference Fit Liner is made of cast iron. There are four selectable sizes available i.e. W, X, Y, Z based on liner outer diameter. **Fig. 1A**

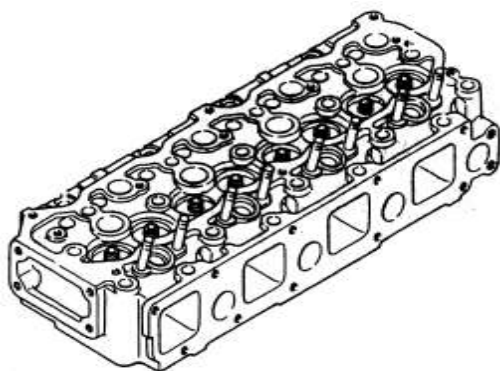


Fig. 2

**Cylinder Head** - made of high-grade cast iron, accommodating all cylinders, fitted with exchangeable, pre finished valve seats and valve guides. **Fig. 2**

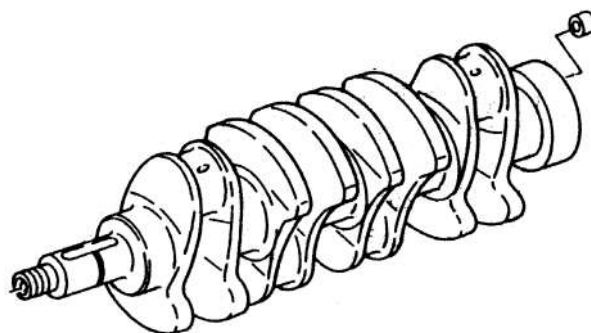


Fig. 2A

**Crankshaft** - an alloy steel forging, mounted in five bearings with exchangeable shells. The main journals and crank-journals are induction hardened. **Fig. 2 A**

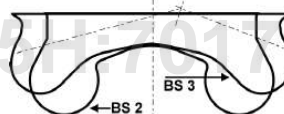


Fig. 3

**Alfin Pistons** - made of special grade aluminium alloy with cast iron insert to form the first compression ring seat. The combustion chamber design is shallow type for better combustion efficiency and reduction in soot emissions. **Fig. 3**

**Main and Small - End Bearing Shells** - thin-walled, with aluminium and tin or lead bronze linings for sliding surfaces.

**Camshaft** - made of steel, mounted in the cylinder block in three exchangeable bearing bushes. Drive is supplied from the engine crankshaft through a gear train.

**Valves** - made of high-grade alloy steel. Valve stem seals prevent oil leakage into combustion chamber.

**Timing Gear Train** - higher drive torque requirement of VE pump, wider gears are provided for crank gear, idler gear and FIP gear.

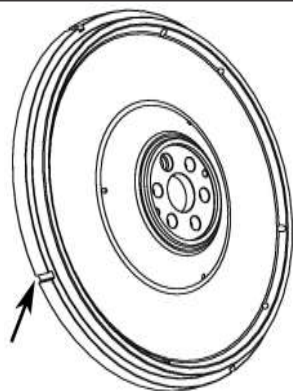


Fig. 4

**Flywheel** - machined with 4 slots on the periphery to facilitate engine speed sensing by engine speed sensor. These slots are equispaced and dimensions are controlled to achieve perfect speed pulse output waveform from the speed sensor. **Fig. 4**

**Flywheel housing** - fitted with sensor mounting holder facilitates fitment of engine speed sensor over the flywheel for engine speed sensing. Aluminium is used for the holder as a non-magnetic base is required for the magnetic pulse pickup to avoid signal disturbances.

**Valve Spring** - made of spring steel, constant pitch coil type springs.

**Electronic Control Unit (ECU)** : The ECU is the heart of the system that compares the requirements thru sensors and the accelerator pedal movement with the fuel mappings already stored in the ECU and decides on the fuel delivery. It operates on 12V DC.

**VP37 EDC Rotary Distributor Fuel Injection Pump:**

This pump is mechanically driven and electronically controlled by ECU. Output signals from ECU triggers the governor there by controls the quantity of fuel injected and the start of injection.



Fig. 5

**Engine Coolant temperature sensor** : It is a thermistor, mounted on coolant return line from cylinder head. It measures the engine operating temperature. **Fig. 5.**

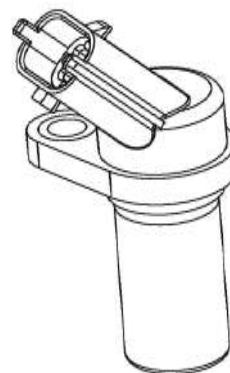


Fig. 6

**Engine speed sensor** : Engine speed sensor is an inductive type sensor. It is mounted on the flywheel housing. Electric pulses are generated when the formed slots on the flywheel pass thro the sensor axis. The Electric pulse - Frequency (Sine Wave) generated by the sensor is proportional to the engine speed. **Fig. 6**

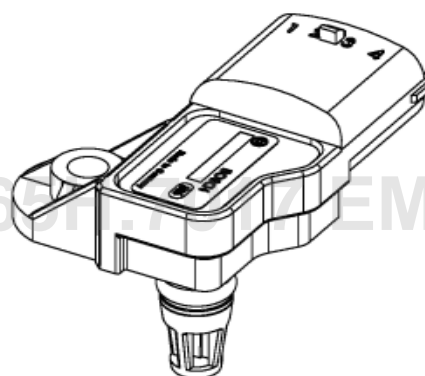


Fig. 7

**Engine Boost Pressure Sensor** : Engine Boost Pressure sensor is mounted on the intake manifold to measure the absolute intake manifold pressure. **Fig. 7**

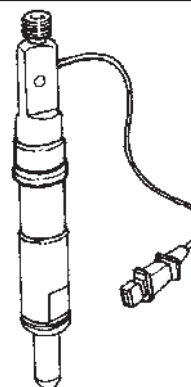


Fig. 8

**Needle Movement Sensor (1st cylinder instrumented injector)** : 1st cylinder injector is integrated with a needle movement sensor and it is used for finding the start of injection. **Fig. 8**



## 16.0.14 Trouble shooting

### 16.0.14.0 Engine

Symptom	Possible Cause	Remedy/Prevention
Engine overheating	<b>Coolant</b> <ul style="list-style-type: none"><li>* Insufficient coolant</li><li>* Defective thermostat</li><li>* Overflow of coolant due to leakage of exhaust into cooling system</li><li>* Coolant leakage from cylinder head gasket</li><li>* Defective coolant pump</li></ul>	Add coolant Replace the thermostat Repair Replace gasket. Repair or replace.
	<b>Radiator</b> <ul style="list-style-type: none"><li>* Clogged with rust and scale</li><li>* Clogged with iron oxide due to leakage of exhaust into cooling system</li><li>* Clogged radiator core due to mud or other debris</li><li>* Defective radiator cap pressure valve</li><li>* In correct gap between radiator and fan</li><li>* Deration pipes blocked due to mud</li><li>* CAC &amp; Radiator fins out side for dust deposit.</li><li>* Working of thermo sensing fan</li></ul> <b>Abnormal combustion</b> <ul style="list-style-type: none"><li>* Reduced injection pressure</li><li>* Poor fuel</li><li>* Poor nozzle spray</li></ul> <b>Other problems</b> <ul style="list-style-type: none"><li>* Defective or deteriorated engine oil</li><li>* Unsatisfactory operation of oil pump</li><li>* Insufficient oil</li><li>* Brake drag</li></ul>	Clean radiator. Clean coolant passage and correct exhaust leakage. Clean radiator. Replace radiator cap Correct the gap Clean and use coolant. Clean. Check and correct. Adjust injection pressure. Use good quality fuel. Adjust or replace nozzle. Change engine oil. Replace or repair Add oil. Repair or adjust.
Excessive oil consumption	<b>Piston, cylinder liners and piston rings</b> <ul style="list-style-type: none"><li>* Wear of piston ring and cylinder liner</li><li>* Worn, sticking or broken piston rings</li><li>* Insufficient tension on piston rings</li><li>* Unsuitable oil (viscosity too low)</li><li>* Incorrectly fitted piston rings (upside down)</li><li>* Gaps of piston rings in line with each other</li></ul> <b>Valve and valve guides</b> <ul style="list-style-type: none"><li>* Worn valve stream</li><li>* Worn valve guide</li><li>* Incorrectly fitted valve stem seal</li><li>* Excessive lubricant on rocker arm</li></ul>	Replace piston rings and cylinder liner. Replace piston rings and cylinder liner. Replace piston rings and cylinder liner. Change oil as required and replace piston rings and cylinder liners. Replace piston rings. Reassemble piston rings. Replace valve and valve guide Replace valve guides. Replace the stem seal. Check clearance of rocker arm and shaft.



Symptom	Possible Cause	Remedy/Prevention
<b>Excessive oil consumption</b>	<b>Excess oil feed</b> <ul style="list-style-type: none"> <li>* Defective oil level gauge</li> <li>* Oil level too high</li> </ul> <b>Other problems</b> <ul style="list-style-type: none"> <li>* Overcooled engine (low temperature wear)</li> <li>* Oil leakage from miscellaneous parts</li> </ul>	Replace oil level gauge Drain excess oil.  Warm up engine before moving vehicle. Check cooling system. Repair.
<b>Piston seizure</b>	<b>Operation</b> <ul style="list-style-type: none"> <li>* Abrupt stoppage of engine after running at highspeed</li> <li>* Hill climbing using unsuitable gear</li> </ul> <b>Oil</b> <ul style="list-style-type: none"> <li>* Insufficient oil</li> <li>* Dirty oil</li> <li>* Poor quality oil</li> <li>* High oil temperature</li> <li>* Defective oil pump</li> <li>* Reduced performance due to worn oil pump</li> <li>* Suction strainer sucking air</li> </ul> <b>Abnormal combustion</b> <b>Coolant</b>	Operate engine properly.  Select suitable gear  Add oil. Change oil. Replace with proper engine oil. Repair Repair oil pump. Repair oil pump. Add oil and/or repair strainer.  See symptom:"Engine overheating"  See symptom:"Engine overheating"
<b>Lack of power</b>	<b>Intake</b> <ul style="list-style-type: none"> <li>* Clogged air cleaner</li> </ul> <b>Fuel and nozzle</b> <ul style="list-style-type: none"> <li>* Poor nozzle spray</li> <li>* Clogged nozzle with carbon</li> <li>* Wear or seizure of nozzle</li> <li>* Air in fuel system</li> <li>* Clogged fuel filter</li> <li>* Use of poor fuel</li> </ul> <b>Abnormal combustion</b> Accelerator pedal not travelling fully. Piston, cylinder liners and piston rings  <b>Other problems</b> <ul style="list-style-type: none"> <li>* Breakage of turbine or blower</li> <li>* EDC system defective</li> </ul>	Clean element or replace element.  Adjust or replace injection nozzle Clean nozzle Replace nozzle Repair and bleed air from fuel system. Replace element Use good quality fuel.  See symptom:"Piston Seizure"  Correct the setting.  See symptom."Excessive Oil Consumption"  Repair Use diagnostic tool for trouble shooting and rectify.



Symptom	Possible Cause	Remedy/Prevention
<b>Difficult starting engine</b>  system.           pinion.	<b>Electrical system</b> <ul style="list-style-type: none"> <li>* Discharged battery</li> <li>* Defective wiring in starter circuit</li> <li>* Loose or open-circuit battery cable</li> </ul> <b>Injection pump</b>  <b>Air cleaner</b> <ul style="list-style-type: none"> <li>* Clogged element</li> </ul> <b>Fuel system</b> <ul style="list-style-type: none"> <li>* No fuel in tank</li> <li>* Clogged fuel line</li> <li>* Air sucked into fuel system through fuel line connections.</li> <li>* Clogged fuel filter</li> <li>* Loose connection in high-pressure line</li> <li>* Water in fuel</li> </ul> <b>Nozzle</b> <ul style="list-style-type: none"> <li>* Seized nozzle</li> <li>* Broken or fatigued nozzle spring</li> </ul> <b>Oil system</b> <ul style="list-style-type: none"> <li>* Oil viscosity too high</li> </ul> <b>Other problems</b> <ul style="list-style-type: none"> <li>* Seized piston</li> <li>* Seized bearing</li> <li>* Reduced compression pressure</li> <li>* Ring gear damaged or worn</li> <li>* Check relays and fuses of EDC system</li> </ul>	Charge battery Repair wiring of starter. Tighten battery terminal connections or replace battery cable. Repair  Clean the element or replace the element.  Supply fuel and bleed air from fuel  Clean fuel line. Tighten fuel line connections.  Replace element Tighten sleeve nut of high pressure line. Drain and clean fuel system  Replace nozzle Replace spring  Use proper viscosity oil, or install an oil immersion heater and warm up oil.  Replace piston, piston rings ,and liner. Replace bearing and /or crankshaft overhaul engine Replace the ring gear and/or starter  Replace defective parts.
<b>Rough idling</b>	<b>Injection pump</b>  <b>Nozzles</b> <ul style="list-style-type: none"> <li>* Uneven injection pressure</li> <li>* Poor nozzle spray</li> <li>* Carbon deposit on nozzle tip</li> <li>* Seized needle valve</li> </ul> <b>Engine</b> <ul style="list-style-type: none"> <li>* Improper valve clearance</li> <li>* Improper contact of valve seat</li> <li>* Idling speed too low</li> <li>* Compression pressure of cylinders markedly different from one another</li> </ul>	Repair  Adjust Adjust or replace nozzle. Remove carbon Replace nozzle  Adjust valve clearance Replace or repair valve and valve seat. Warm up engine. Overhaul engine





Symptom	Possible Cause	Remedy/Prevention
Leakage of exhaust	<b>Cylinder head gasket</b>	
	* Fatigued gasket (aging)	Replace gasket
	* Damage	Replace gasket
	* Improper installation	Replace gasket
	<b>Cylinder head bolts</b>	
	* Loose bolts	Tighten bolt
	* Elongated bolts	Replace bolt
	* Improper tightening torque of tightening sequence	Tighten properly
	<b>Cylinder block</b>	
	* Cracking	Replace cylinder block
	* Surface distortion	Repair or replace.
	* Fretting of cylinder liner insertion portion (in sufficient projection of cylinder liner)	Replace cylinder lines or cylinder block
	<b>Cylinder head</b>	
	* Cracking	Replace cylinder head
	* Surface distortion	Repair or replaces.
	<b>Cylinder liners</b>	
	* Cracking	Replace cylinder liner
	* Corrosion	Replace cylinder liner
	* Insufficient projection of cylinder liner	Replace cylinder liner
	<b>Other problems</b>	
	* Incorrect injection timing	Adjust injection timing.

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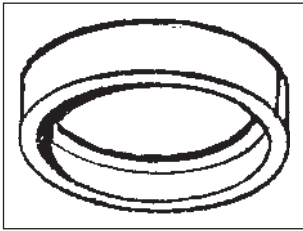
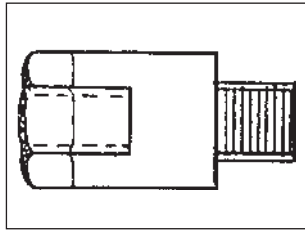
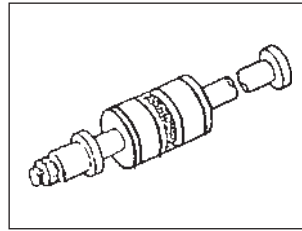
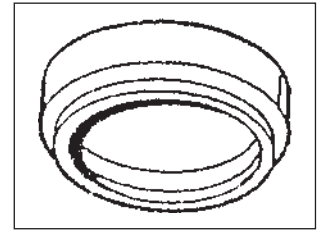
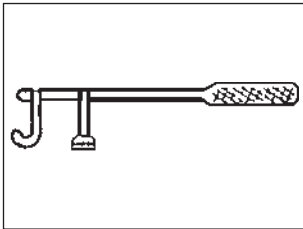
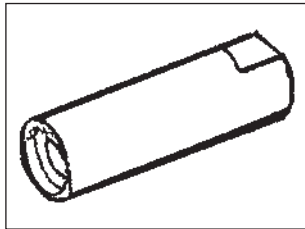
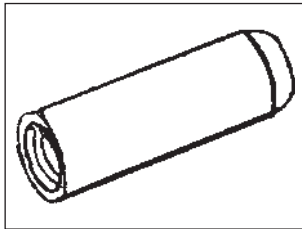
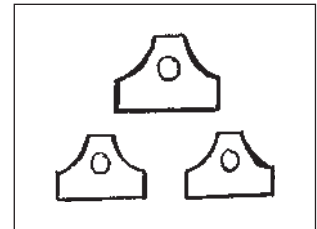
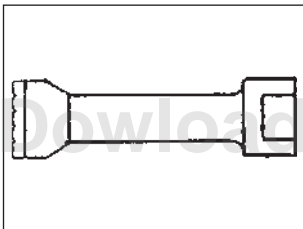
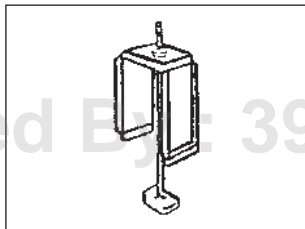
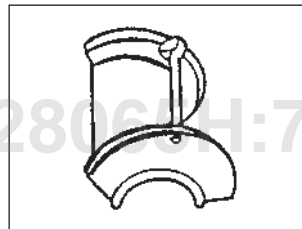
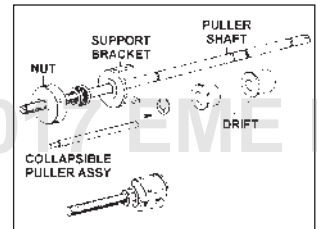
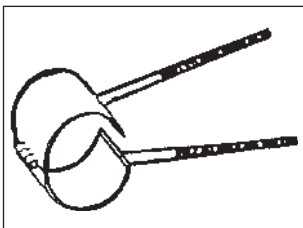
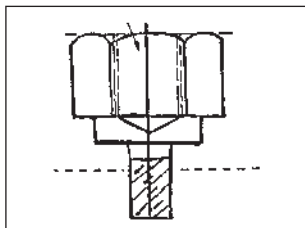
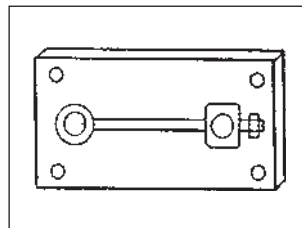
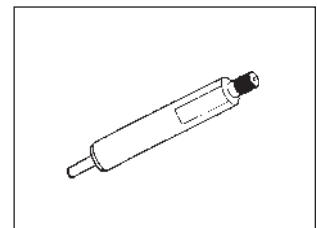
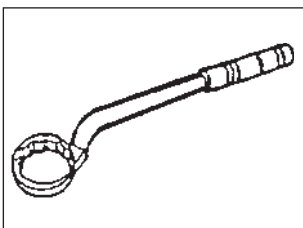
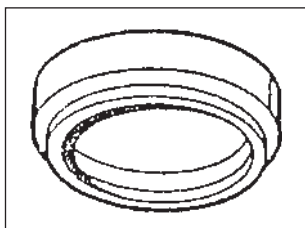
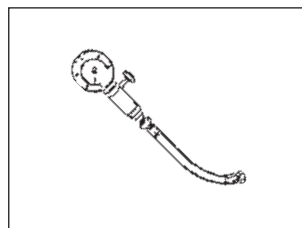


16.0.14.1 Fuel Injection Pump

Symptom	Possible Cause	Remedy/Prevention
Engine does not start	<b>Fuel not reaching injection pump</b> <ul style="list-style-type: none"><li>* Fuel lines clogged or damaged</li><li>* Fuel filter clogged</li><li>* Air in fuel caused by improper connections of fuel line between fuel tank and feed pump.</li><li>* Filter incorporated in inlet side of feed pump clogged</li><li>* Faulty feed pump check valve</li><li>* Feed pump piston spring broken</li><li>* Feed pump push rod or tappet sticking</li></ul> <b>Nozzle faulty</b> <ul style="list-style-type: none"><li>* Fuel leakage caused by loosened nozzle holder.</li><li>* Low opening pressure of nozzle</li><li>* Nozzle pressure spring broken</li><li>* Nozzle needle sticking to nozzle body</li></ul> <b>Pump out of timing</b> <ul style="list-style-type: none"><li>* Improper pre-stroke adjustment</li></ul>	<p>Clean or replace fuel lines.</p> <p>Clean or replace the filter elements.</p> <p>Repair connections.</p> <p>Remove foreign material.</p> <p>Repair or replace it.</p> <p>Replace it.</p> <p>Repair or replace it.</p> <p>Inspect and tighten it.</p> <p>Adjust it.</p> <p>Replace it.</p> <p>Correct or replace it.</p> <p>Correct it to obtain specified injection timing.</p>
Excessive smoke	<b>Black smoke</b> <ul style="list-style-type: none"><li>* Bad nozzle fuel spray characteristics</li><li>* Faulty booster sensor</li></ul> <b>White smoke</b> <ul style="list-style-type: none"><li>* Water in fuel</li><li>* Faulty coolant temperature sensor</li><li>* Fuel starvation</li></ul>	<p>Check and correct them.</p> <p>Check and replace.</p> <p>Check and clean fuel lines.</p> <p>Check and replace.</p> <p>Check and correct.</p>
Engine always runs at high speed	Accelerator pedal sensor sticky	Check and replace.
Engine starts and stops	Fuel lines clogged Air in fuel caused by damaged fuel lines of improper connection of fuel lines.	<p>Clean or replace fuel lines.</p> <p>Repair fuel lines or replace fuel lines and gaskets.</p>
Engine has low power	<b>Pump</b> <ul style="list-style-type: none"><li>* Feed pressure too low</li><li>* EDC system faulty</li></ul> <b>Nozzle faulty</b> <ul style="list-style-type: none"><li>* Fuel leakage from nozzle holder</li><li>* Bad nozzle spray characteristic</li></ul>	<p>Repair the feed pump.</p> <p>Check with diagnostic tool and rectify.</p> <p>Check and repair nozzle holder.</p> <p>Repair or replace it.</p>
Loud knocking	<ul style="list-style-type: none"><li>* Bad fuel nozzle spray pattern.</li><li>* High nozzle opening pressure</li></ul>	<p>Check and correct it.</p> <p>Adjust the opening pressure.</p>



## 16.0.15 Special Tools

Special Tool 0102001  
Drift Oil Seal Gear CaseSpecial Tool 0102002 Adaptor  
Idler Gear ShaftSpecial Tool 0102003  
Sliding HammerSpecial Tool 0102004  
Drift (I) Oil Seal Fly Wheel  
HousingSpecial Tool 0102005  
Compressor Valve SpringSpecial Tool 0102006  
Drift Valve stem SealSpecial Tool 0102009  
Drift Valve GuideSpecial Tool 0102013  
Retainer Cylinder LinerSpecial Tool 0102010  
Wrench Cylinder Head BoltSpecial Tool 0102011  
Extractor Cylinder LinerSpecial Tool 0102012  
Guide Cylinder LinerSpecial Tool 0102018  
Drift and Extractor  
Cam BushesSpecial Tool 0102014  
Compressor Piston RingSpecial Tool 0102015  
Adaptor Injector RemovalSpecial Tool 0102017  
Drift & Extractor  
Connecting rod BushesSpecial Tool 0102023  
Adapter Engine  
CompressionSpecial Tool 0102019  
Wrench Engine CrankingSpecial Tool 0102020  
Drift-II Oil Seal  
Flywheel HousingSpecial Tool 0102021  
Gauge Compression  
Checking



## 16.0.16 Factors Which Determine When an Engine Overhaul is Needed

The following factors determine the engine condition and the necessity of engine overhauling.

### 1. Low compression pressure.

Follow the procedure given below for measuring engine compression pressure.

#### a. Before the measurement

Warm up the engine to operating temperature (bring the coolant temp to about 80°C)

Check and correct valve clearance.

Charge the battery fully.

#### b. Measurement

Remove the nozzle holder.



Fig. 1

Install the gauge adapter (Special Tool 0102023) in the nozzle holder and connect compression gauge (Special Tool 0102021). **Fig. 1**

Keep the EDC reset switch in "OFF" position.



Fig. 2

Crank the engine with the starter motor (ensure min. cranking speed of 280 rpm).

The gauge needle will start rising. Cranking should be continued until the needle in the gauge stops, without any further rising.

Note the reading. Loose gauge vent knob to ensure the needle returns to zero. **Fig. 2**

Repeat the procedure to the remaining cylinders.

Low compression pressure may be due to leakage past / thru piston rings / valves / blown cylinder head gasket.

To find out the exact point of leakage, a small amount of engine oil may be sprayed into the cylinder through nozzle hole and recheck the compression pressure.

If the compression pressure increases, wear in piston rings/cylinder bore is indicated. If it does not, leak is through the valves.

If compression pressure of adjacent cylinder is on lower side it may be due to cylinder head gasket.



**Do not continuously operate the starter for more than 15 seconds at a time.**

Measure the compression pressure for each cylinder. If the compression pressure is low, be sure to repeat the measuring.



**Make sure no leakage through the sealing face.**

### C. Compression pressure (Recommended Values)

Minimum : 24 kg/cm<sup>2</sup> @ 280 rpm

Maximum : 29 - 32 kg/cm<sup>2</sup> @ 280 rpm

Pressure difference between each cylinders should be below 3 kg/cm<sup>2</sup>

### 2. Low oil pressure

Check the oil pressure warning lamp when the oil and coolant temperature is hot and at about 80°C.

- If the warning lamp is lighted , check the oil level.
- Check oil deterioration. If oil quality is poor, replace with a suitable grade oil.
- Measure the oil pressure at coolant temperature about 80°C.

Standard oil pressure for Turbo engines

Idling	: 1.0 kg/cm <sup>2</sup>
Max.	: 4.8 kg/cm <sup>2</sup>

### 3. Other factors

- Blow by gas increases.
- Engine does not start easily.
- Engine output decreases.
- Fuel consumption increases.
- Engine makes greater noise.
- Excessive oil consumption.



## 16.1 To Remove and Refit Engine from Vehicle

### 16.1.0 To Remove Engine

- Disconnect battery terminals and choke the wheels.
- Drain engine oil
- Drain the coolant and remove cooling system, radiator, pipes, hoses etc.
- Disconnect all the connections from the sensors and FIP (governor, timer and electrical shut off) boost sensor, engine speed sensor, water temperature sensor and 1st injector sensor from the engine. **Remove above all sensors and keep them safely away from dust and water.**
- Remove air intake system, turbo connection, charge air cooler, exhaust system and fuel pipe connections,
- Disconnect the clutch / gear linkage system.
- Remove gear box and clutch.
- Unscrew engine fixing bolts of the engine mounting pad.
- Fasten hoisting cable to the lifting eyes on right front and left rear of engine.

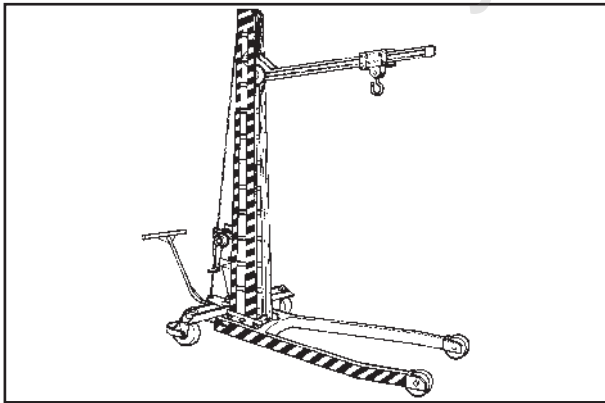


Fig. 1

- Use multipurpose jip crane SME 11001 to lift the engine. **Fig - 1**
- Lift the engine slightly and move it outwards.
- Place the engine on suitable platform keeping in mind that the oil sump is not damaged.

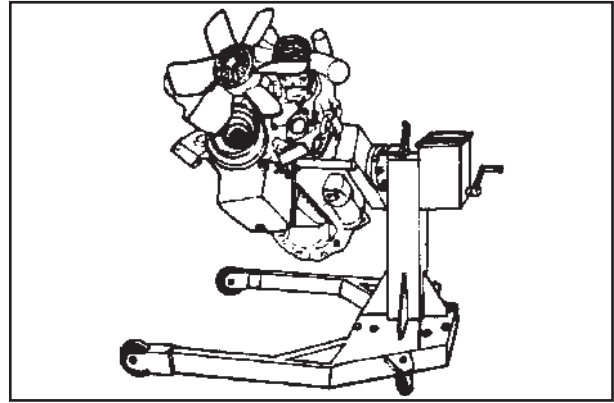


Fig. 2



**Use Engine stand of proper dimensions to keep the engine or use Special Maintenance Equipment, SME No. 01006. Fig - 2**

- Engine should be thoroughly washed with a suitable cleaning liquid before it is dismantled.
- Dismantling and assembly should be carried out by experienced personal and utmost cleanliness must be observed. Special tools manufactured for this purpose to be used.

### 16.1.1 To Refit Engine

- The above mentioned procedure to be followed in reverse order.
- Ensure the alignment of the engine in the exact centre of the chassis frame.
- Before initial starting of the engine, check whether, engine injection pump, governor, gear box and cooling system have been filled with lubricants and coolants according to specifications.
- Ensure proper matching of connectors with respective sensors and FIP equipments.



## 16.2 Crankcase

### 16.2.0 To Remove and Refit Cylinder Liners

Use Special Tool 0102011 - Extractor Cylinder Liner for removal of cylinder liners.

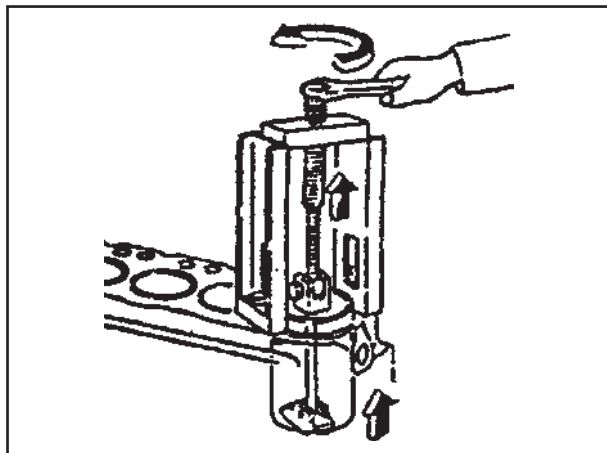


Fig. 1



Liners are of transition fit type. Special tool to be used only when liner removal is difficult. Fig - 1.

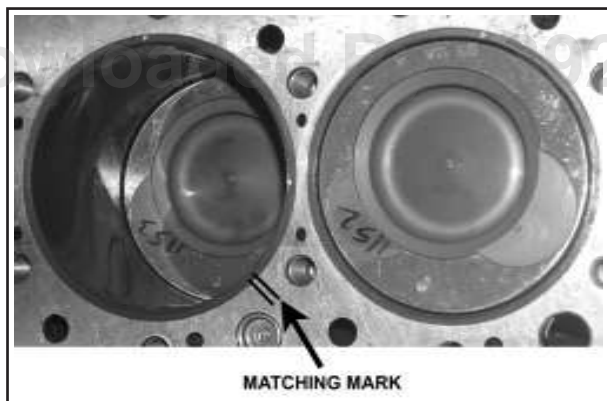


Fig. 2

Incase you want to reuse the liner be sure to put matching marks with marker pen on the cylinder block and liner flange for repositioning. **Fig - 2**

After removing the cylinder liners, put numbers on their periphery or arrange them in sequence.

Make sure that the liner grade mark has the same mark on the cylinder block.

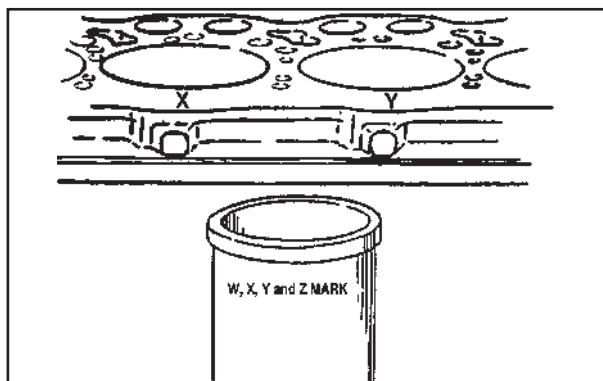


Fig. 3

There are 4 different grades of liners and cylinder block matches. Each liner has any one of the following markings W, X, Y or Z of the OD. These indicate the size of the O.D. of the liner.

Similarly, the matching I.D. markings of the cylinder bore is indicated by W, X, Y or Z on crank case LH side top for each Bore. **Fig - 3**



Fig. 4

Apply a small amount of clean engine oil on the outer periphery of liner. The special tool should be used as liner is extremely thin and can easily get damaged. Thin and sharp ring on the top face of the liner is called "FLAME ARRESTER". Any damage to this flame arrester ring can cause cylinder head gasket failures. When reusing a liner, insert the liner in its original position aligning the markings marked before disassembly. Use Special Tool 0102012 - Guide Cylinder Liner. **Fig - 4**



Only Multi Layered Gasket (MLS) should be used along with Mild Interference liners (MIF).



Measure the projection of the cylinder liner.



Fig. 5

Fix Special Tool 0102013 - Retainer Cylinder Liner (Fig - 5)

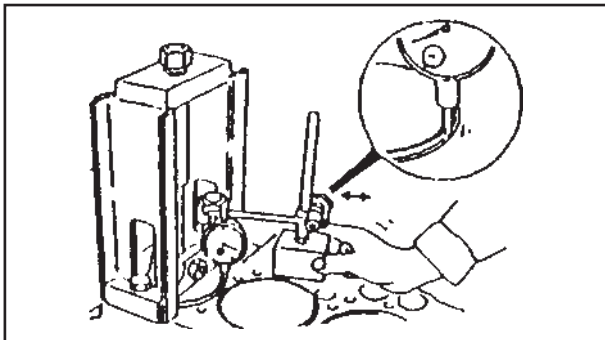
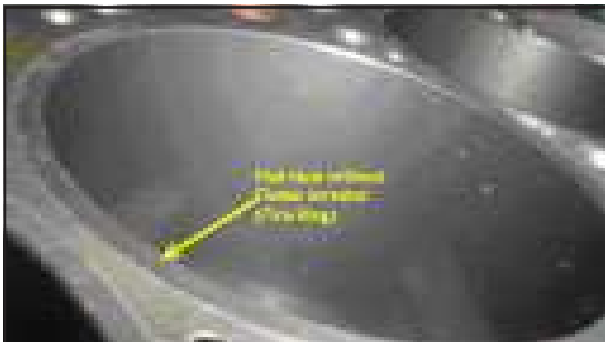


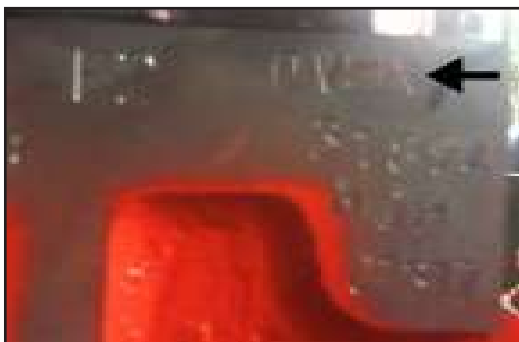
Fig. 6

Measure the amount of projection of the liner from the cylinder block with a dial gauge and magnetic stand. Fig - 6

#### MIF Liner Identification



MIF liners can be identified by the absence of flame arrestors as shown above.



Cylinder blocks of engines with MIF liner will have "I" as prefix in block sl. no. for easy identification. (e.g OVHN 31894 is with out MIF liners and IOVHN 31894 is with MIF liners).

#### 16.2.1 To Remove and Refit Timing Casing Cover and Back Plate

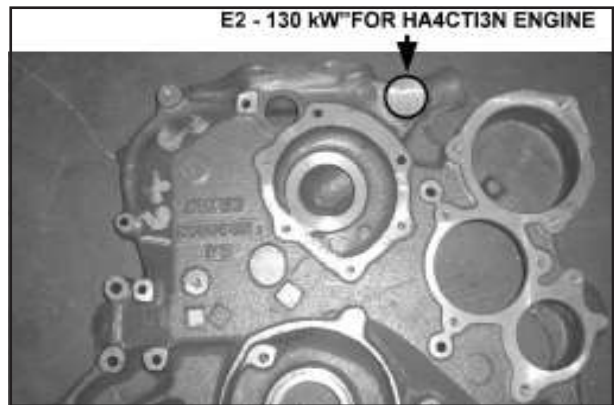


Fig. 7

For BS III Engine, Identification mark is punched as E2-130 kW" Fig - 7

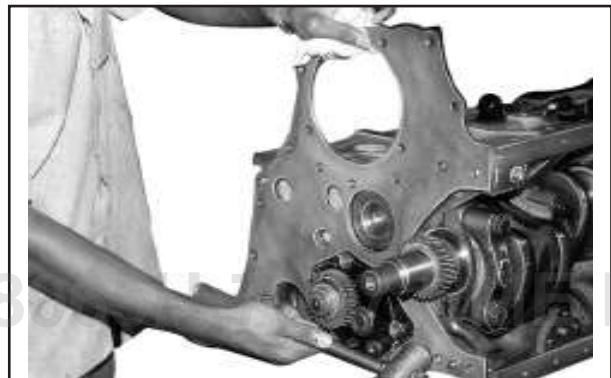


Fig. 8

Backout fixing screws of the Timing back plate. Fig - 8

Take off the Timing back plate, taking care of both dowel pins. Before refitting, remove the old Liquid gasket material and clean front face of the crankcase.

Apply fresh liquid gasket (Anabond 683) with new gasket to crank case face of the Timing Back plate.

Screw down Timing Back plate with hex screws and spring washers.



Fig. 9

Timing back plate mounting bolt holes, in which one mounting hole is provided with a counter bore, use special bolt with a thread sealant (without washer).

Fig - 9.





Fig. 10

Remove timing cover and Replace new oil seal using Special Tool 0102001 - Drift Oil Seal Gear Case. **Fig - 10.**

Installation should only take place with engine in normal upright position.

#### 16.2.2 To Remove and Refit Flywheel Housing

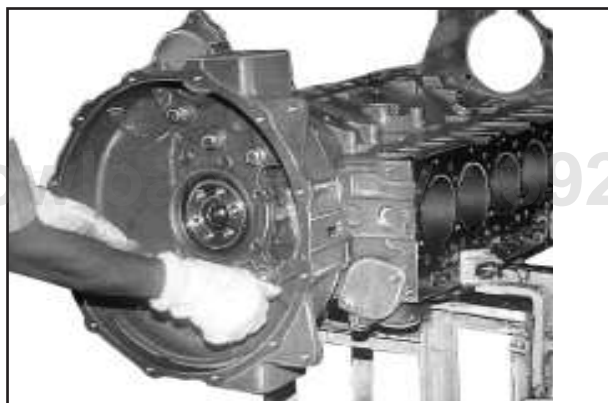


Fig. 11

Backout fixing screws of the flywheel housing. **Fig - 11.** Start with M8 bolts (6 nos.) and then M14 bolts (8 nos.).

Take off the flywheel housing, taking care of rear main oil seal.

#### 16.2.3 Install the Oil Seal in the Flywheel Housing

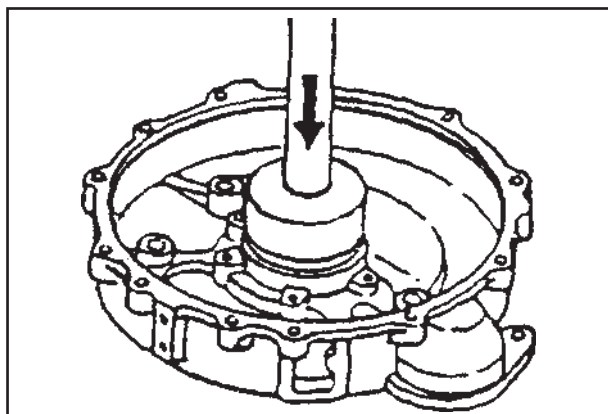


Fig. 12

Using a special tool, press in the oil seal in the flywheel housing. **Fig - 12**

Special tool 0102004 : Drift for Oil Seal Flywheel Housing.

Before refitting, remove the old Liquid gasket material and clean rear face of the crankcase. Apply fresh Liquid gasket to inner side of the flywheel housing.

Fit flywheel housing and tighten it securely with hex screw. Fig - 11. Start with M14 bolts (8 nos.) and M8 bolts (6 nos).

#### 16.2.4 To Remove and Refit Flywheel



Fig. 13

Backout fixing screws and remove flywheel. **Fig - 13**

Check ring gear, if necessary replace.



**Do not damage the slots on the flywheel**

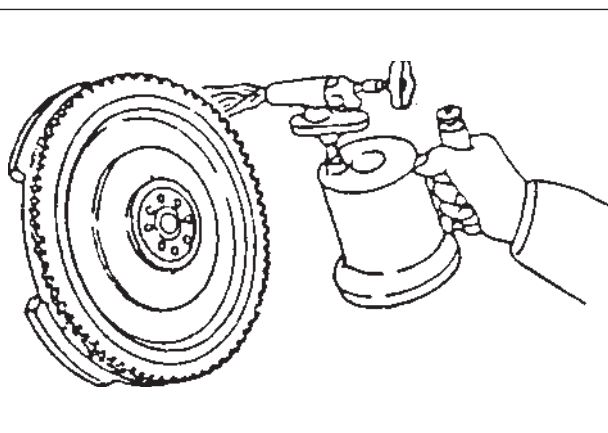


Fig. 14A



### 16.2.5 To Remove Ring Gear (Fig - 14A)

- Heat the ring gear with a blow torch in a uniform manner (approx. 180°C).
- Using a metal rod as pad and strike all around the ring gear in uniform manner and remove the ring gear.

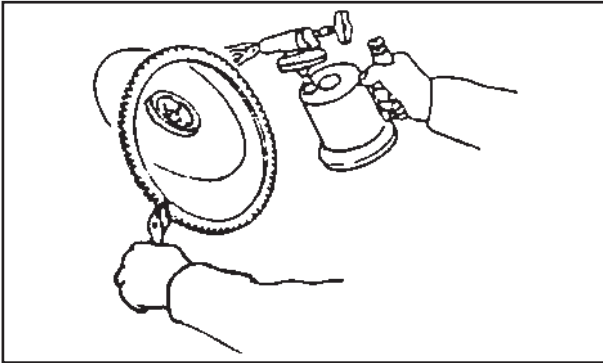


Fig. 14B

### 16.2.6 To Install Ring Gear (Fig - 14B)

- Heat the ring gear uniformly using a blow torch (approx. 180°C).
- Drive the ring gear with its chamfered gear teeth facing the block onto the flywheel using a metal rod.

### 16.2.7 Install Flywheel

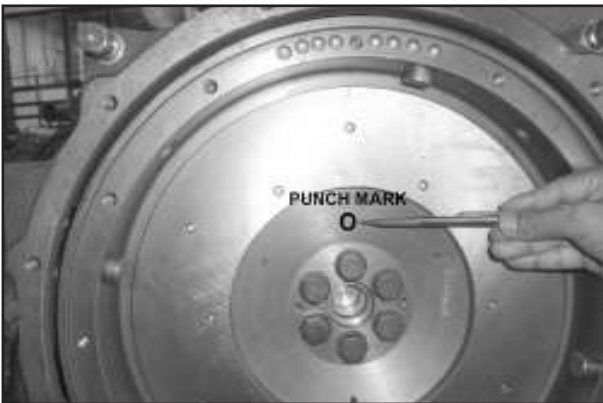


Fig. 15

Align the 'O' mark on the flywheel and crankshaft collar knock pin. **Fig - 15.**

Fig. 16a

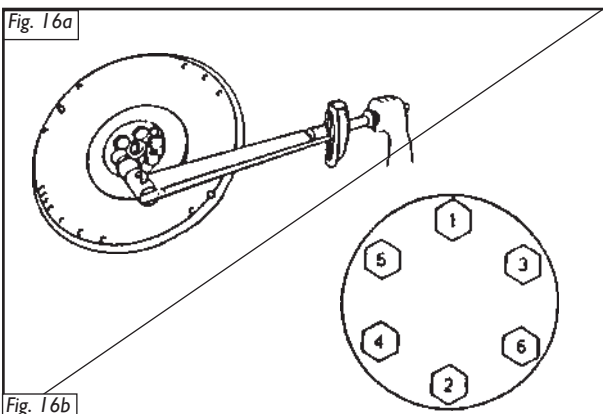


Fig. 16b

Install the flywheel and tighten the bolts through several repetition of the tightening order so as to reach specified torque evenly and gradually then slacken and tighten them one by one to the specified torque as per sequence. **Fig - 16a & 16b.**

When tightening the bolt, apply engine oil to the threads and flywheel surface of the bolts.

Install the pilot bearing and stopper.

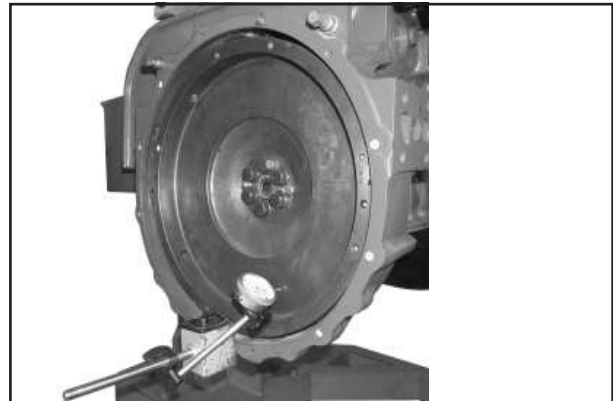


Fig. 17

Check the flywheel faceout and it should be within the recommended value. **Fig. 17**



Fig. 17 A

Check the flywheel Runout and it should be within the recommended value. **Fig. 17A**



**Ensure there is no fouling of speed sensor with flywheel after fitment of sensor. Also ensure gap between flywheel and speed sensor is  $1.00 \pm 0.1$  mm by using gauge.**





### 16.3 Crankshaft

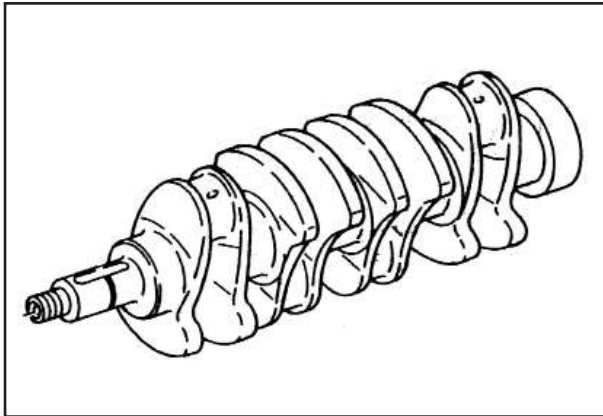


Fig. 1

The crankshaft is supported by 5 main bearings. **Fig.1**  
Thrust is taken up by the thrust washer at the fourth journal.

#### Identification of engine crankshaft.



Fig. 2

BS III 4Cylinder crankshaft is punch marked with 4CT on the first web. **Fig. 2**

1<sup>st</sup> & 4<sup>th</sup> crank pin and 1<sup>st</sup> & 5<sup>th</sup> main journal fillets are induction hardened.

#### 16.3.0 To Remove and Refit Crankshaft

Backout collared bolts and remove bearing caps.



Fig. 3

Remove thrust bearing cap (4th) last. **Fig - 3**

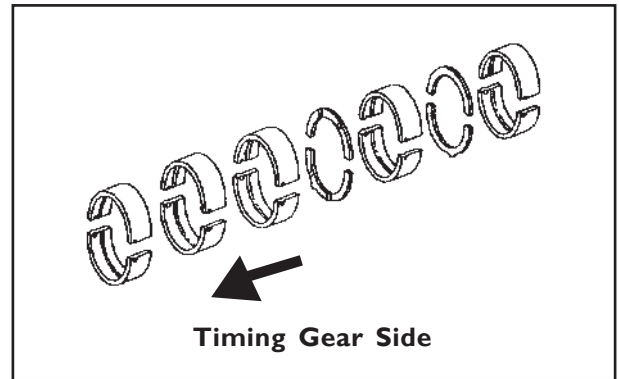


Fig. 4

Arrange all the caps bearing and thrust washer in order. **Fig - 4**

The bearing caps are match marked with the crankcase by the punch mark 1 - 5, commencing from timing gear side.



Fig. 5

Lift the crankshaft out of the crankcase. **Fig - 5.**

#### 16.3.1 To Renew Crankshaft Gear

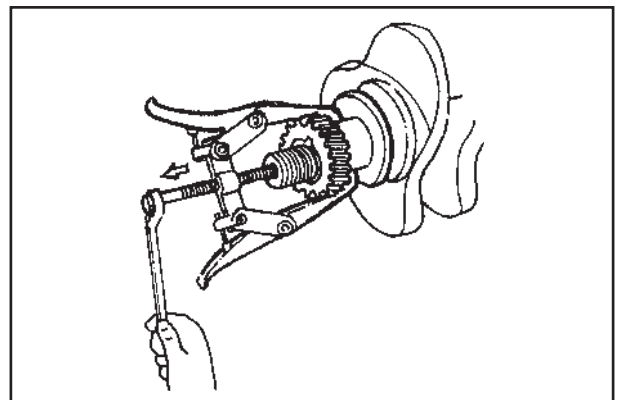


Fig. 6

By using Conventional puller remove crankshaft gear from crankshaft. **Fig - 6**

#### 16.3.2 To Refit the Crankshaft Gear

Heat the gear upto 130°C and fix it.



### 16.3.3 To Check Crankshaft Bend

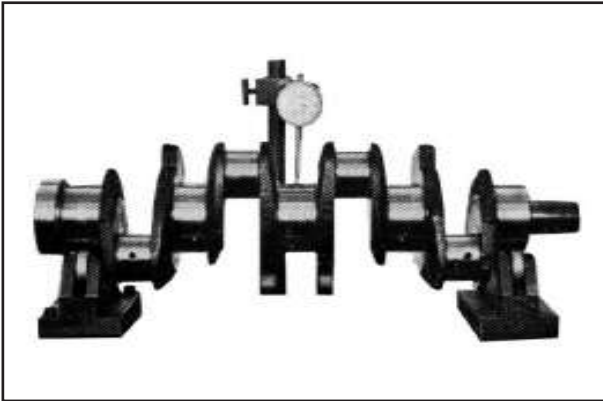


Fig. 6a

Maximum permissible bend is 0.04 mm. **Fig. 6a**

### 16.3.4 Installation

Clean crankcase, crankshaft and bearing shells by blowing compressed air through the lubrication holes.

### 16.3.5 To Renew Crankshaft Main & Connecting Rod Bearing and Check Main & Connecting Rod Bearing Spread

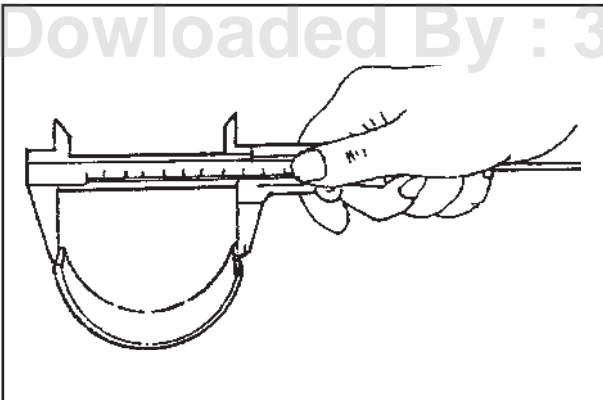


Fig. 7

Hold the bearing shell without applying any pressure and measure the outside diameter.

Main bearing dimension : 79.00-79.60 mm

Connecting rod  
bearing dimension : 67.05 - 67.55 mm

Fig - 7

Install the crankshaft, main bearing on the crankcase and bearing caps.

Lubricate crankshaft journals, bearing shells, cap bolt threads and under the bolt heads with the engine oil.

Carefully lower the crankshaft into position.



Fig. 8

Fit bearing caps and starting off with the thrust bearing No.4, adhering to the match marks. Connecting faces, of bearing caps and crankshaft should be perfectly clean. **Fig - 8**

Bearing cap set identification number is punched on the bearing cap and LH side rear end of the crankcase.



Fig. 9

Tighten collared bolts uniformly in three stages in tightening order 3-2-4-1-5, to the recommended torque. **Fig - 9**

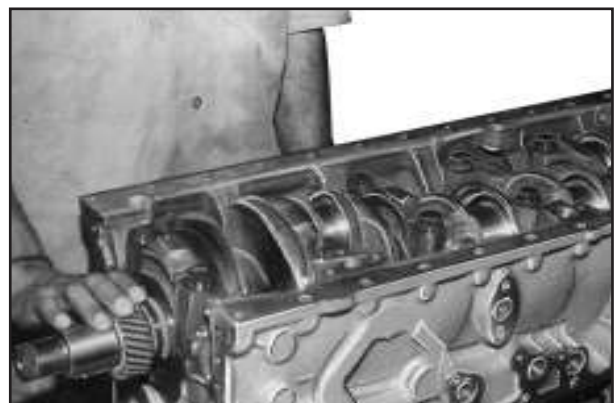


Fig. 10

Do not attempt to rotate crankshaft before all bearing caps have been bolted down. The crankshaft must



turn freely without binding i.e. a strong push by hand should make it turn atleast one revolution. **Fig - 10**

Check endplay of crankshaft as follows:

Force crankshaft in one axial direction and measure the gap between thrust bearing side and crank web face.



**Fig. 11**

The initial end clearance with new thrust and main bearings should amount to 0.05 to 0.22 mm end clearance should not exceed 0.4 mm. **Fig - 11**

#### **16.3.6 To Check and Grind Crankshaft**

Clean crankshaft and blow out lubrication holes with compressed air, check journals and crankpins for cracks.

Check wear of crankshaft if wear is more than 1.2 mm from standard size, replace crankshaft.

No further heat treatment is recommended.

Support crankshaft at front and rear journals. The bend must not exceed 0.04 mm.

Check journals & crankpins for ovality, Taper.

Max. permissible ovality = 0.02 mm

Max. permissible Taper = 0.02 mm

Concentricity = 0.03 mm

Grind the crankshaft according to the available replacement bearing shells. This work may only be performed by experienced crankshaft grinders. For repair data of undersize big end bearings and main bearings refer section 16.0.7.

#### **16.3.7 To Remove and Refit Crank Pulley**



**Fig. 12**

Backout the hex nut with box spanner 46 mm. **Fig-12**

Withdraw the crank pulley.

If found external damage, replace with new one.

Fit the new O ring on the inner dia of the hub.

To refit crank pulley, reverse the procedure for removal.



## 16.4. Piston and Connecting Rods

### 16.4.0 To Remove Piston Assembly

Fix Special Tool 0102013 - Retainer Cylinder Liner to hold the liner.

Backout connecting rod bolts and remove bearing cap.

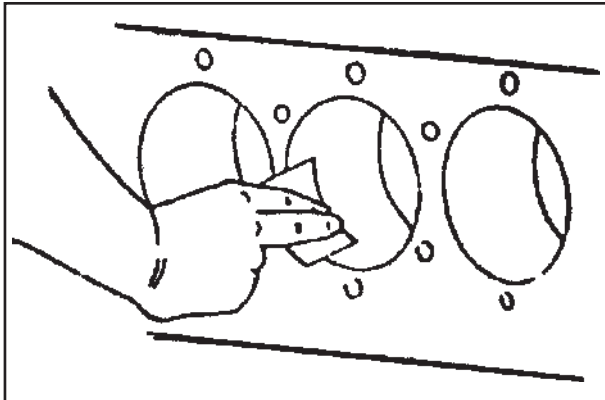


Fig. 1

Scrape off carbon deposit from the upper end of the cylinder liner with the help of emery paper or scraper.

### Fig. 1

Extract all the pistons and connecting rod assemblies through top of the cylinders.

### 16.4.1 To Dismantle and Assemble Piston and connecting rod



Fig. 2

Remove gudgeon pin circlip with the circlip plier. **Fig-2**

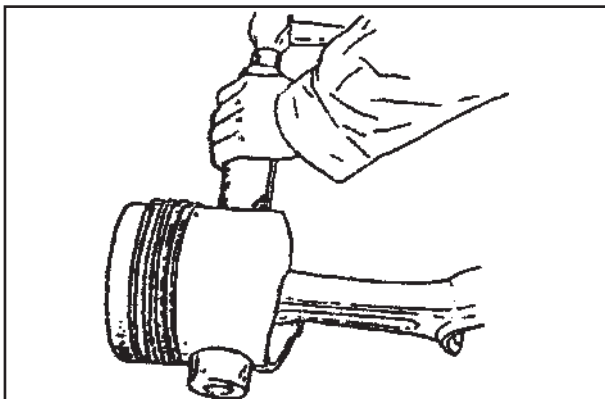


Fig. 3

Place a copper drift on the pin and strike it out with the hammer. **Fig - 3**

### 16.4.2 Connecting Rod Bush

#### 16.4.2.0 To Remove Bush

Using a special tool 0102017 - Drift and extractor.

Align supporting surfaces of the guide and press sub assembly flush on the flat plain.

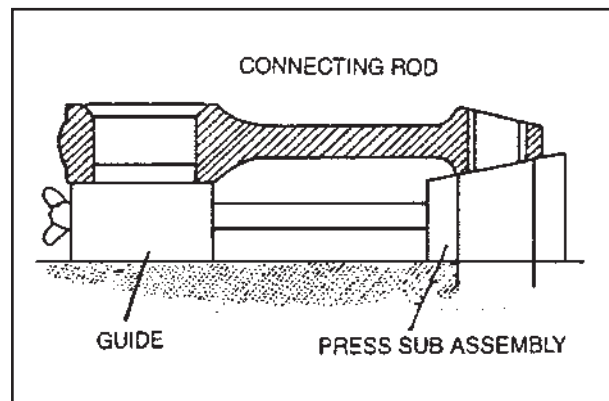


Fig. 4

Set the connecting rod assembly without crank pin bearing on the guide and press assembly. **Fig - 4**

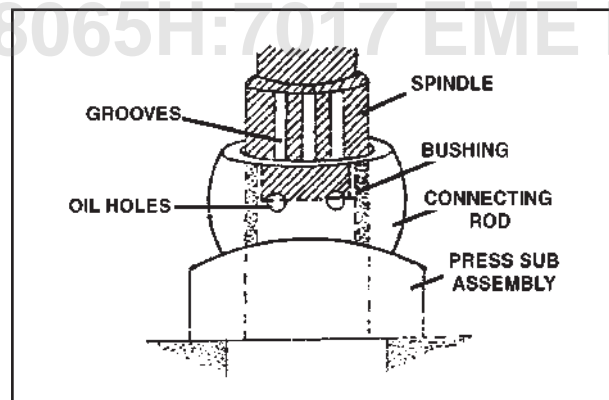


Fig. 5

Install the spindle into the bushing. Align the grooving of the spindle with the oil hole of the bush. **Fig - 5**

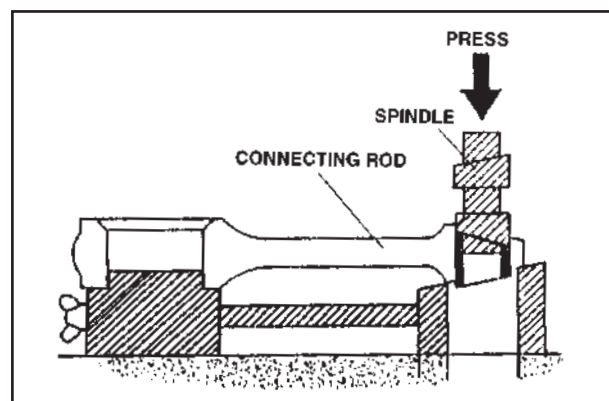


Fig. 6

Using a hydraulic press, remove the bush slowly and smoothly. **Fig - 6**





#### 16.4.2.1 Installation of Connecting Rod Bush

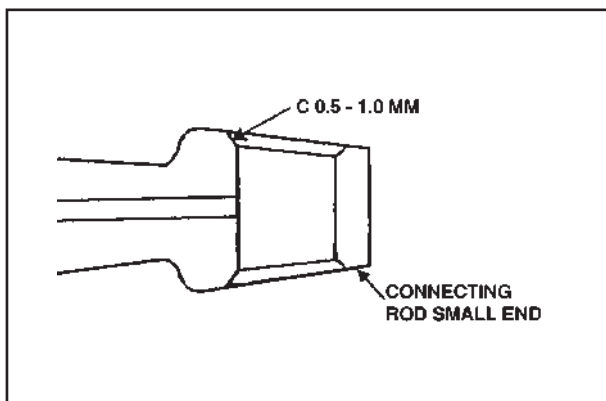


Fig. 7

Chamfer one edge of the bush hole at the small end of the connecting rod uniformly by C 0.5 - 1.0 mm. **Fig - 7**

Set the bush and guide on the spindle then secure them with the bolt.

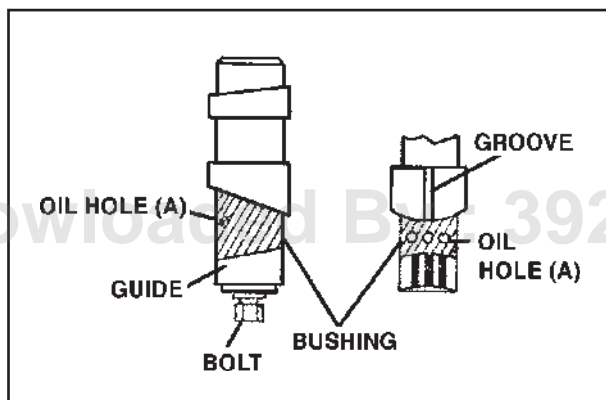


Fig. 8

Be sure to slip the bushing over the spindle in the proper direction, so that oil hole 'A' will later align with the rifle hole in the connecting rod. **Fig - 8**

lubricate the bush guide and bush bore on the connecting rod.

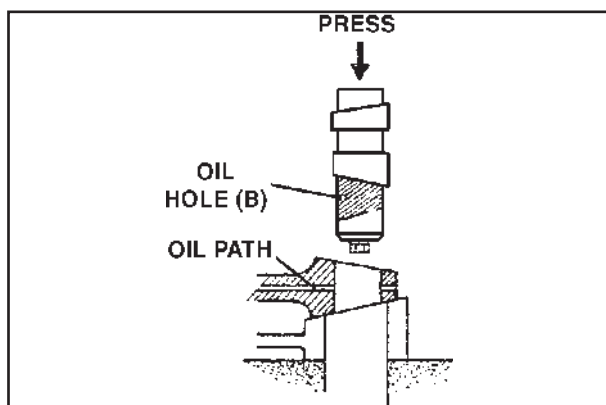


Fig. 9

Align oil hole 'B' in the bushing with the rifle hole of the connecting rod. **Fig - 9**

Always operate the press slowly and smoothly.

#### 16.4.2.2 Inspect the Bushing Position after Installation

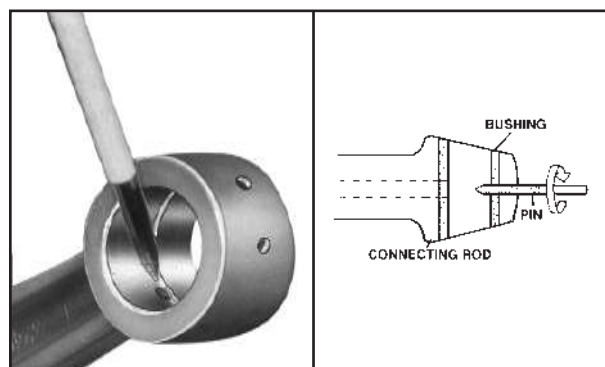


Fig. 10

Make sure that the oil holes of the bushing and connecting rod are aligned. **Fig - 10**

Insert a pin of 3 mm dia into the hole at the end of the connecting rod, and make sure that the pin fully goes in.

If there is any deviation in the alignment of the oil holes correct it with a drill of 3 mm dia. If drilling is carried out, take care to remove the machined burrs clears off the connecting rod small end bore and oil holes.

#### 16.4.2.3 Check for Bend of Connecting Rod

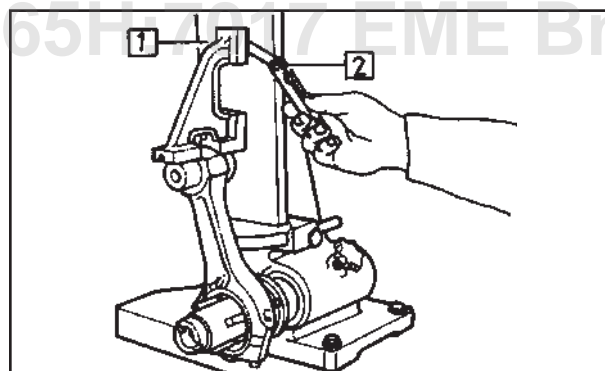


Fig. 11

Check for bend of connecting rod by means of bend checking tool and feeler gauge. The permissible tolerance is 0.1 measured at the distance of 200 mm from the longitudinal axis of connecting rod. **Fig - 11**

#### 16.4.2.4 Install the Connecting Rod Bearing

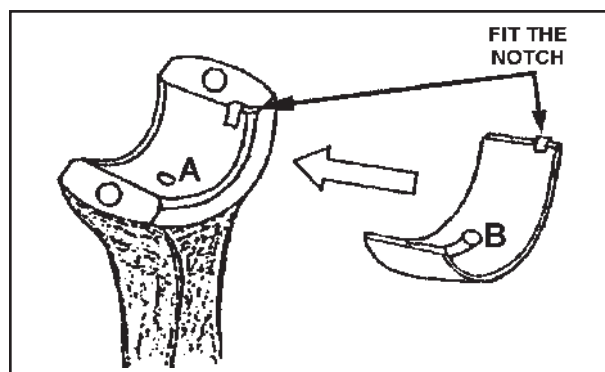


Fig. 12

Confirm the oil hole A & B are in line. **Fig - 12**



### 16.4.3 Piston and Piston Rings

#### 16.4.3.0 Piston General

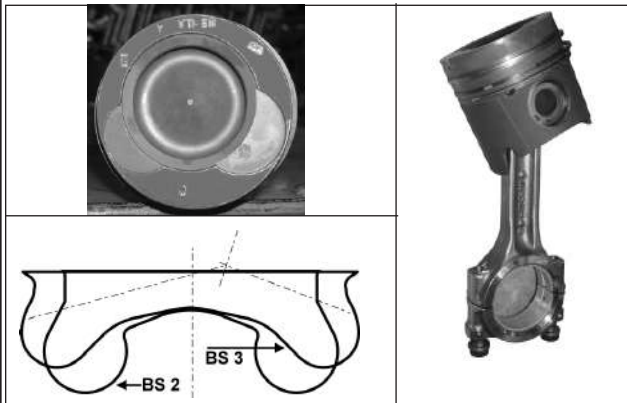


Fig. 13

The piston combustion chamber is of shallow type for faster and more efficient combustion.

The piston consists of two compression Ring grooves, one oil scraper ring groove and crown face with valve pockets. **Fig. 13**

Max. difference in the weight of the piston in an engine set of 4 pistons should not exceed 5 gms.

Weight group identification mark is punched on the piston crown.

#### 16.4.3.1 To Remove Piston rings

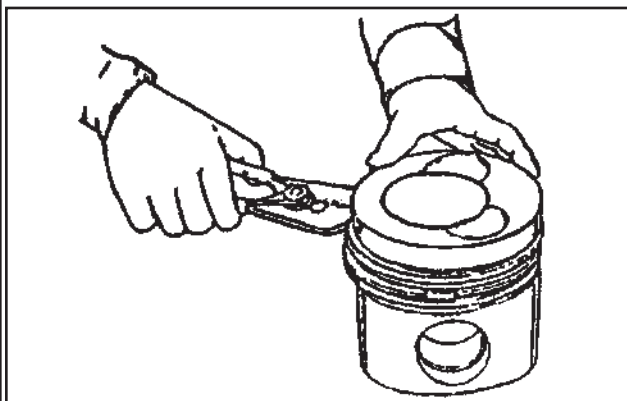


Fig. 14

Remove compression rings and oil scraper rings with the aid of piston ring plier. **Fig - 14**

Remove carbon deposits from piston ring grooves.

Heat the piston to approximately 80°C temperature.

#### 16.4.3.2 Assemble Piston and Connecting Rod

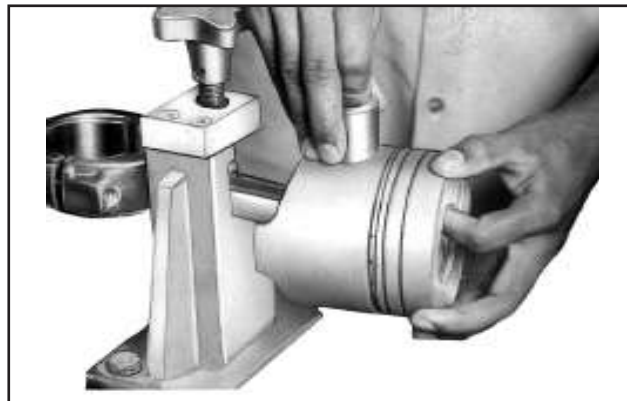


Fig. 15

Insert the gudgeon pin into the piston with connecting rod. **Fig - 15**

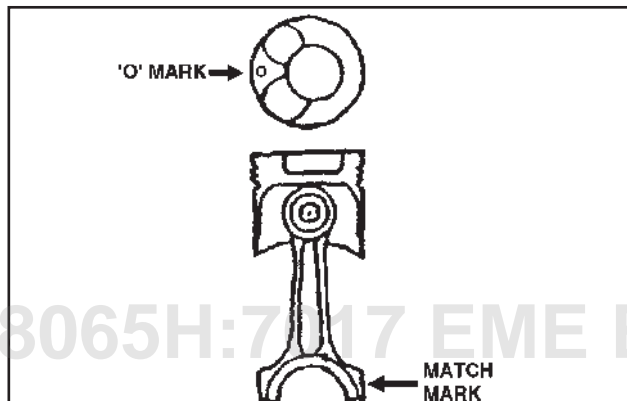


Fig. 16

O mark on the piston top and and connecting rod match mark should remain opposite to each other, while assembling the piston to connecting rod. **Fig - 16**

#### 16.4.3.3 Install Piston Rings



Fig. 16

Before fitting new piston rings, check each ring gap separately by inserting the ring into the cylinder bore at right angles and measure the ring gap with a feeler gauge. **Fig - 17**

Apply oil over the piston ring. use a piston ring expander while fitting the piston rings.



Install the piston ring in sequence viz; oil ring, second ring and top ring with the identification mark at the top of the ring facing upwards.

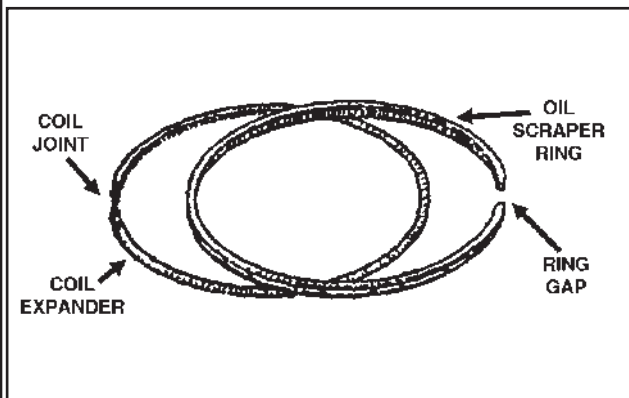


Fig. 18

Connect the ends of the coil expander and then fit the coil inside the piston ring after ensuring that the gap of the piston ring is 180° away from the joint of the coil. Coil expander and piston scraper ring are supplied together. **Fig - 18**



Fig. 19

Check the side clearance of the piston rings. **Fig - 19**

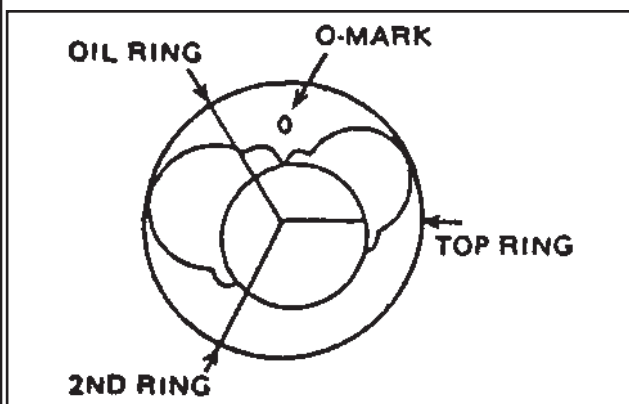


Fig. 20

Stagger the piston ring gaps so that they are not in line, approximately at 120° away from each other. **Fig-20**

#### 16.4.3.4 Installation

Lubricate piston, piston rings, cylinder bore and con rod bearing with engine oil.

Displace the piston ring gaps relative to each other by 120°.

Make sure that 'O' mark on the piston top is on the tappet side, when fitted.

Rotate crankshaft so that the crankpin of the respective piston is in B.D.C. position.



Fig. 21

Insert piston with connecting rod assembly into the cylinder bore compressing the piston rings by means of Special Tool 0102014 - Compressor Piston Ring.

**Fig - 21**

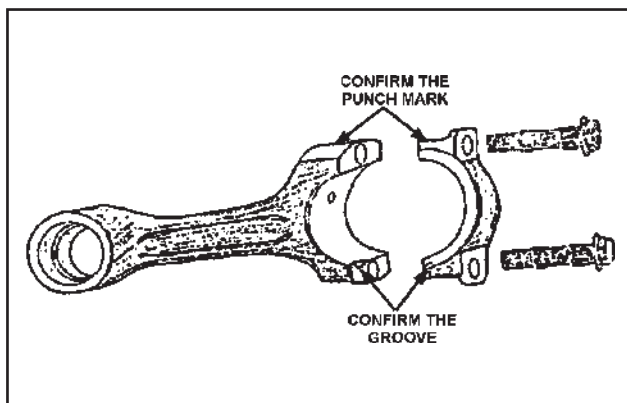


Fig. 22

Push the piston into the crankcase until the big end bearing is seated on the crankpin.

Align the punch mark on the connecting rod and cap.

**Fig - 22**



*Fig. 23*

Fit bearing cap with bearing, taking care that the bearing halves are seated properly in the connecting rod and cap.

Tighten con rod bolts alternatively to recommended torque. **Fig - 23**

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## 16.5 Cylinder Head Assembly

### 16.5.0 To Remove Cylinder Head

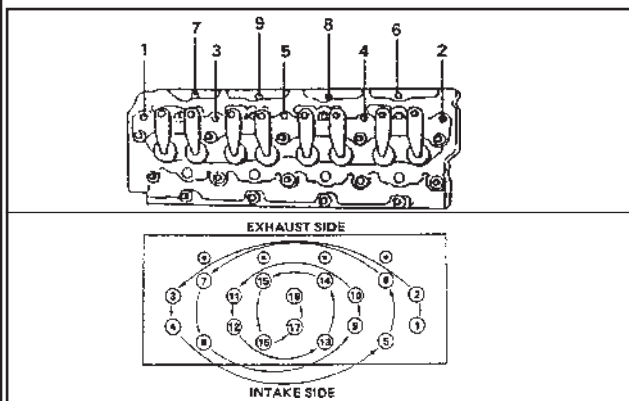


Fig. 1

Loosen the cylinder head bolts / rocker arm support bolts as per sequence shown. **Fig - 1**. Start with M10 bolts and then M12 bolts.

Using a special tool 0102010 - Wrench Cylinder Head Bolt

Lift the cylinder head from the dowels on the cylinder block and place it on wooden blocks (supporting on both the ends) to avoid nozzle tip damage.

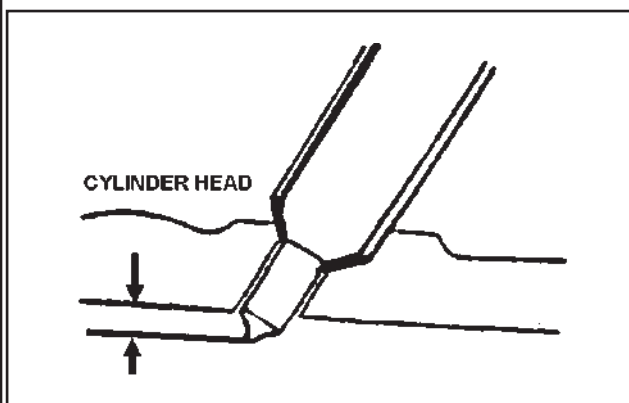


Fig. 2

Nozzle protrusion from the cylinder head surface is 2.1 to 2.5 mm. **Fig - 2**

Ensure that all the nozzles are removed from the cylinder head.

Remove the valve split cone lock, collar and spring from cylinder head.

Remove coolant sensor from the cylinder head.

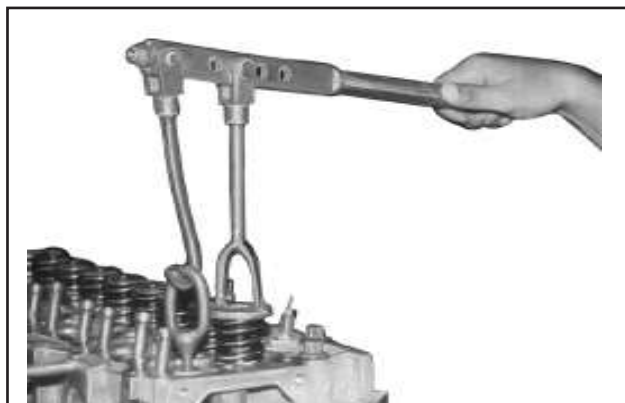


Fig. 3

Using Special Tool 0102005 - Compressor Valve Spring, remove the exhaust and inlet valves. **Fig - 3**

Before removal of all valves, punch the serial nos of cylinder numbers on the valve face, to avoid mixing of valves.

Clean the cylinder head, valves, spring and all other parts thoroughly with the suitable solvent.

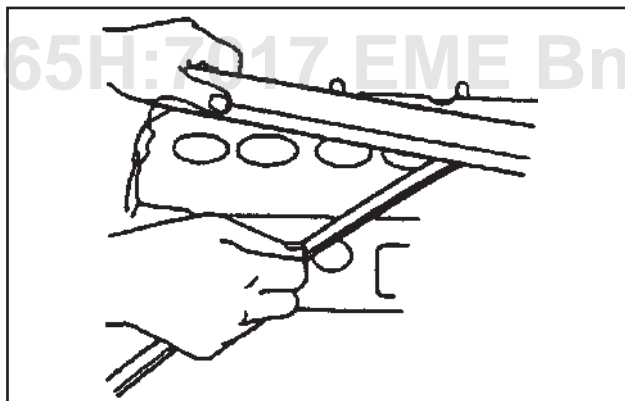


Fig. 4

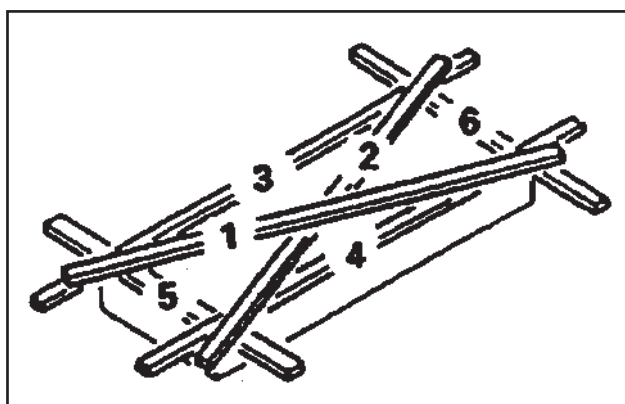


Fig. 4A

Check cylinder head surface unevenness.

**Fig - 4 & 4A**

Hand lap valve and valve seat.

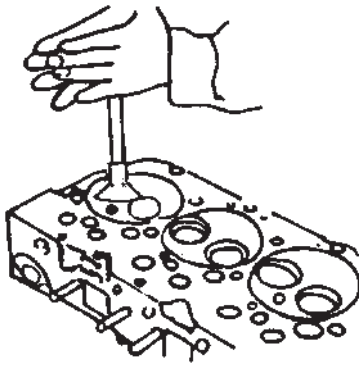


Fig. 5

Lightly apply lapping compound to the valve face. Install the valve with a Valve Lapping Tool, tap and rotate valve against the seat. **Fig - 5.**

#### 16.5.1 To Grind Valves and Valve Seats

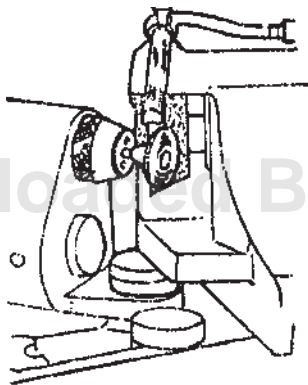


Fig. 6

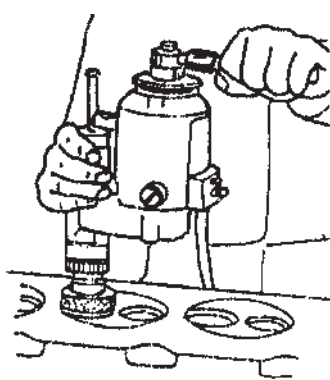


Fig. 7



Grinding of valves and valve seats should only be performed when handlapping does not result in proper seating.

Any conventional valve grinding machine can be used.  
**Fig - 6 & 7**

After grinding, always recheck the valve sink.

For repair data refer section 16.0.3.

#### 16.5.2 To Remove Valve Seat

Cut the circumference of a valve head at three places with a grinder and install it into seat and weld valve to seat. Then to remove, drive out valve and seat with a hammer and a brass block.

#### 16.5.3 Valve Seat Installation



Heat the cylinder head to about 80° - 100°C with hot water. On the other hand, cool the valve seat with dry ice or liquid nitrogen for about 30 minutes.

Hold the seat with pincers and place it into the heated cylinder head. **Fig - 8**

#### Valve seat section machining specifications

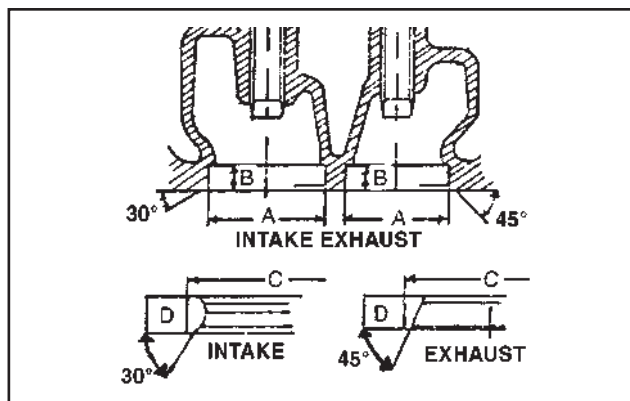


Fig. 9



		Intake (mm)	Exhaust (mm)
Cylinder Head Dimension	A	46.500 - 46.516	41.000 - 41.016
	B	8.8 - 9.0	7.2 - 7.4
Valve Seat Dimension	C	46.630 - 46.645	41.130 - 41.145
	D	7.5 - 7.7	6.0 - 6.2

Fig - 9

#### 16.5.3.0 To Check the Valve Guide

The Valve guide may require replacement if stem to valve guide clearance exceeds

Intake - 0.035 - 0.068 mm

Exhaust - 0.050 - 0.083 mm

Fig - 10

#### 16.5.3.1 To Renew Valve Guide

Remove the valve stem seal.

Using a brass rod and hammer, drive out the valve guide.

Install the valve guide.

Special Tool 0102009 - Drift Valve Guide.



**Apply engine oil lightly to the valve guide outer circumference before installation.**

#### 16.5.3.2 To Refit Valve and Valve Stem Seals

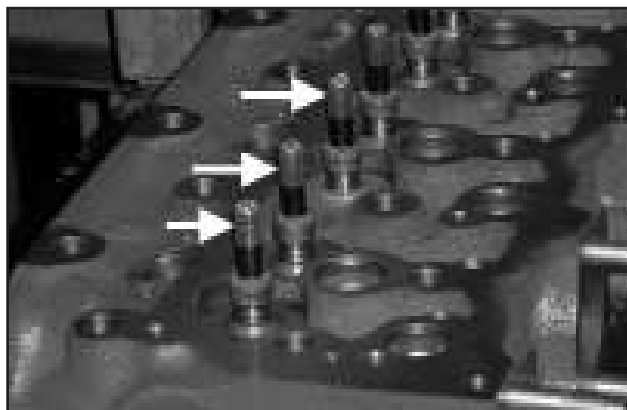


Fig. 11

Install the valves, lower spring seat and stem seals.

**Use fitment sleeve for valve guide seal to part no. X1102160. Fig - 11**

Then apply engine oil to the lip of the stem seal and install the stem seals.

Remove and scrap the fitment sleeve.



Fig. 12

Drive the special tool until it hits the lower spring seat.

Special Tool 0102006 - Drift Valve Stem Seal. **Fig - 12**

#### 16.5.3.3 To Check Valve Springs

Check valve springs on a valve spring scale for re-usability

Valve spring

straightness = 2.0 mm

Setting load = 26.5 kg at 45.5 mm

limit 24.6 mm



### 16.5.4 To Assemble the Cylinder Head

Apply engine oil to contact surface of all the parts. Make sure that the valves are installed in the respective cylinders.

Valve springs are constant pitch in place of progressive spring (Equal pitch coil).

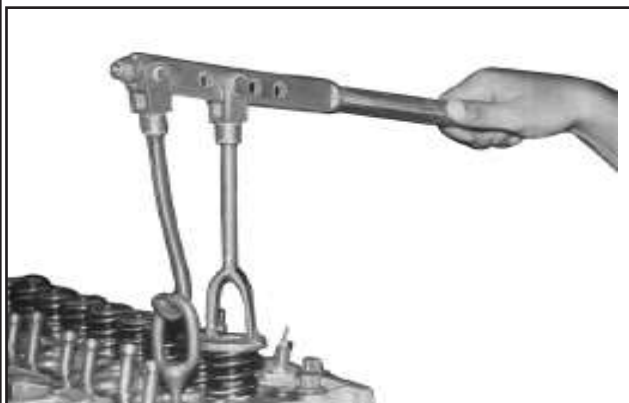


Fig. 13

Press valve spring and collar to install split cone lock.

Using Special Tool 0102005 - Compressor Valve Spring. **Fig - 13.**

### Install the Cylinder Head

Install the cylinder head gasket, always use new cylinder head gasket. After cleaning the surfaces of the cylinder head, cylinder block and head gasket free from dirt, water and grease.

Fit 8 numbers valve tappets on to the cylinder block after applying the oil to the tappet bores on the cylinder block.

Ensure fitment of two dowel pins on the cylinder block top, to locate cylinder head and gasket.

Install the cylinder head over the dowels on the cylinder block.

Insert push rod in correct position.

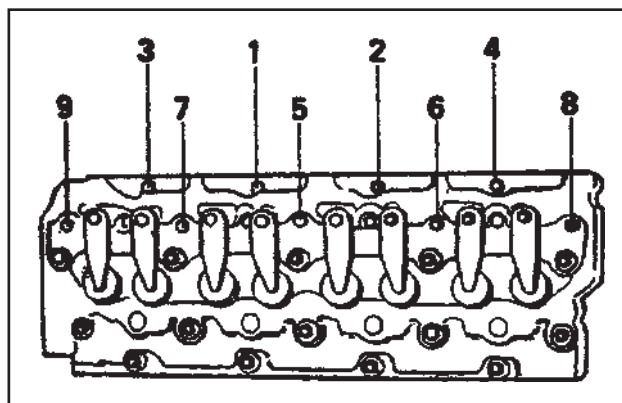


Fig. 14

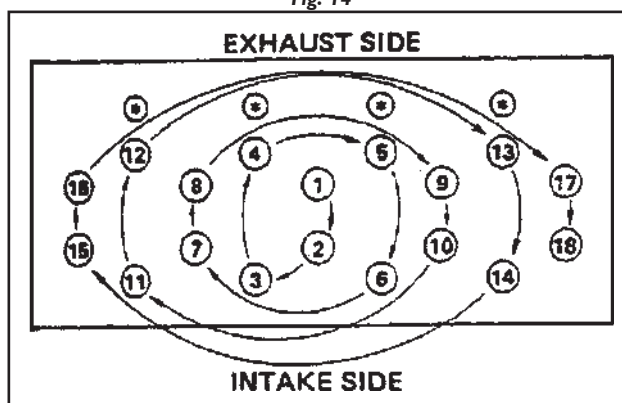


Fig. 14 A

Tighten the cylinder head bolts in three stages as per tightening sequence and recommended torque.

**Fig - 14 & 14A.** Start with M12 bolts and then M10 bolts.

Mount the rocker arm assembly on the cylinder head, make sure that the push rods interlock with the adjusting screws.



**Only Multi Layered Gasket (MLS) should be used along with Mild Interference liners (MIF).**



## 16..6 Timing

### 16.6.0 To Remove and Refit Rocker Levers

Backout fixing bolt and remove rocker shaft assembly.

Reassemble rocker arm assy. in the order as follows:-

Bracket, Inlet valve lever, Spacer, Exhaust valve lever, Bracket . . . ,

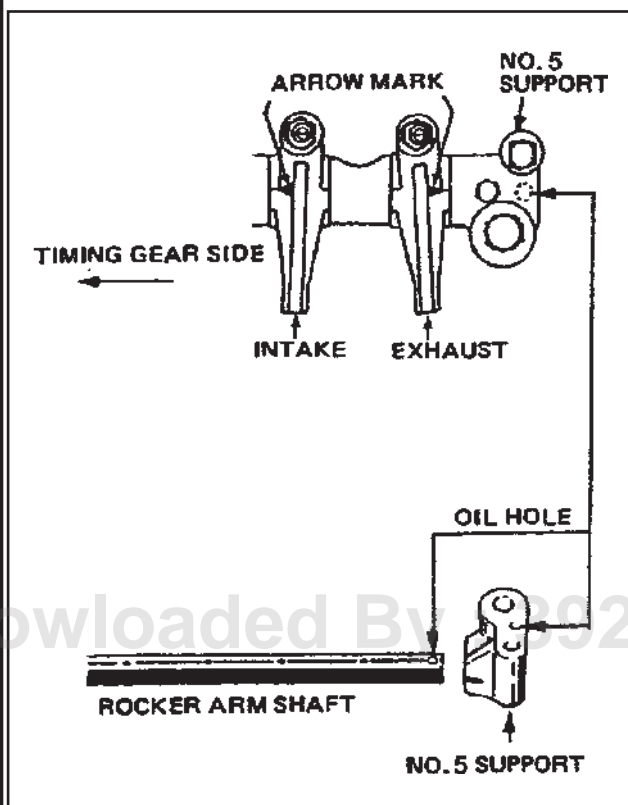


Fig. 1

Confirm that oil hole of rocker arm assembly No.5 support aligns with shaft oil hole. **Fig - 1**

Improper installation will result in seizure of the entire valve assembly.

### 16.6.1 To Remove, Refit and Check Push Rod and Tappets

Remove push rods and tappets.

Check out of true (bend) of push rods between centres.

Maximum permissible out of true = 0.3 mm.

Examine push rod ends for wear. Replace if necessary and check rocker lever and tappet lubrication in this case.

Check diametral clearance of tappet in crankcase bore and inspect sliding surface and push rod seat for wear.

If necessary replace worn out parts.

To refit push rods and tappets, reverse the procedure for removal.

### 16.6.2 To Remove and Refit Camshaft

Unscrew 2 Nos Hex screws of 12mm size from camshaft holding flange through opening provided in camshaft gear.

Do not unscrew camshaft drive gear holding bolt and try to pull the gear using puller.

Extract camshaft after removing push rods and tappets.



Fig. 2

Pull out the camshaft slowly turning it, so that the bearings are not damaged. **Fig - 2**



### 16.6.3 Removal and Replacement of Camshaft Bushes

Use Special Tool 0102018 - Drift & Extractor Camshaft Bushes to remove and refit camshaft bushes. **Fig - 3**

#### Extraction

The cylinder block is designed with minimum aperture, the camshaft bushes are not approachable from the LH side or bottom side of the engine.

Hence the parent bores of camshaft bushes in the cylinder block have been machined in different diameters to facilitate the removal and re-fitment of the bushes. For this reason, the diameters of the camshaft bearing journals are in descending order.

#### 16.6.3.0 Camshaft Bush Dimensions (in mm)

Parent bore diameter

First Bush - 60

Second Bush - 59.8

Third Bush - 59.6

Bush inner diameter

First Bush - 57

Second Bush - 56.8

Third Bush - 56.6

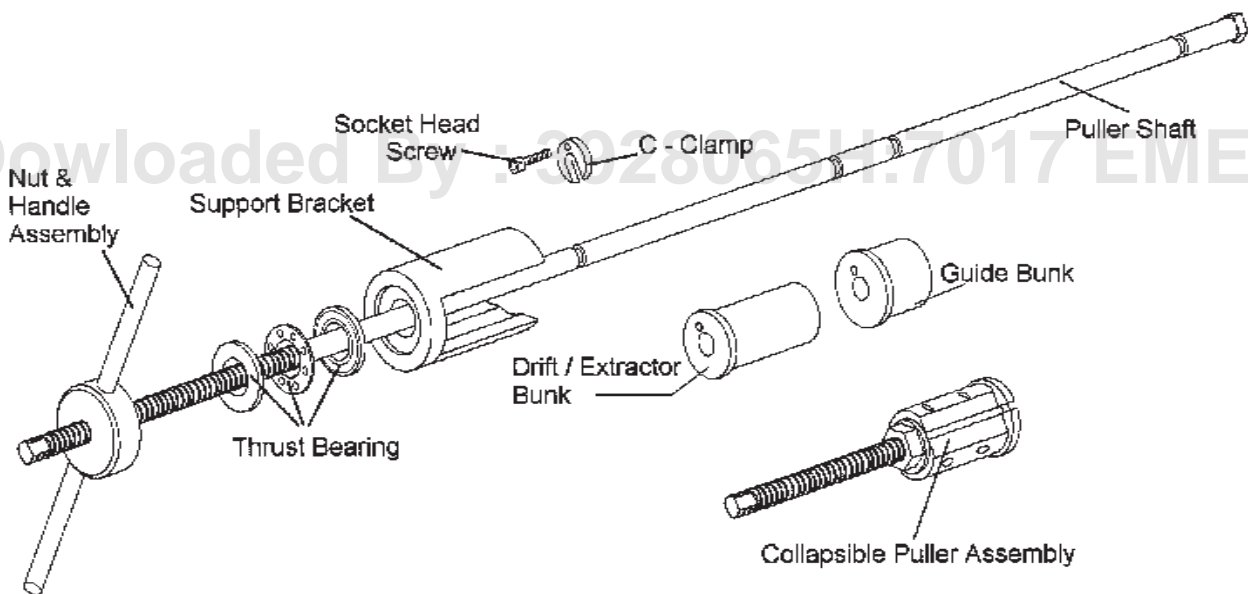


Fig. 3



#### 16.6.4. Removal of bushes

Proceed in the following manner to remove the camshaft bushes.

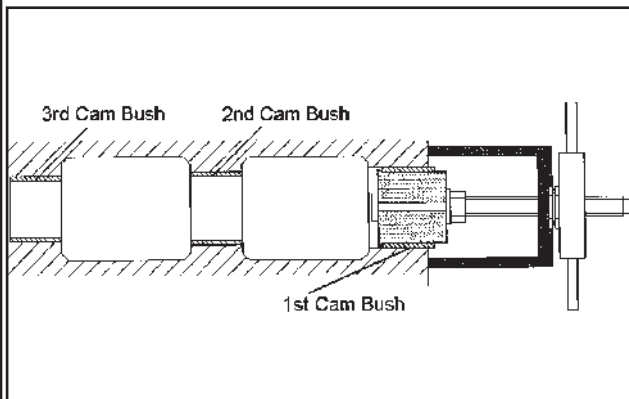


Fig. 4

1. Remove the 1st bush using collapsible puller assembly and support bracket from front.

##### Fig - 4

2. Compress the collapsible puller and insert the same in to the bush until the collapsible bunk expands and holds the bush snugly.
3. Lightly tighten the nut next to the collapsible bunk so that the bunk does not collapse when the bush is being pulled out.
4. Place the support bracket and thrust bearing in place and using the nut and handle assembly, pull out the bush.

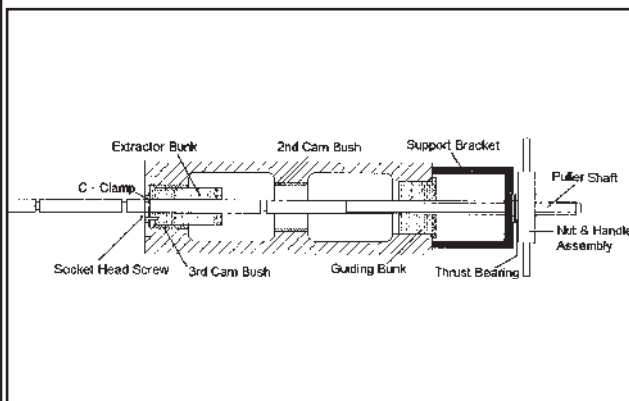


Fig. 5

5. Fix the extractor bunk on the appropriate groove on the puller shaft, insert the puller shaft from rear side of the engine carefully locating the bunk inside the 3rd bush. **Fig - 5**
6. Arrange the guiding bunk, support bracket, thrust bearing and nut & handle assembly at the front end of the engine on the puller shaft and extract the 3rd bush.

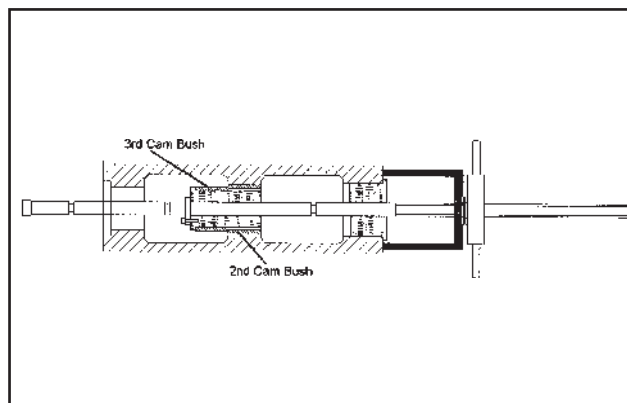


Fig. 6

The 3rd bush will be in between the 3rd and 2nd parent bores of the camshaft bushes now.

7. Guide the extractor bunk along with the extracted 3rd bush in to the 2nd bush and continue to rotate the nut & handle assembly until the 2nd bush is extracted. **Fig. 6**
8. Take out the puller arrangement along with the 2nd and 3rd bushes carefully through the 1st bush parent bore of the camshaft.

#### 16.6.5 Installation:

The camshaft bushes are pre-finished; hence handle them carefully.

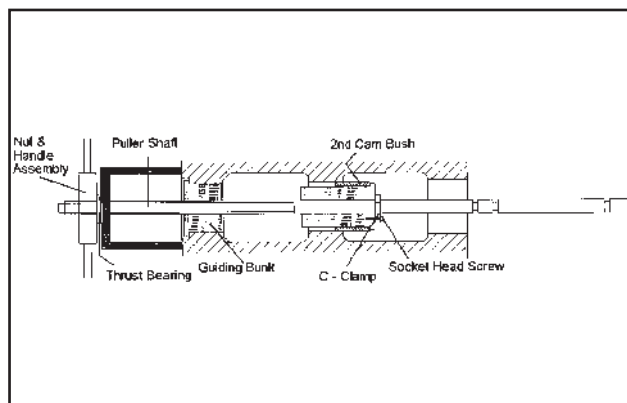


Fig. 7

1. Place the 2nd camshaft bush on the drift bunk.

Insert the puller from the front side of the engine until the front portion of the drift bunk sufficiently enters the 2nd camshaft bush parent bore.

Arrange the guide bunk, support bracket, thrust bearing and nut & handle assembly at the rear end of the cylinder block as shown and tighten the nut & handle assembly until the 2nd camshaft bush is in its place. **Fig - 7.**



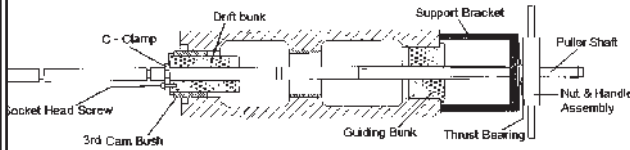


Fig. 8

- Remove the puller from the cylinder block and fix the drift bunk in the appropriate groove as shown in figure. Place the 3rd camshaft bush on the bunk and insert the puller shaft from rear end of cylinder block until the front end of the drift bunk is sufficiently inside the parent bore of the 3rd camshaft bush as shown in figure. Arrange the guide bunk, support bracket, thrust bearing and nut & handle assembly at the front end of the cylinder block as shown and tighten the nut & handle assembly until the 3rd camshaft bush is in its place. Check for the alignment of oil holes. When the bush is in its place, it would be about 2 mm inside the parent bore. **Fig - 8**

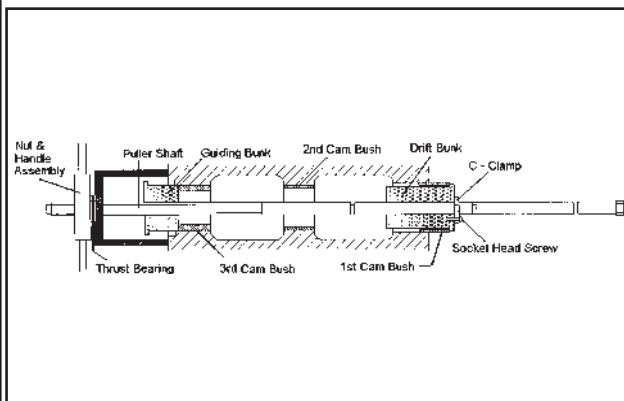


Fig. 9

- Remove the puller from the cylinder block and place the 1st gear bush on the drift bunk. Insert the puller from front end until the front portion of drift bunk is sufficiently inside the parent bore of 1st camshaft bush parent bore.

Arrange the support bracket, thrust bearing, nut & handle assembly and the guide bunk (in about 2 mm space provided by bush) at the front end of the cylinder block as shown in the figure, at rear and tighten the nut & handle assembly until the 1st camshaft bush is in its place. **Fig - 9.**

To refit camshaft reverse the procedure for removal.

**If necessary, remove the camshaft gear**

Hold the camshaft assembly with a suitable vice through wooden supports.

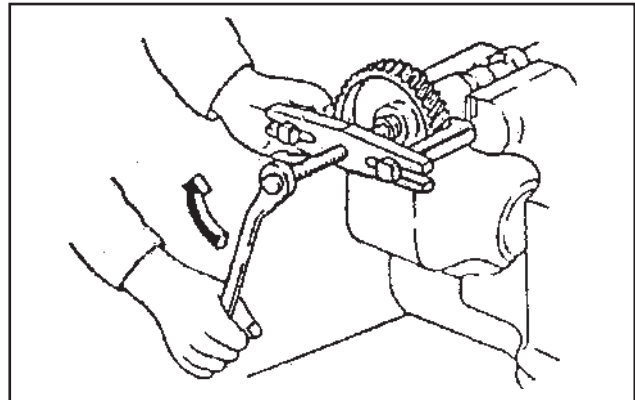


Fig. 10

Remove the nut, then using a gear puller, remove the gear. **Fig - 10**

#### 16.6.6 Install the camshaft gear on the shaft

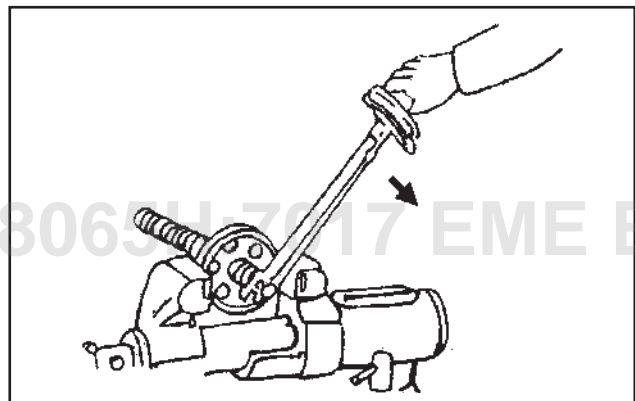


Fig. 11

Install the camshaft bearing with a thrust bearing. When installing the gear to the camshaft, heat the gear in hot water (approx. 100°C), then install the gear on the camshaft by using a press. When tightening the bolts, apply engine oil to the threads and bearing surface of the bolt. **Fig - 11**

#### 16.6.7 To Refit the Camshaft



Fig. 12

'E2' punch mark is punched on the rear end of the camshaft. **Fig - 12**





Set the no. 1 piston to Top Dead Centre of the compression stroke.

Lubricate all journals of the camshaft and insert the camshaft assembly into the cylinder block, by slowly turning, so that the bearing will not be damaged.

Align the camshaft timing gear matching mark with the oil pump gear mark.

#### 16.6.8 To Remove and Refit Intermediate Timing Gear

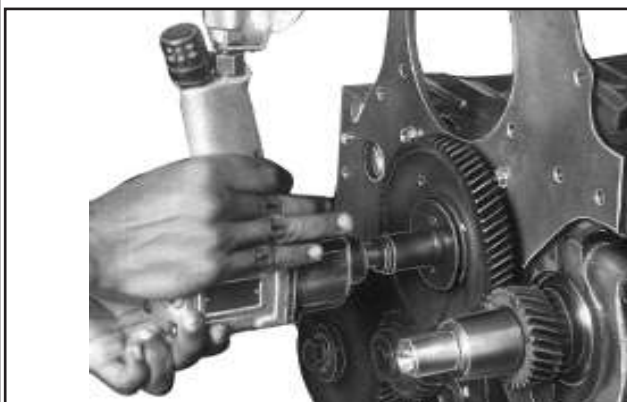


Fig. 13

Backout fixing bolt and remove it with thrust washer, withdraw intermediate gear. **Fig - 13**



Fig. 14

To remove the spindle use special tool 0102003 - Sliding Hammer and special tool 0102002 - Adaptor Idler Gear Shaft. **Fig - 14**

#### 16.6.9 Install the Idler Gear Shaft (Spindle)

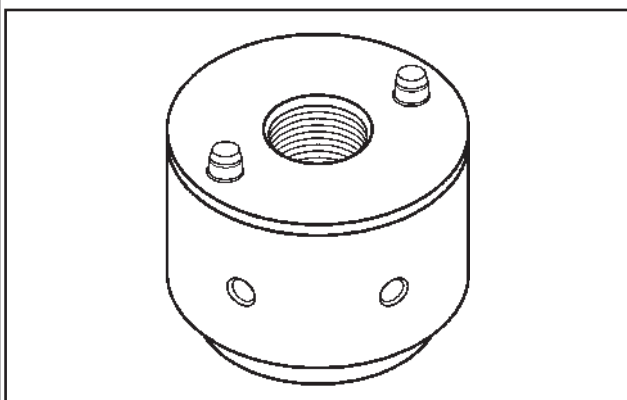


Fig. 15

Install idler gear shaft with thrust plate using a plastic hammer.

Make sure that the two oil holes is facing downward (oil pan side) so that it does not become clogged due to accumulation of sludge and other foreign material in the oil. **Fig - 15**

#### 16.6.10 Install the Idler Gear

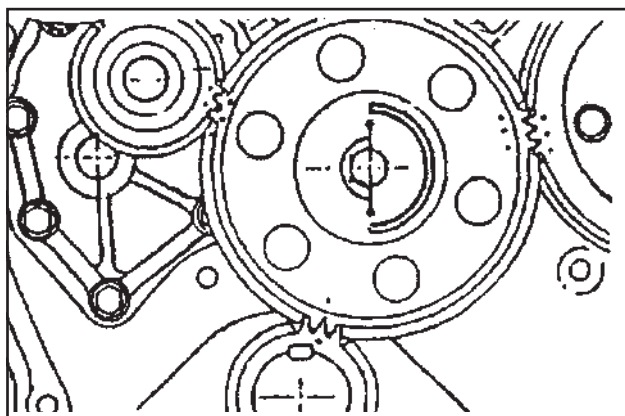


Fig. 16

Install the Idler gear, be sure that the matching marks of the crankshaft gear, oil pump drive gear and idler gears are aligned correctly. **Fig - 16**

Check end play within 0.040 - 0.095 mm.

Ensure backlash - 0.068 - 0.194 mm.

#### Tightening torque procedure for idler gear bolt

- Apply oil on bolt thread and face
- Initial torque by 100 Nm, then loosen the bolt.
- Then torque the bolt to 40 Nm + 60° - 65°

#### 16.6.11 To Re-bush Intermediate Gear

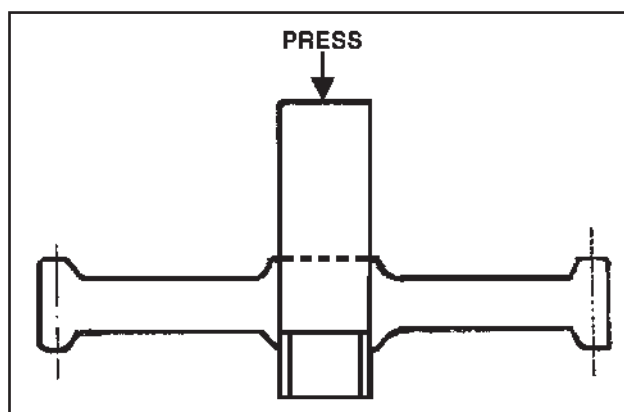


Fig. 17

Press out the worn bush with a suitable drift. **Fig - 17**  
Drive in the new bush.

The replacement bush is supplied finished.



Max. oil clearance  
between spindle  
and bush = 0.1 mm

Intermediate gear  
endplay = 0.15 mm

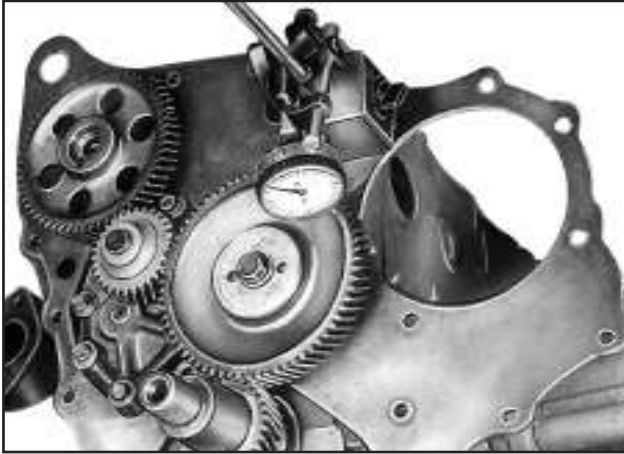


Fig. 18

Fig - 18

Bush internal diameter = 50.00 mm

Spindle dia = 49.95-49.97 mm

#### 16.6.12 To Position Timing Gears for Valve Timing and FIP Timing

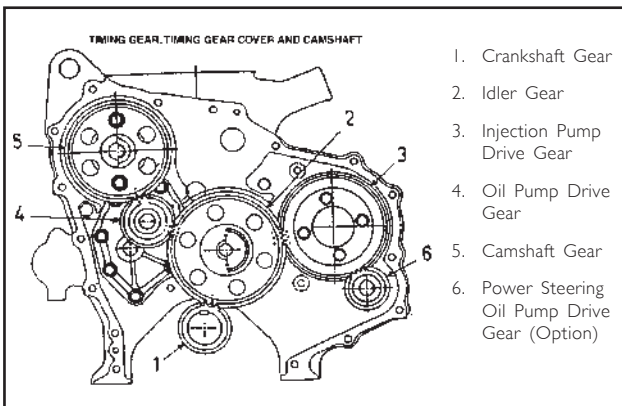


Fig. 19

The gear train to be matched as per matching punch marks on gear circumference. **Fig - 19**

#### 16.6.13 Timing Gear Backlash Checking



Fig. 20

Check tooth backlash with feeler gauge. **Fig. 20**

Backlash between driving gear and intermediate gear, should be within the recommended values.

Max. limit = 0.3 mm.

#### 16.6.14 To Fit Air Compressor

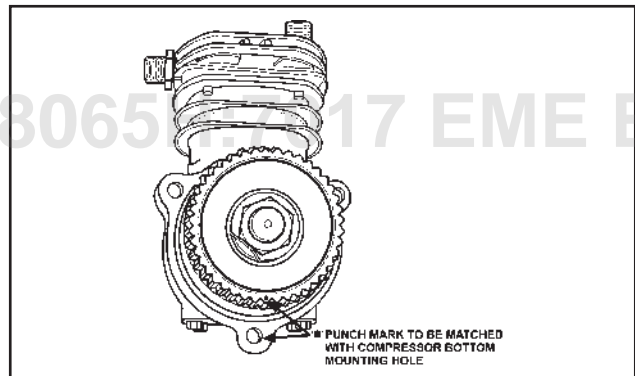


Fig. 21

While assembling, keep engine first cylinder at TDC, align '•' punch mark on the gear teeth with the bottom mounting hole, then assemble the compressor and tighten the mounting bolts. **Fig - 21**



### 16.6.15 To Remove and Refit Fuel Injection Pump and To Adjust the Injection Timing

Use special Tool 0102019 - Wrench for Engine Cranking.

#### A. Removal of FIP from Engine:

1. Isolate battery.
2. Remove high pressure pipe connections, remove over flow pipe connection from the fuel injection pump.
3. Remove the plate fitted on the flywheel timing window. Also remove connectors and cables from the FIP.



Fig. 22

4. Bring the no.1 cylinder at TDC on compression stroke by rotating the crank pulley suitably **Fig - 22** (Hint: there is no need to remove the rocker cover. At the first cylinder compression the double groove in the Inj. Pump drive coupling, which can be felt with hand from the open rear end of the Inj. Pump drive housing, will be 12 O'clock position).
5. Loosen the 3 nuts mounting the FIP onto the injection pump drive housing, and remove the FIP. There is no need to remove the injection pump drive housing.

#### B. Bench Calibration:

1. Remove the splined bush by a suitable tool. now, the FIP can be put on bench for calibration.
2. After bench calibration, fix the splined bush and torque tighten to the specified value.
3. Ensure position of the double tooth of the splined bush at 12 O'clock position.
4. The FIP is now ready for fitment onto the engine.
5. Ensure that the inlet adaptor on the FIP fuel inlet, Overflow ('OUT') Banjos are fitted back onto the FIP after bench calibration.



For latest Calibration chart refer MICO dealer.

#### C. Injection Pump Timing

The static timing spec for HA4CTI3N is  $0.3 \pm 0.02$ mm plunger lift at TDC.

#### D. To Refit the Fuel Injection Pump and adjusting the Fuel Injection Timing

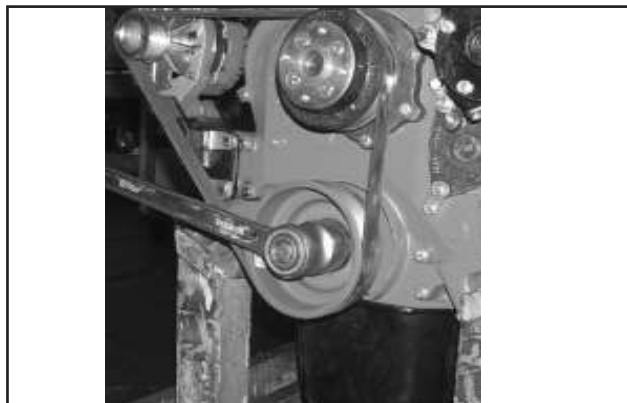


Fig. 22A

1. Bring the no.1 cylinder at TDC on compression stroke by rotating the crank pulley suitably **Fig - 22A**

( Hint: there is no need to remove the rocker cover. At the first cylinder compression, the double groove in the Inj. Pump drive coupling, which can be felt with hand from the open end rear end of the Inj. Pump drive housing, will be 12 O'clock position).



Fig. 23

2. Check the FIP mounting Gasket. **Fig - 23**



Fig. 23A

3. Fit the FIP onto the engine aligning the double tooth with the double groove in the injection pump drive coupling.

(Hint: at the correct timing the double tooth on the splined bush would be 12 O'Clock position).

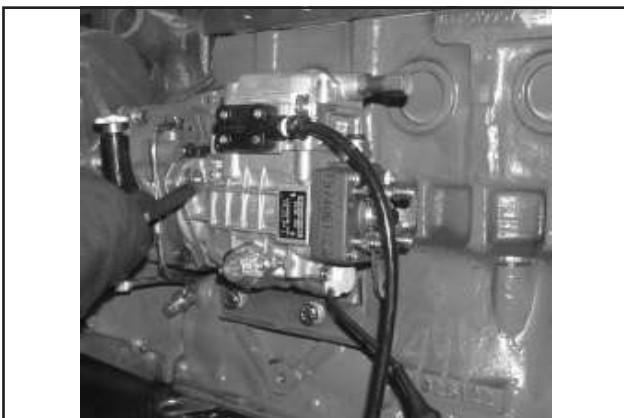
**Fig - 23A**

Fig. 24

4. Tighten the 3 FIP mounting nuts, by pushing the pump towards cylinder block. **Fig - 24**

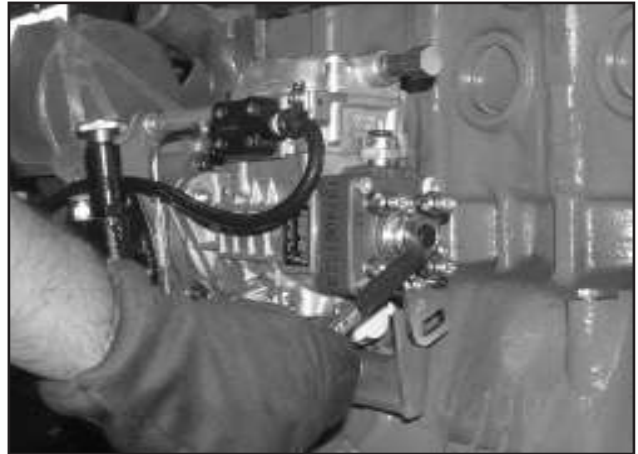


Fig. 25

- Remove the dummy plug from the distributor head. **Fig. 25**

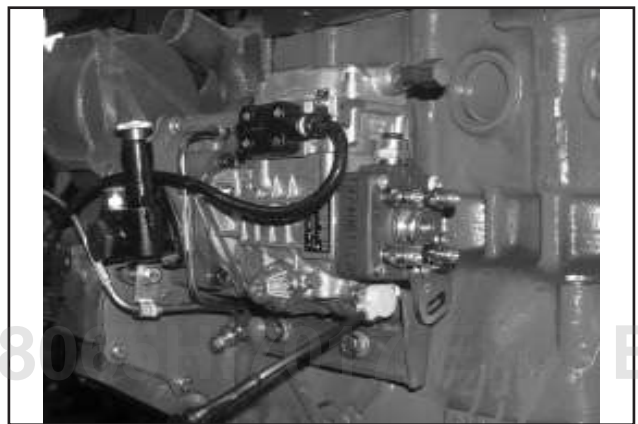


Fig. 26

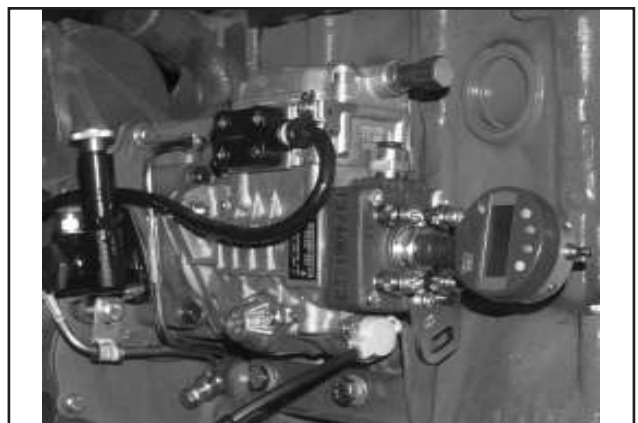


Fig. 26 A

6. After removing the dummy plug from the distributor head, fix the special tool. **Fig - 26 & 26A**
7. Rotate the engine in the opposite direction of rotation. Stop the rotation when the pointer of the dial indicator stops moving.
8. Set Zero on the dial.
9. Rotate the engine in the direction of rotation and align the 1/4 mark on the engine flywheel to the flywheel housing ref.





Fig. 27

10. The dial indicator should now read pre-stroke specified for the engine.

Static timing -  $0.3 \pm 0.02$  mm plunger lift at TDC.

11. If not, loosen the three nuts holding the FIP to the housing-inj. Pump drive and turn the FIP towards or away from the engine so that the dial reads the required pre-stroke value.

**Fig. 27**

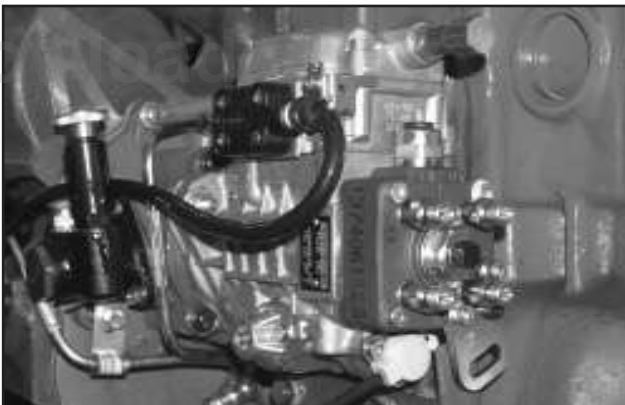


Fig. 28

12. Tighten the three nuts to torque ( $25 + 10$  Nm) secure the FIP firmly. **Fig. 28**

13. Remove the dial indicator and fit the dummy plug. **Fig. 28**

14. Fit the over flow pipe, fuel inlet / outlet pipes, high pressure pipes and FIP support bracket properly.

Ensure proper connections of governor, timer and shut off solenoid connectors.

#### FIP Timing Setting Tool

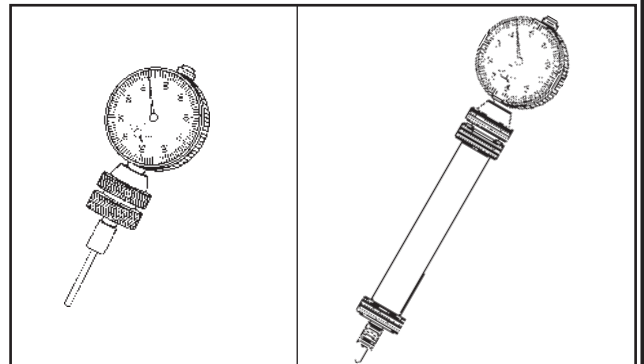


Fig. 28A - 28B

FIP rear end dummy plug sizes are M8 and M10.

Timing setting tool part no. SMT 3860. **Fig - 28A & 28B**

#### 16.6.16 To Adjust the Valve Clearance

**Method for determining if the No. 1 or No.4 piston is at the Top Dead Center on compression stroke.**

- \* Turning the crankshaft, align the mark "1-4" on the flywheel pointer on the flywheel housing.
- \* In this position either the No. 1 or No. 4 piston is at the top dead center on compression stroke.

If both No. 1 intake and exhaust rocker arms can be moved easily by hand, the No. 1 piston is at top dead center on compression stroke.

With the No. 1 piston positioned at top dead center on compression stroke, adjust the No. 1 valve clearance using a feeler gauge.



Fig. 29

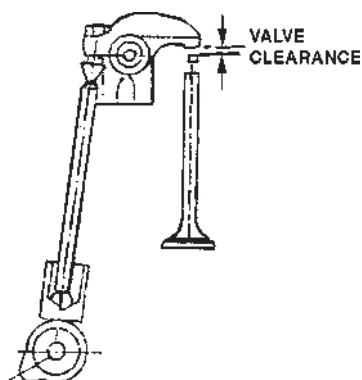


Fig. 29A

The feeler gauge should move with a very slight pull.

To adjust the other cylinder valves, by turning the crankshaft clockwise 180° (viewed from the front side). Adjust the valve clearance for each cylinder as per firing order. **Fig - 29 & 29 A**

#### 16.6.17 To Assemble FIP Drive Coupling

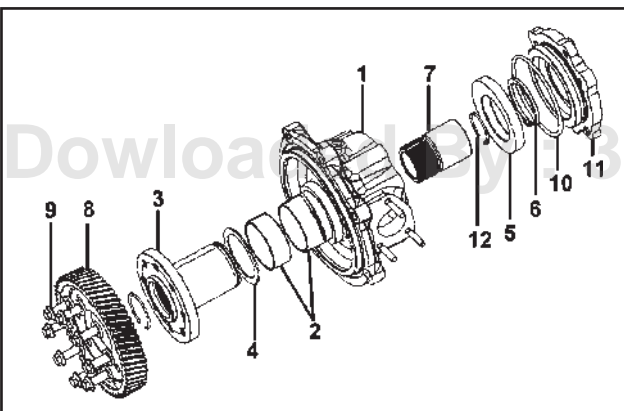


Fig. 29A

Assemble the bushes (2) on to the injection pump drive housing (1). **Fig. 30**

Pump drive shaft (3) is assembled along with a thrust washer (4) into the housing (1).

Eccentric (5) is press fit on to the drive shaft (3) and retainer circlip (6) is fitted.

The IPD (Injector Pump Drive) coupling (7) is assembled into the drive shaft (3).

Circlip (12) is fitted into the IPD.

FIP gear (8) is fitted onto the drive shaft (3) and retained with 8 bolt (9).

The end cover (11) with O ring (10) is fitted.

Feed pump is fitted on the drive on the injection pump drive housing.

#### Identification for FIP Splined Bush

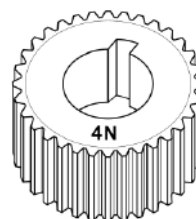


Fig. 31

Part No.	ID Mark	Application
X1600815	4N	HA4CTI3N

FIP is assembled with splined bush on to the FIP drive coupling. **Fig - 31**

#### 16.6.18 To Fit Injector High Pressure Pipes

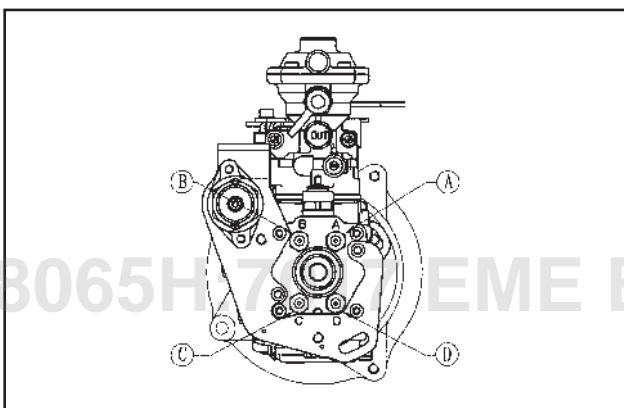


Fig. 32

The fuel outlet at distributor head of the FIP would be identified with alphabets A-B-C-D as shown in **Fig. 32**

The fuel outlet on the pump corresponding to each Engine cylinder is given in the table below :

#### Connection Sequence

Engine Cylinder no.	1	2	3	4
Fuel Outlet on the pump	A	D	B	C



### 16.6.19 Fuel Filters (MICO)

Effective fuel filtration is absolutely essential for trouble free operation of the fuel injection equipment.

Fuel filters have been designed to retain even the smallest of the impurities and protect the extremely sensitive precision parts of the injection pump and nozzle from damage.

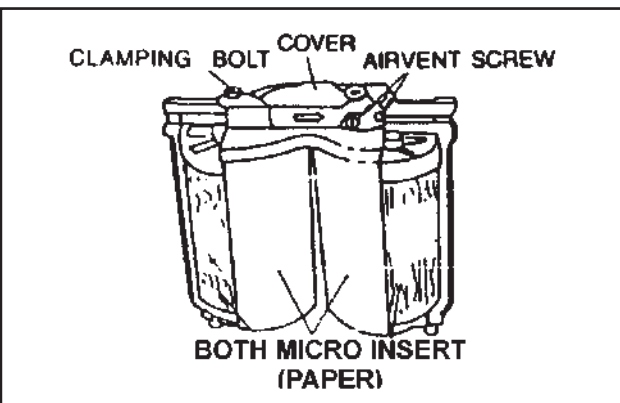


Fig. 33



**Do not use star type filter inserts.  
Always use coil type fuel filter. Fig - 33**

#### Maintenance

Filter inserts must be replaced at regular intervals. Guidelines for replacement period under normal conditions are given below.

#### Filter Change Period (Both Paper Coil Type)

First stage element	First 16000 km and thereafter every 16000 km
Second stage element	First 24000 km and thereafter every 16000 km



**Never change both the filters at a same time.**

The filter elements (inserts) should never be cleaned, at an interval lesser than the recommended period.

Sometimes the filter inserts get clogged in a very short time due to asphaltene or waxy compounds present in fuel. In such cases the filter inserts have to be replaced.

#### Renew Fuel Filter Element

- Unscrew centre bolt and withdraw the bowl and filter, Install new sealing ring and ensure it is correctly located.
- Clean the bowl free of sediments. Replace a genuine filter element and refit the bowl.

#### Bleed the fuel system

While bleeding the fuel system bleed the fuel through the high pressure injector pipes upto the injector end. It is necessary to crank the engine intermediately.



**Do not disturb FIP for bleeding.**

#### Water Separator (Fitted along with MICO fuel filter)

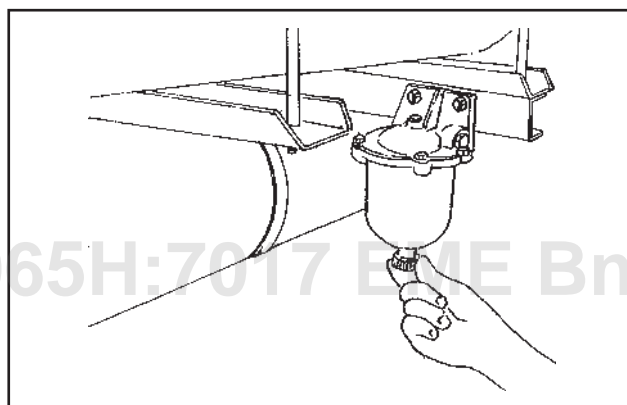


Fig. 34

Remove and empty the bowl and wash out with clean fuel. Prefill the bowl with clean fuel before refitting. Always renew the sealing ring.



### 16.6.20 Fuel Filter cum Water separator (Fleet Guard Make)

SCHEMATIC LAYOUT OF FLEET GUARD FUEL FILTERING ARRANGEMENT

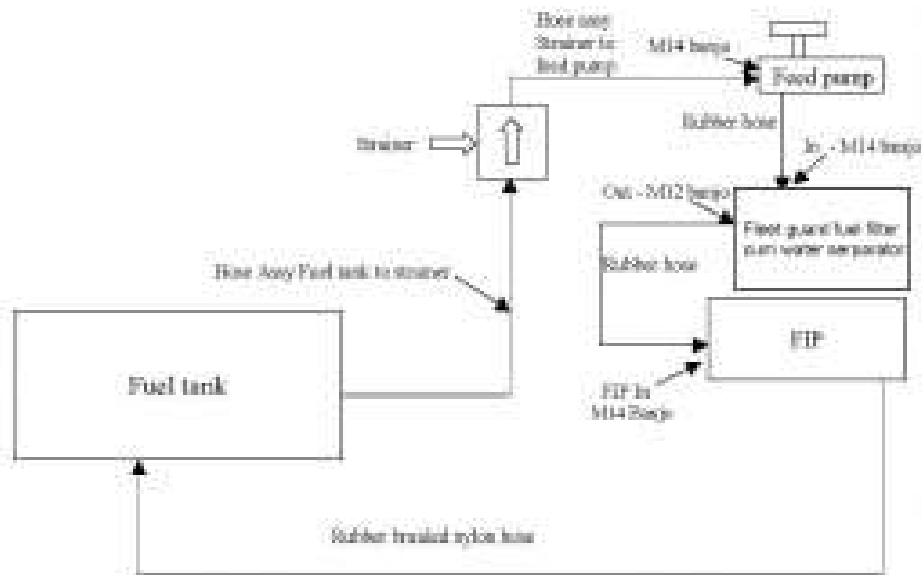


Fig. 35

Fleet guard fuel filtering system consists of a strainer (Fitted before feed pump) and a fuel filter cum water separator (fitted at pressure side before FIP). **Fig. 35.** For ease of identification, fuel in and out ports are embossed clearly on the filter-head.

Further, as a mistake proofing, the fuel in port is provided with M14 size and fuel out port is provided with M12 size threads.

#### Maintenance

Fuel filter must be replaced at regular intervals for efficient operation.

Under normal operating conditions, Fleet guard fuel filter cum water separator to be replaced at every 25,000 km of operation.

Fuel strainer to be replaced at every 50,000 km of operation.

Drain water daily or as and when required depending upon the prevailing condition.

#### Renewal procedure for Fuel Filter cum Water separator.

- Remove old filter using a filter wrench.
- Clean filter base and ensure that all the old gasket material is completely removed.
- Check the filter mounting adaptor for tightness.
- Install stud / thread seal.
- Apply a thin coat of clean engine oil to the gasket sealing surface of the new filter. Press the gaskets firmly into the gasket retainer groove while lubricating the sealing gasket. Do Not Use Grease.

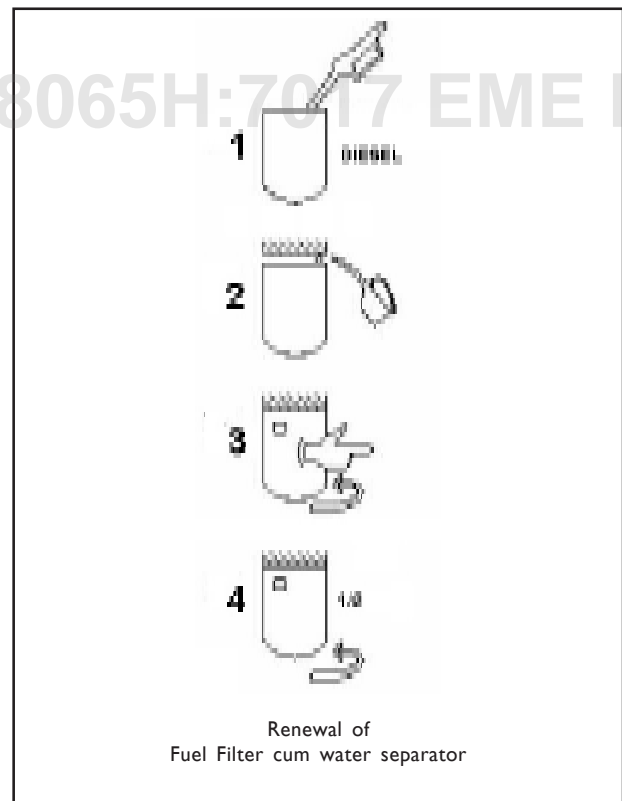


Fig. 35A

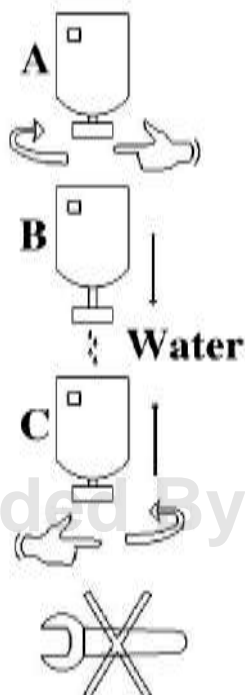
- Carefully read the installation instructions printed on the outside of the filter to determine the number of turns the filter must be rotated past gasket contact for proper installation and gasket compression.
- Pre-fill the new filter with clean fuel.
- Spin on the new filter until the sealing gasket makes contact with the sealing surface on the fuel filter head.





- Mark a reference point on the filter and head to identify the point that the sealing gasket first makes contact with the sealing surface of the head.
- Rotate the filter the number of turns past gasket contact indicated by the installation instructions printed on the side of the filter canister.
- Start the engine and check for fuel leakage around the sealing gasket and filter assembly.

#### Procedure for draining water



Draining Water from Water Separator

Fig. 35 B

Drain water from the unit as per the instructions provided on the component **Fig. 35B**.

- Rotate the drain cock anti-clockwise (as shown in the instructions printed on the outside of the filter)
- Drain the water till the fuel starts to flow.
- Rotate the drain cock clockwise the number of turns as indicated by the installation instructions printed on the side of the filter canister.
- Start the engine and check for fuel leakage around the sealing gasket and filter assembly.
- Never use a spanner for rotating the drain cock.



**Drain water daily or as and when required depending upon the prevailing condition.**



**Drain cock should be hand tightened fully. Never use any spanner.**

#### 16.6.21 To Remove and Refit Injector Nozzle

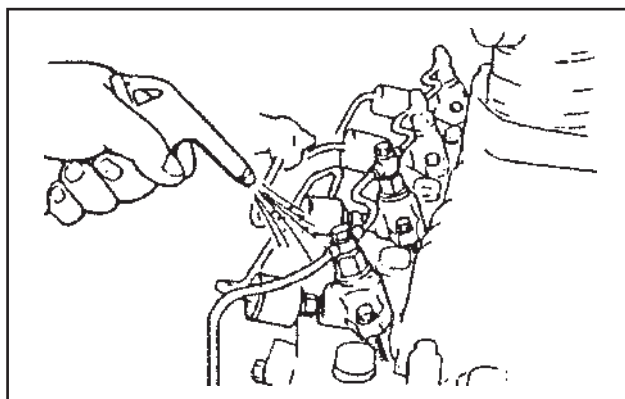


Fig. 36

Clean the surrounding area of the nozzle and fuel line connections. **Fig - 36**

Remove injector pipes, clean and cover both the ends of the pipes to prevent entry of the dirt.

Remove nozzle assembly.

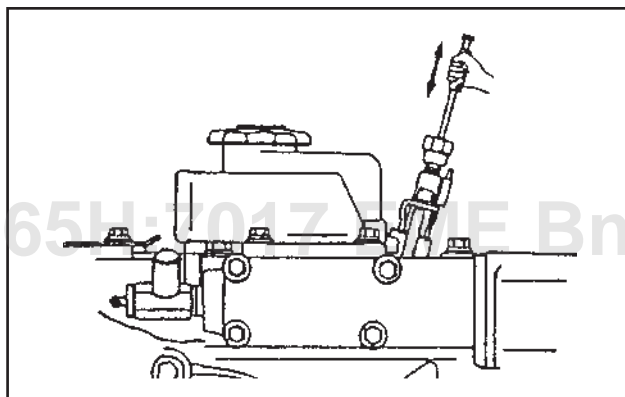


Fig. 37

Use a special tools 0102015 - Adaptor Injector Removal and 0102003 - Sliding Hammer. **Fig - 37**

#### 16.6.21.0 Cleaning



**The ball profile of DSLA nozzle is not hardened, extreme care to be exercised in handling the injectors and nozzles at all levels. Do not use emery sheet or hard material to clean the nozzles.**

#### To Clean nozzles

Use ultrasonic cleaning equipment.

Ultrasonic cleaning is a safe and effective way of cleaning the nozzles.

Ultrasonic cleaning equipment consists of generator capable of generating electrical energy at an ultrasonic frequency and a 'transducerized tank' which holds the cleaning solution and the parts to be cleaned. The Ultrasonic frequency waves are transmitted to the cleaning solution contained in the tank, which dislodges the dirt and soot.

The main objective of using this equipment is to clean the spray holes of the nozzles especially the DSLA type in which the ball profile is soft.



### 16.6.21.1 Test the nozzle sinking

Wash the nozzle with the diesel then immerse it in diesel oil.

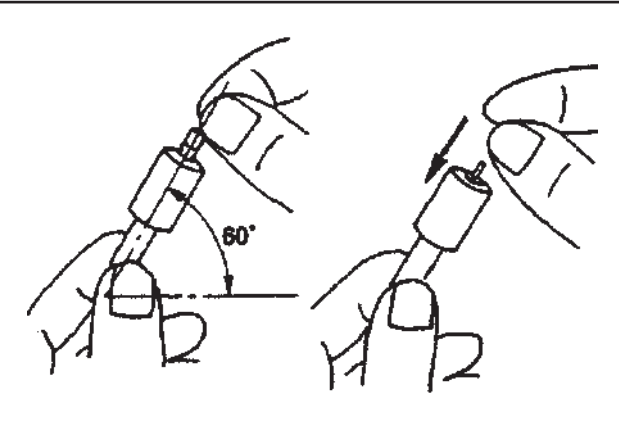


Fig. 38

Slide the needle inside the nozzle and ensure it moves smoothly.

The needle should fall under its own weight when withdraw vertically about 1/3rd and released. If its motion is sluggish, replace the nozzle with new one.

### Fig - 38

Adjust the injection pressure.

Connect the nozzle holder with a nozzle tester and move the lever at the rate of about 50 - 60 strokes per minute.

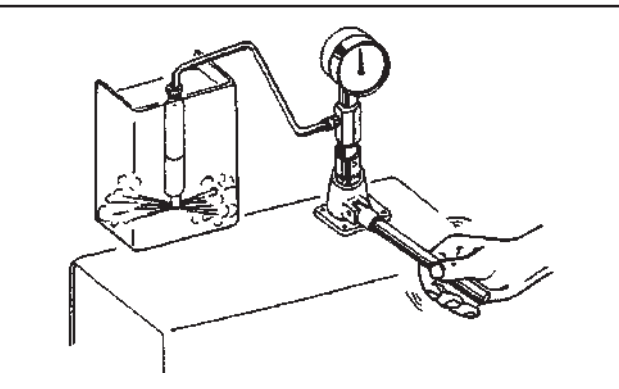


Fig. 39

Adjust the injection pressure as recommended. **Fig-39**

If the injection pressure is not within specifications, readjust the injection pressure with the shims.

### 16.6.21.2 Test the spray profile

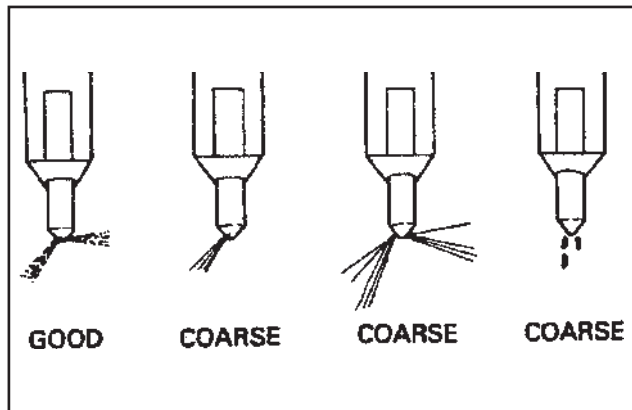


Fig. 40

In case of the new nozzle, operate the lever at the rate of 30 - 60 strokes per minute and for a used nozzle, operate the lever at the rate of 15 - 60 strokes per minute. **Fig - 40**

### 16.6.21.3 Test the fuel leakage (Dribbling)

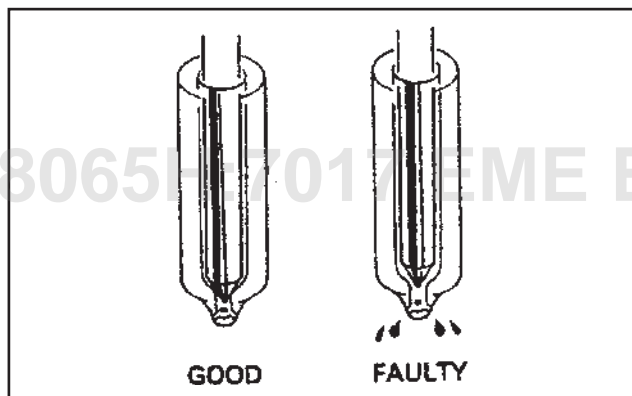


Fig. 41

When checking for fuel leakage from the nozzle, apply a pressure of about 10 - 20 kg/cm<sup>2</sup>, to lower than correct injection pressure to the nozzle. If there is no leakage, the nozzle is normal. **Fig - 41**

### 16.6.21.4 Install the nozzle holder assembly.

Fit the new nozzle washer.

Tighten the nozzle holder bolts alternatively right and left, until the specified torque is reached evenly



**1st Injector is integrated with a needel position sensor. Hence handle first cylinder injector with at most care. Do not use the connecting cable for lifting the injector.**

**Do not pull the injector cable for removing the injector assembly as it will damage the electrical circuitary and internal connections.**



## 16.7 Engine Lubrication

### 16.7.0 Design and Operation

The **Fig-1** diagram illustrates the arrangement of the equipment, and the flow of oil through the systems.

The engine is arranged for forced feed lubrication. The oil pump supplies the lubricating oil for engine.

The oil pump is located within timing gear cover and driven by Intermediate gear, the oil pump gear in turn drives the engine camshaft.

The oil pump forces the oil from the sump to the oil cooler. The oil is then filtered through full flow paper type oil filter, there are by pass valves for cooler and

filter respectively. After cleaning the oil passes to the main gallery via oil pressure relief valve it is forced through oil ducts to the crankshaft and camshaft bearings. The connecting rod big end bearings are supplied with lubricant from the crankshaft main bearings, through inclined oil ducts. The lubricating oil rises from the camshaft bearing No. 3 to the rocker shaft assembly. The intermediate gear pin is lubricated from the 1st main Journal Bearing & Aux. gallery. This oil also lubricates the other timing gears. The lubricating oil for the injection pump drive housing and Air compressor is tapped off from the duct feeding 1st main journal and carried to the injection pump drive housing and Air compressor by the pipe arranged outside the crankcase.

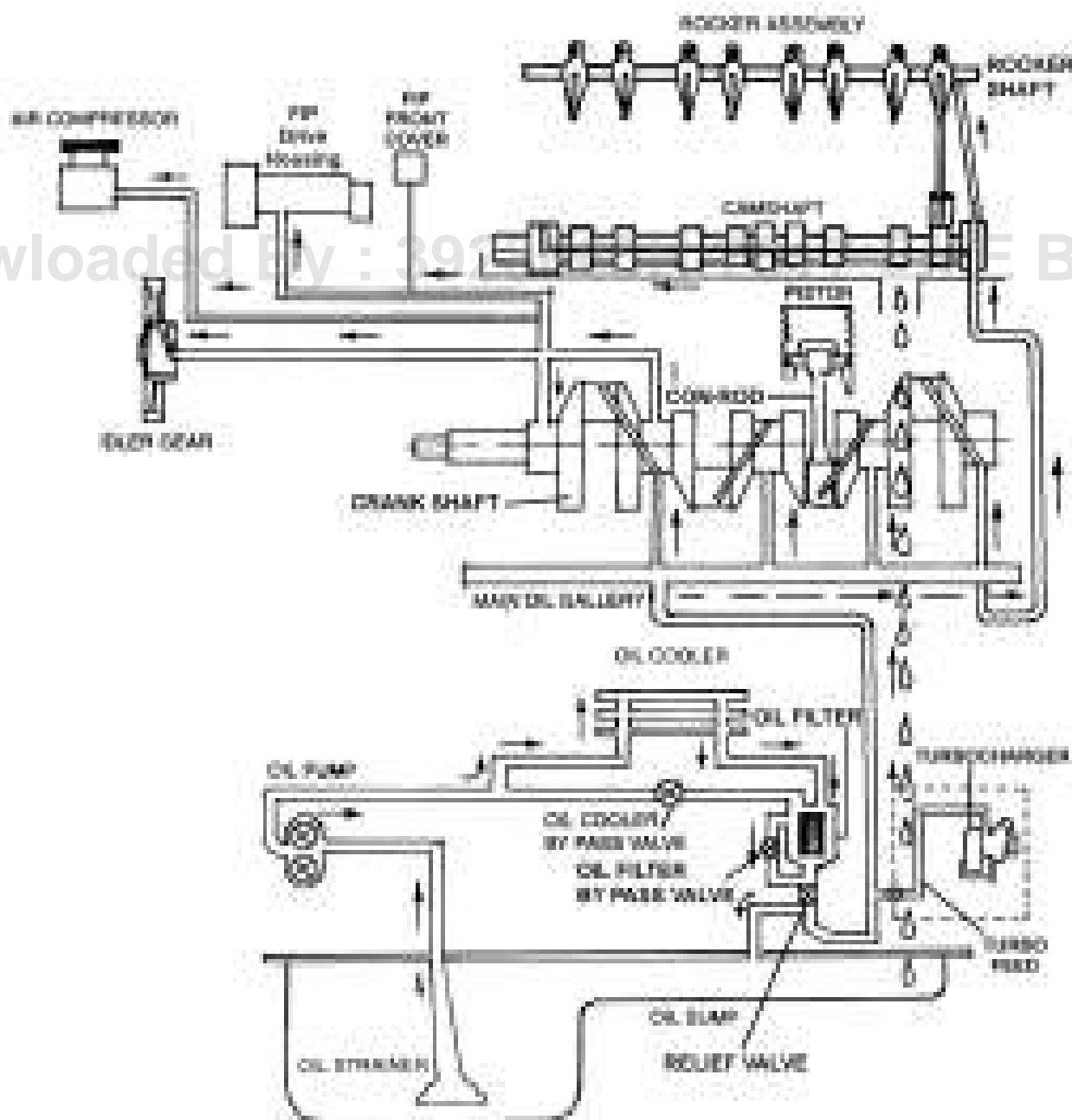


Fig. 1



### 16.7.1 To Remove and Refit Oil Pump

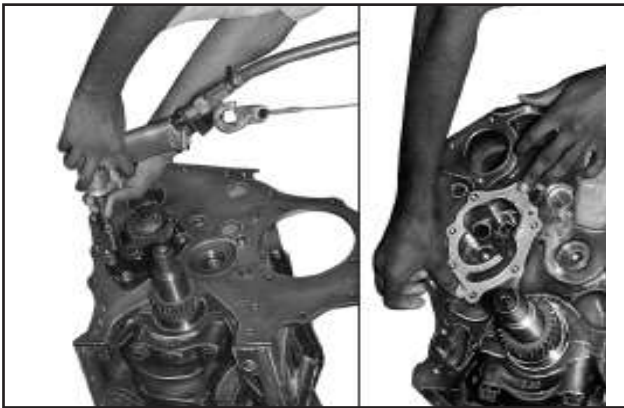


Fig. 2

Remove oil pump from front face of Crank case after removing intermediate gear and camshaft. **Fig - 2**

### 16.7.2 To Overhaul Oil Pump

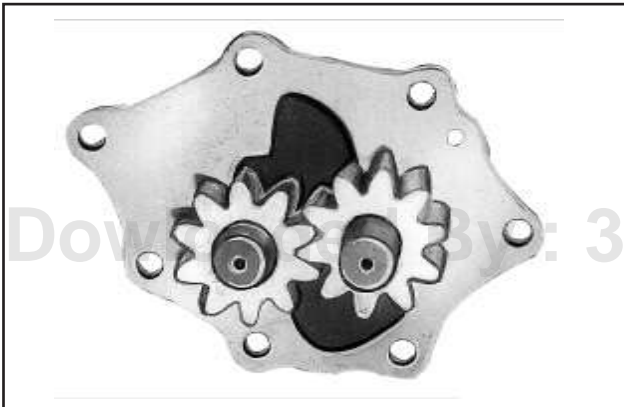


Fig. 3

Check Gear backlash between oil pump gears specification is 0.09 - 0.21 mm (limit - 0.30 mm). **Fig - 3**



Fig. 4

Replace the gear if Backlash exceeds the limit.

Drive gear shaft diameter to drive gear Bushing Inner diameter clearance should not exceed 0.040 mm - 0.085 mm, If found excess by measuring the Drive gear shaft and Bushing inner dia separately. The drive gear shaft diameter dimension - 18.088 - 18.106 mm (limit 18.06 mm). **Fig - 4**

Check clearance between driven gear and shaft 0.040 - 0.075 mm (limit - 0.1mm). Replace gear or shaft whichever is worn excessively.

Driven gear Shaft Diameter 17.979 - 17.997mm (Limit 17.970 mm). Driven gear inside diameter 18.037 - 18.054 mm (Limit 18.070 mm).

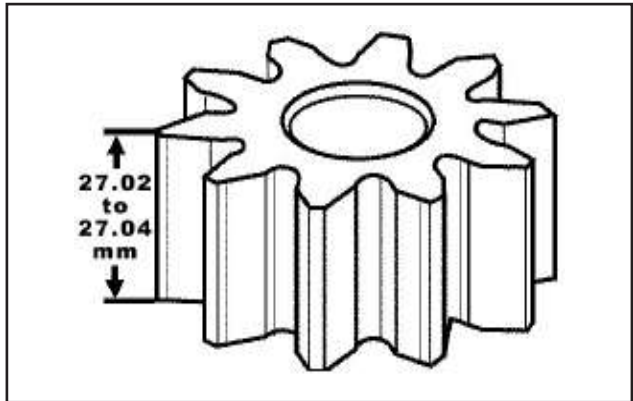


Fig. 5

Ensure height of the oil pump gear is between 27.02 & 27.04 mm. **Fig - 5**

### 16.7.3 To Refit the Oil Pump



Fig. 6

The oil pump assembly is fixed by means of 7 screws, two of which are located at the counter sunk area.

The bolts used at these 2 locations have controlled head thicknesses and are to be fitted using thread sealant and without washers. Tightening sequence of the oil pump. **Fig - 6.**

Make sure adequate clearance between idler gear and oil pump cover, in view of the increased width of idler gear.



## 16.7.4 To Overhaul Oil Cooler and Filter Assy

### 16.7.4.0 To Remove



Fig. 6

Remove the entire assy of oil cooler and oil filter from engine after draining coolant from cylinder block and oil from filter drain plug. **Fig - 6**



**All Bolts are of 13 mm size, But of Varied length. Be careful to identify the bolts to its original place during reassembly. Remove & refit O-rings 4 nos during reassembly**

### 16.7.4.1 To Overhaul Assembly



Fig. 7



Fig. 8

Clean the oil filter head and oil cooler plate.  
Clean the oil cooler.  
Assemble the oil cooler by-pass valve.



Fig. 8A

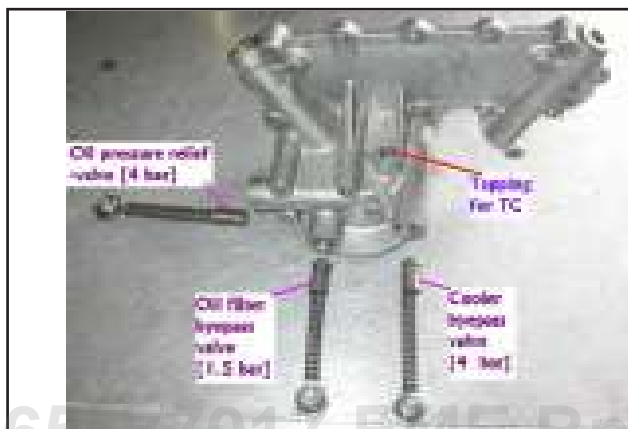


Fig. 9

Assemble the oil filter by-pass valve.  
Assemble oil pressure regulator valve.  
Assemble oil pressure gauge adaptor.  
Assemble the oil cooler on the oil cooler plate.  
Replace the 'O' ring at oil filter centre bolt and position the bolt in oil filter bowl.  
Replace the 'O' ring on the top of filter bowl.  
Refit the spring and the plate washer in the bowl.  
Fit a new oil filter element, washer, sealing ring facing upwards.  
Fit filter bowl with filter element to the filter head tighten the centre bolt.  
Also tighten the drain plug. **Fig - 7, 8, 8A & 9**





#### 16.7.4.2 To Refit Oil Cooler



**Fig. 10**

Clean the gasket sealing faces thoroughly. **Fig - 10**



**Fig. 11**

For oil cooler / oil filter assembly a compressed asbestos gasket is used. **Fig - 11**

This will prevent oil cooler casing from direct contact with coolant, in turn aluminium surface erosion.



**Install Oil Cooler with filter.**

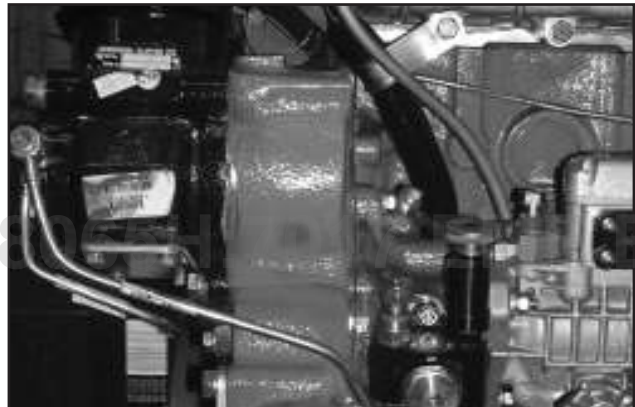
#### 16.7.4.3 Install the Oil Strainer

Make sure to install O ring guide and O ring on adaptor.

**Lubrication pipe connections.**



**Fig. 12**



**Fig. 13**



**Fig. 14**

Lubrication pipe connection from crankcase to FIP cover timer / Air compressor and front cover. **Fig 12, 13 & 14**



## 16.8 Cooling System

### 16.8.0 General

The engine is water cooled, and forced circulated by a water pump.

The coolant, drawn by the pump from the radiator or the thermostat control by-pass enters the crankcase and oil cooler. It is then passed to the cylinder head. The coolant returns to the radiator via thermostat housing.

During vehicle operation the thermostat functions to maintain the operating temperature of 80° to 85°C.

The thermostat installed in the cooling system controls not only the flow of coolant to the radiator but also regulates the by-pass flow alternately i.e when it allows the coolant to flow back to the radiator it closes the by pass fully and vice versa.

The sensing unit of the coolant temperature is provided at thermostat housing. It shows the engine coolant outlet temperature.

### 16.8.1 To Flush Cooling System

Flushing of the cooling system might become necessary because of impurities in the coolant itself.

The cooling system may also be clogged by rust deposits, grease or other impurities in the coolant. This should be removed by flushing the system several times with hot water containing a grease dissolving agent.

Let the engine run when flushing the system.



**Make sure that solution does not contain any acid as even the smallest amount of it in the cleaning fluid is likely to affect the cooling system unfavourably.**

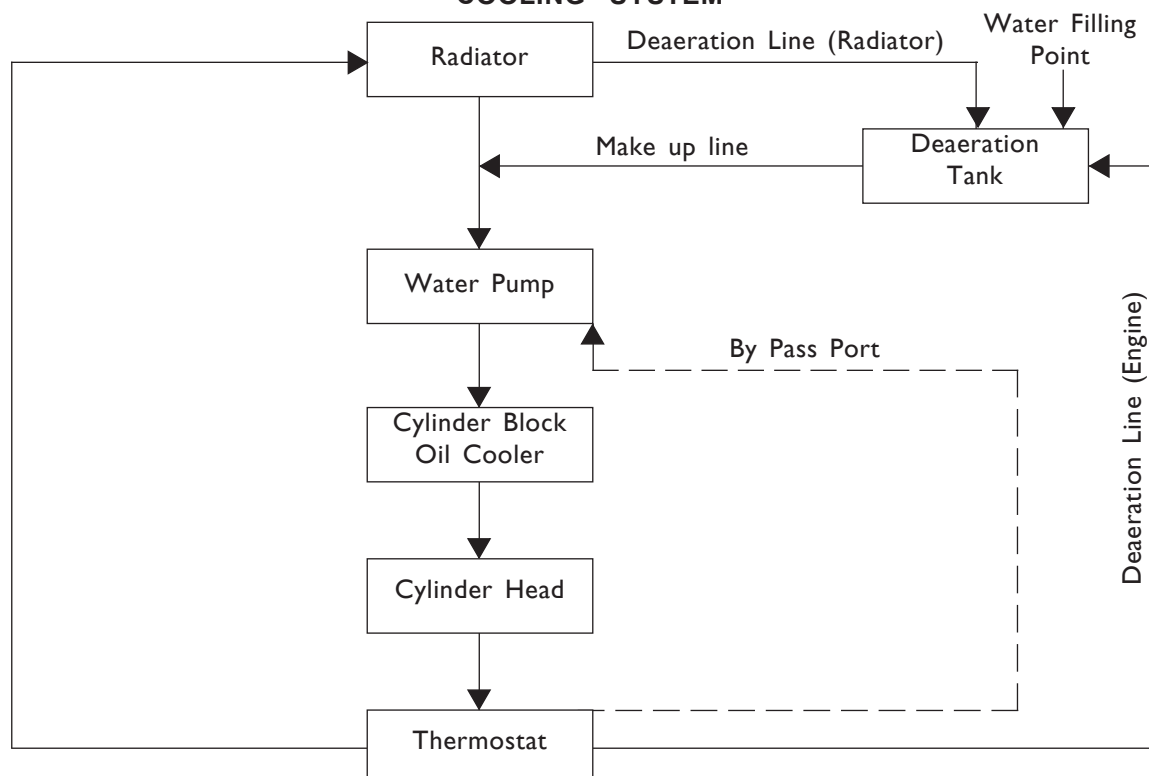
Having drained off the solvents, flush the system several times whilst the engine is running.

The use of hard water fosters the formation of fur which may be removed with aid of an acid free solvent. The fur removing agent must not be aggressive to copper brass and zinc materials used in the cooling systems.

Also flush the cooling system several times after application of a fur solvent.

Should lime has deposited too heavily in the radiator tubes remove radiator and have it cleaned mechanically by a specialised workshop.

### COOLING SYSTEM





### 16.8.2 External Cleaning of Radiator

The radiator tubes/fins may be cleaned by washing them with using a suitable hot cleaning solutions such as 0.5% of HP Radiator cleaner (supplied by M/s Hindustan Petroleum corporation).

A 5% caustic soda solution (sodium hydroxide) may also be used for this purpose. In addition, the radiator fins can be blown from the inside with air or water with less than 2 kg/cm<sup>2</sup> pressure.

### 16.8.3 Engine Cooling Fan and Fan Clutch



Fig. 2

- 520 mm dia 10 bladed fan with viscous clutch is fitted in HA4CTI3N engine. **Fig - 2**
- Viscous fan clutch engages when the sensor senses about 55°C (air temperature).
- Reduces fan power consumption at low temperatures, thereby improving fuel economy.

### 16.8.4 Service Tips for Viscous Fan / Clutch

- Handle the fan / fan clutch with care.
- Check the bimetallic temp sensing coil for any mud or dust. If the coil is covered with mud or dust, the fan performance will be erratic. Remove any mud / dust carefully with a brush.
- Do not paint the fan / clutch.
- Do not try to dismantle the clutch, the clutch is a sealed unit for removal.

### 16.8.5 To Test Thermostat



Fig. 3

Remove hose connection and take out thermostat.

### Inspection of thermostat function

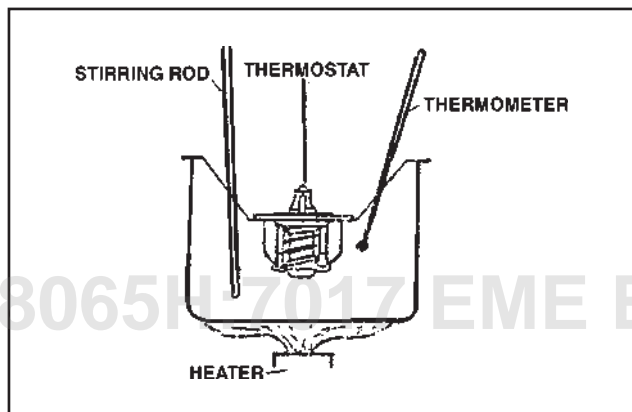


Fig. 4

Place the thermostat in hot water and check the valve opening temperature and valve lift. The thermostat valve opening temperature is punched on the thermostat seat, and it should be confirmed. **Fig - 4**

Check commencement of opening. This is the temperature at which the stroke of the thermostat has risen to 0.1 mm in a gradually heated water bath.

Commencement of opening = 82°C ± 2°C.

Measure the stroke with the aid of special device and dial gauge.

Check full working stroke.



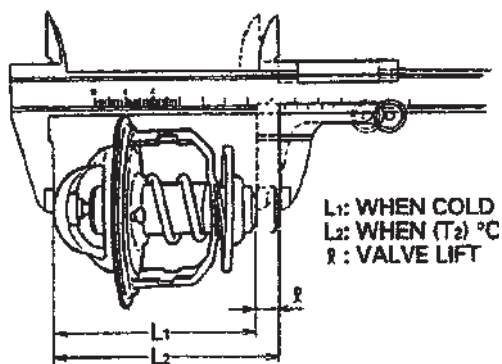


Fig. 5

Working stroke = 10 mm at 92°C. **Fig - 5**

#### Install the thermostat

Remove the water and dirt adhering to the thermostat casing.

Replace the gasket without fail, if it is corroded, damaged or flattened.

Before install the casing cover apply the liquid gasket on the casing joint.

#### 16.8.6 To Remove and Refit Water Pump



Fig. 6



Fig. 6A

Drain off coolant collecting it in a clean container if anti-freeze has been added.

Unscrew fan and remove V belt for water pump fan and alternator.

To refit water pump reverse the procedure for removal.

**Fig - 6 & 6A**

#### 16.8.7 To Overhaul Water Pump

##### Dismantling

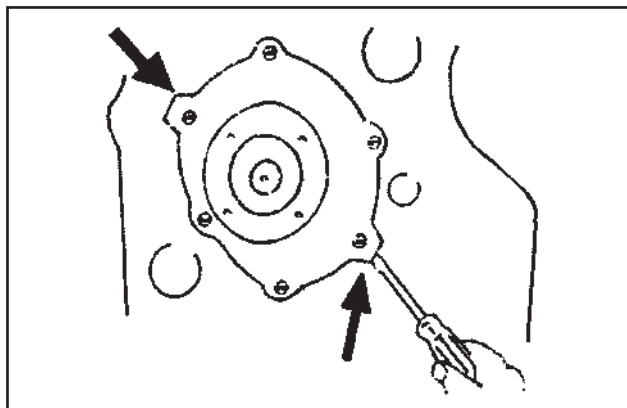


Fig. 7

Unscrew water pump mounting Hex screws, remove water pump by prying loose with screw driver at the 2 points on the flange. **Fig - 7**

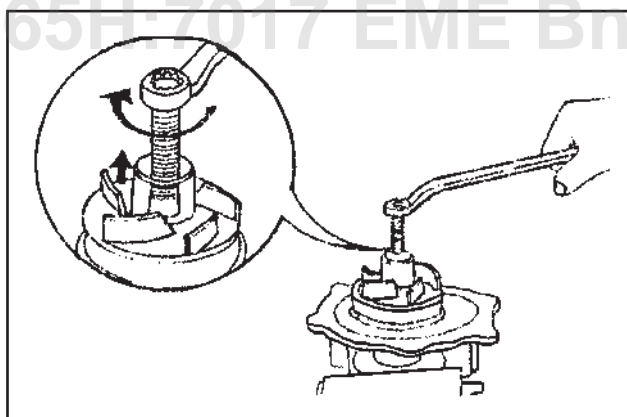


Fig. 8

Remove the water pump vane from shaft by screwing in a bolt of 10 mm dia, 1.5 mm pitch. **Fig - 8**

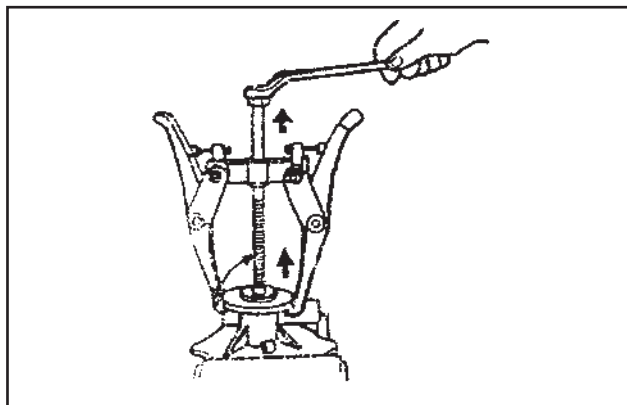


Fig. 9

Using a conventional puller remove the pulley from the shaft. **Fig - 9**

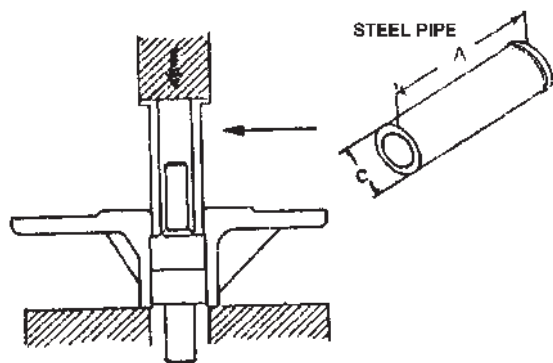


Fig. 10

Using a steel pipe and press, remove the water pump shaft along with sealed bearings from water pump body. **Fig - 10**

To install new water pump seal apply a little liquid sealant to the water pump seal outer circumference and water pump body. Install the slinger and coolant seal.

To install Vane. (Impeller)

Using a press install the Vane to the shaft.



Apply a little engine oil to the seal face.

**Maintain distance between water pump mounting face to impeller outer dia end tip.**

Model	Dimensions (in mm)	
	A	B
HA4CTI3N	20.8	85 dia

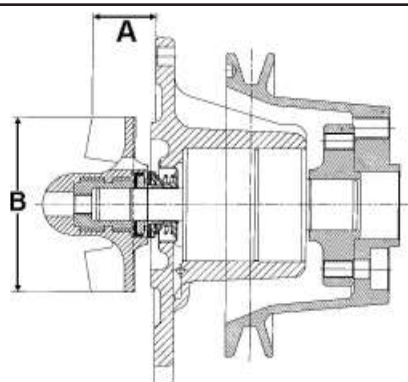


Fig. 11

Fig - 11

Refit the water pump assy after applying fresh liquid sealant over clean surface.

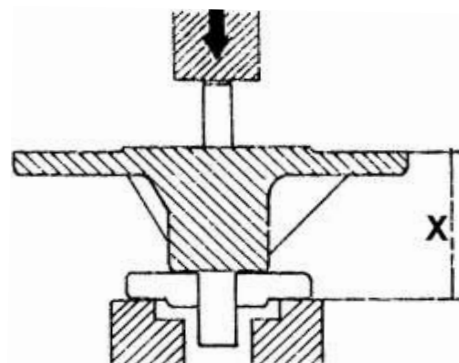
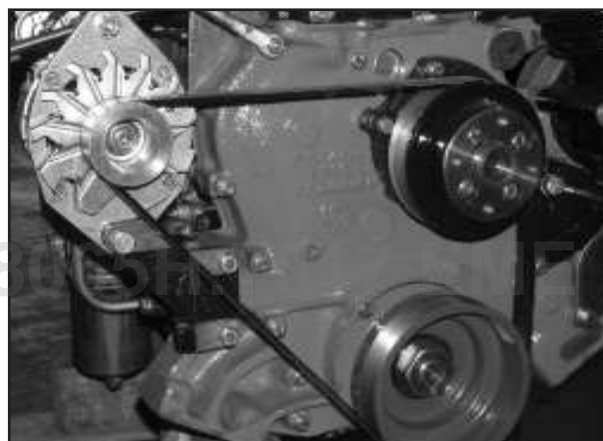


Fig. 12

Using a press, install the pulley drive flange. The distance(X) from water pump installation face to flange outer face should be 99 mm **Fig. 12**

#### 16.8.8 To Remove and Refit Fan Belt - To adjust fan belt tension



Loosen the necessary fasteners, slacken the pulleys & remove the old belt.

Check pulley grooves for wear / damage and replace the pulley if required.

Clean the pulley grooves for debris and ensure not to apply oil or grease on the pulley grooves.

Check alignment of the pulleys.



**Misalignment of pulleys will produce noise & shorten the belt life.**

Mount the belt over pulleys and ensure that the belt ribs are seated in the respective pulley grooves.

Tension the belt and tighten all the fasteners.

Run the engine for 3 to 5 minutes with the applied tension to allow the belt to seat in the respective pulley grooves properly. Reset tension.

Apply initial belt tension of 700N by adjusting the alternator position.



To ensure the applied tension, measure it in the middle of span between water-pump pulley and alternator using electronic type tension gauge.

Verify the initial tension after running the engine for 24 hours

### Tensioning of fan belt

A tight belt results in rapid wear of

- a) Fan belt
- b) Alternator and Water pump bearings

A loose fan belt result in

- a) Squeaking noise
- b) An undercharged battery
- c) Engine overheating

### Belt tension Procedure

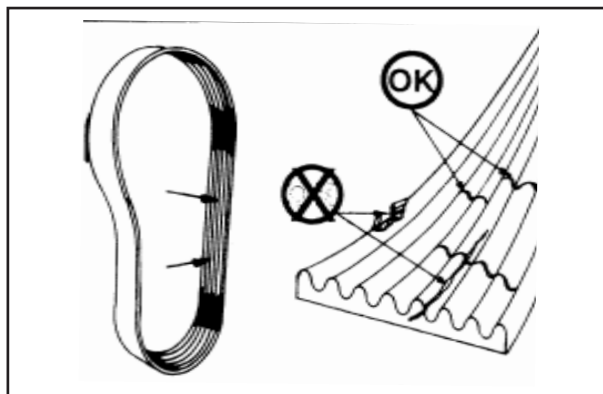
- Hold the sensing head steadily across the belt span within 5~10 mm distance above the top surface of the belt.
- Tap the belt gently near the mid span using a rod or with similar tool to cause the belt span to vibrate.
- Check the required tension display on the LCD panel of the Tension Meter.
- If a reading is not obtained, check the sensing head for correct positioning and ensure that it is positioned properly.
- Repeat the same procedure to recheck.

### DO's:

- Check belt tension at regular intervals and adjust as needed.
- Check for any abnormal wear and damage in pulleys / Belt
- Check for pulley alignment
- Make belts free of fluffs and dirt.

### DON'Ts:

- Don't over tension the belt
- Don't apply oil/grease or paint on pulley grooves
- Don't fix the belt improperly aligned
- Don't use worn out belts
- Don't pry the belt using sharp tools.



Visually inspect the belt.



**Replace the belt if it is frayed or pieces of material missing or longitudinal cracks intersect with transverse cracks.**

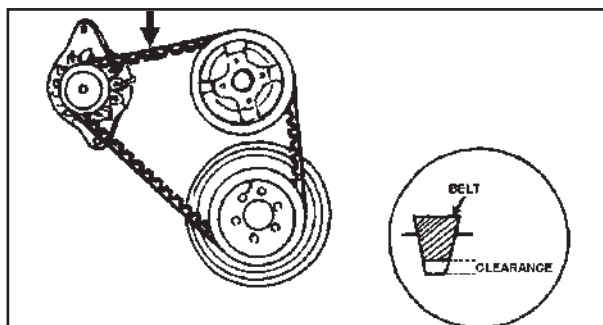
### To Remove and Refit V Belt. To Adjust V Belt Tension (Cogged V Belt arrangement)



Loosen the adjusting Bolt on the Alternator and remove the V belt.

To refit V Belt, swing the alternator towards the crankcase

To Tension the V belt swing the alternator outwards.



Tighten the fixing screw on the alternator adjusting bracket. Fan belt play (tension) should be 10 - 15 mm, when applying load of 10 kg by pressing with your finger.

The V belt should not touch the bottom of the pulley groove.



## 16.9 EXHAUST AND INTAKE MANIFOLD

### 16.9.0 To Remove and Refit Exhaust Manifold

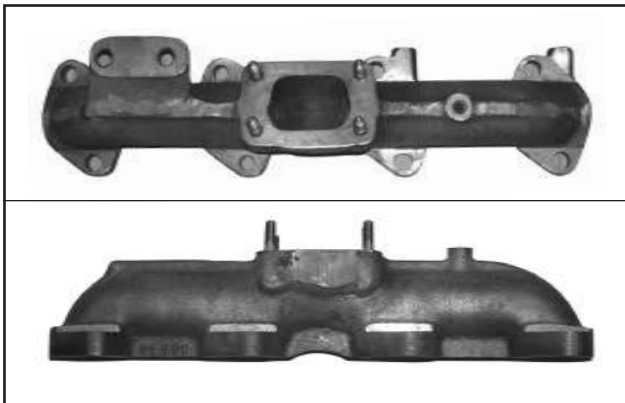


Fig. 1

Disconnect front exhaust pipe from the turbocharger outlet elbow.

Backout manifold attaching screws from cylinder heads and remove the exhaust manifold taking care of the gaskets.

To refit manifold, reverse the procedure for removal.

### 16.9.1 To Remove and Refit Intake Manifold

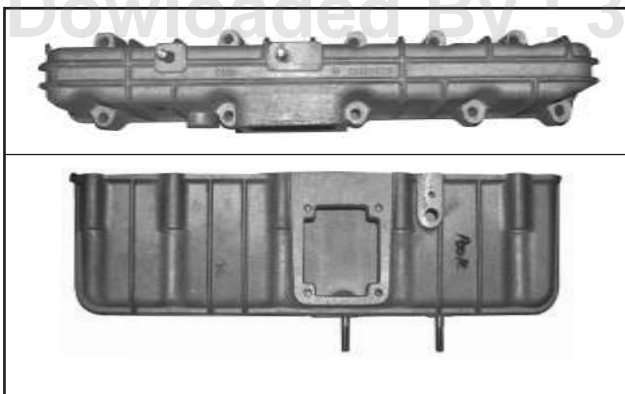


Fig. 1A

Backout fixing screws and remove the vertical intake pipe. Backout manifold attaching screws from cylinder head and remove intake manifold.

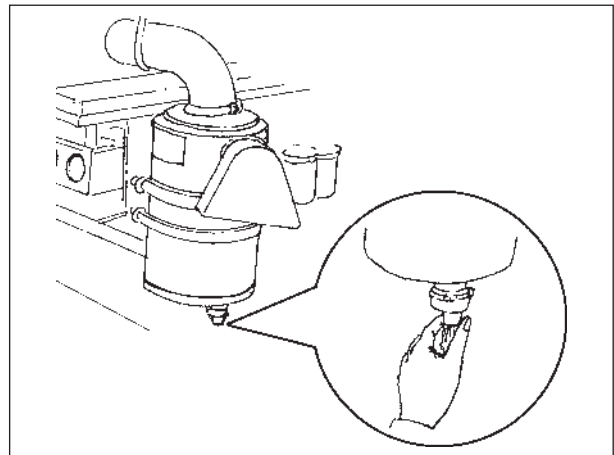
Clean thoroughly inlet manifold gasket sealing face and refit new gasket.

To refit intake manifold, reverse the procedure for removal.



**Use liquid gasket. Take care that the gasket does not get in to the inside surfaces. Tighten down the attaching screws evenly.**

## 16.9.2 Maintenance and Servicing of Dry Type Air cleaner



Maintenance of Air cleaner plays a major role in engine performance and life. Poor air cleaner maintenance will result in complaints like excess liner wear, high engine oil consumption, excess blow by and poor pick up.

### Maintenance and Servicing

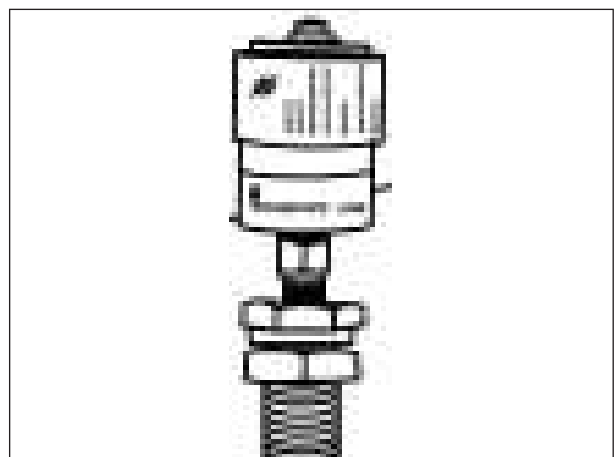
Following maintenance recommendations need to be strictly followed.

- Remove dust deposit weekly by squeezing the dust evacuator valve.
- Replace dust evacuator valve immediately if it is torn, cracked, remains open or missing.
- Never operate the engine, if the restriction indicator is either broken or missing.



**Do not clean the air filter elements.**

- Replace primary filter element as soon as vacuum indicator shows red band.



- Replace the secondary filter element at the time of every third replacement of the primary filter element.



**The wing nut should be tightened with hand alone. Excessive tightening would damage the air cleaner.**



## 16.10 Aluminium Radiators and Charge Air cooler

### 16.10.0 Service Instruction

#### 16.10.0.0 Introduction

This manual explains the procedure for servicing (specifically, the sealing of leakages) of aluminium radiators fitted with plastic tanks that may damage in actual usage due to improper handling before installation on the vehicle.

The procedure covers the following aspects of servicing:-

- \* Leakage spot detection
- \* Sealing Techniques and the tools required
- \* Confirmation of proper sealing

#### 16.10.0.1 Details of Radiator

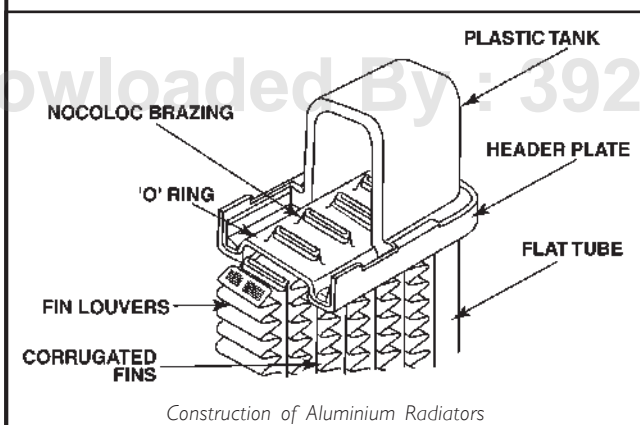
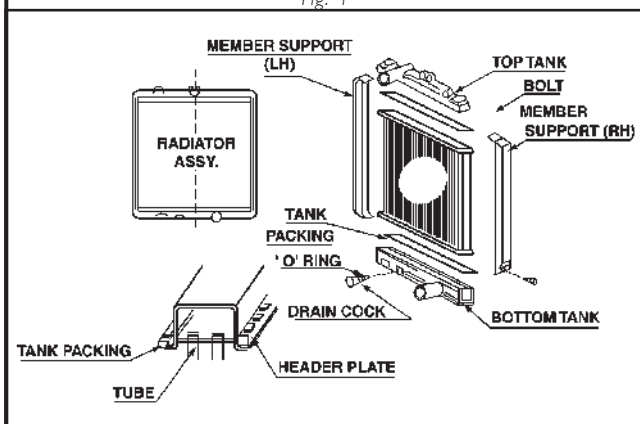


Fig. 1



A typical radiator is shown in Fig - 2 for reference.



Users are requested to get themselves familiar with all the parts and the assembly of radiator before undertaking the servicing.

#### 16.10.0.2 Servicing Kit

The radiator servicing kit consists of following items:-

- \* Screw Driver
- \* Monkey Plier
- \* Sealant resin and hardener containers (Araldite Standard of M/s Ciba Geigy make or on equivalent Epo x y based system)
- \* Alumaseal container
- \* Araldite applicator
- \* Brush



Araldite rapid may be used in place of Araldite standard for faster drying and curing of seal.

#### 16.10.0.3 Procedure for Servicing

##### Removal of radiator from vehicle -

- \* Allow the coolant in the radiator to reach to the room temperature.
- \* Drain the coolant from radiator completely by unscrewing the drain cock.
- \* Remove all the mounting fasteners, attachments like shroud, hoses etc.
- \* Take out the radiator from the vehicle carefully without damaging the core.



Radiator core and plastic tanks are susceptible to cracking due to impact and deformation. Handle carefully.

##### Detection of Leakage Spot -

- \* Connect the inlet of the radiator to air supply at the gauge pressure of 1.5 bar.
- \* Seal all other outlet points.
- \* Dip the radiator completely in a clean water tank.
- \* Tilt the radiator and shake it vigorously to let the air bubbles trapped at the clinching area to escape.
- \* Observe carefully for one minute and locate the source of air leakage on the radiator from the direction of air bubbles that are coming out of the radiator.



Do not use the water tank that is used for copper radiators.

##### Sealing the leakage spot -

Following procedures shall be adopted for arresting leakages at different locations of the radiator.





### Replacement of Plastic tank –

- \* Take out the member supports using 13 size spanner

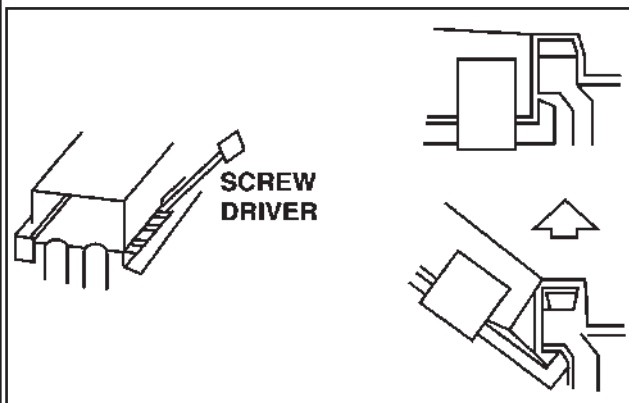


Fig. 3

- \* Release the clinch projections of header plate using screw driver. **Fig - 3**
- \* After making all the clinching projections up, take out the tank from its seat in header plate while grasping the outlet.

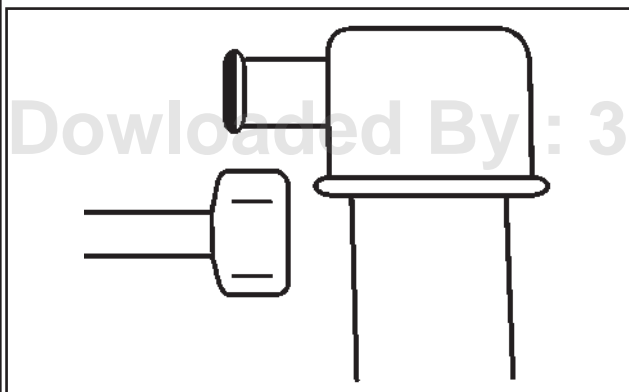


Fig. 4

- \* In case, it takes more effort, pat the tank with rubber or plastic hammer lightly. **Fig - 4**
- \* Take off the tank packing.
- \* Clean the area of the header plate where the tank sits, thoroughly.
- \* Insert new tank packing in the place without twisting.
- \* Insert new tank (top or bottom) as applicable.



**If the source of leakage is at the base of the tank, i.e. area between header plate and tank there is no need to replace the tank.**



**Tank packing shall be replaced, every time, the tank is taken off for servicing.**

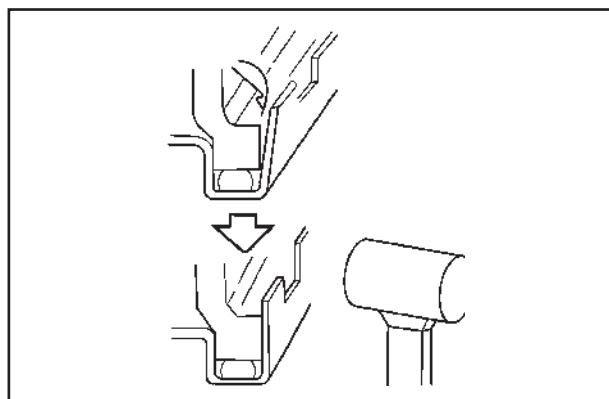


Fig. 5

- \* If gap is found between the clinching projections of header plate and tank, softly hammer the projections. **Fig - 5**
- \* Clinch the header plate projections with monkey plier.

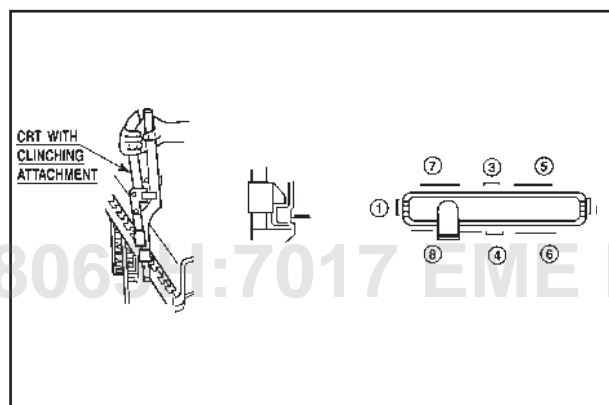


Fig. 6

- \* The sequence of clinching should be followed as illustrated in the figure. **Fig - 6**

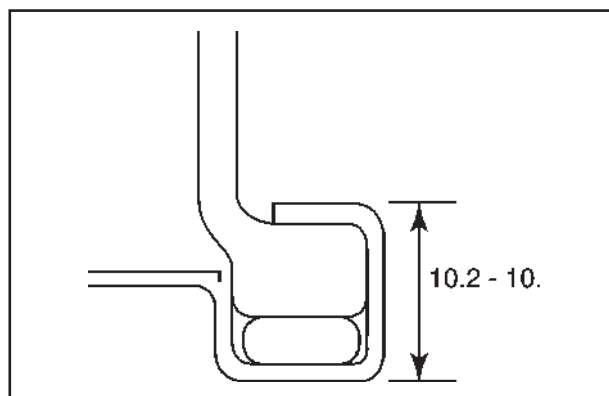


Fig. 7

- \* After clinching, confirm the dimension. **Fig - 7**



**If any of the clinching projections is broken during the clinching or releasing process, discontinue the servicing and replace the entire radiator by a new one.**

- \* Fix the member supports and tighten the bolts properly wherever applicable.



Bottom Type pipe, Drain Cock and Pressure Cap –

*Bottom Type pipe -*

- \* Take out the Bottom Type pipe using 10 size spanner.
- \* Remove the 'O' ring.
- \* Clean the seat of Bottom Type pipe and the 'O' ring groove.
- \* Insert a new 'O' ring.
- \* Fit the Bottom Type pipe back, ensuring proper tightness of the bolts.

*Drain Cock*

- \* Unscrew the drain cock.
- \* Remove the 'O' ring.
- \* Clean the 'O' ring groove.
- \* Insert a new 'O' ring.
- \* Screw the drain cock back.

*Pressure Cap –*

- \* Replace the pressure cap with a new one, if leakage is through if after cleaning the filler neck.



**Always use recommended radiator pressure cap.**

*Radiator Core –*

Different procedure of sealing shall be followed for minor and major leaks in the radiator core.

Minor Leaks : Leak spots which are very minute, are to be sealed in following manner.

- \* Install the radiator onto the vehicle as explained in section 16.10.0.4.
- \* Pour the contents of alumaseal in the radiator.
- \* Fill proper quantity of coolant liquid.
- \* Run the engine in idling for more than 20 minutes to detect leakage, if any.

Major Leaks: Procedure of sealing major leaks in the radiator is as follows :

- \* Wash the core with clean water and brush provided in the kit to remove dirt, dust etc.

- \* To remove the greasy spot on the core, apply thinner with cotton swab and take off the grease.
- \* Dry the core using a dryer.



**Drying by heating must be avoided.**

- \* Mix adequate quantity of Araldite resin and hardener in the ratio of 1:1 and stir it thoroughly.
- \* Apply the mixture immediately at the leakage spot with the applicator.
- \* If required, apply the mixture to dry and harden under the shade at room temperature for 10-12 hour.
- \* Allow the mixture to dry and harden under the shade at room temperature for 10-12 hour.
- \* Araldite Rapid of M/s Ciba Geigy dries and hardens within one hour and hence users may use it to minimize the down time.
- \* Silver colour paint may be used for touching up the araldite spots and impart the aluminium type appearance.



**Do not damage the fins during the process.**

**Confirm that fins are set properly, if disturbed during the process.**

**As the Araldite is inflammable, do not dry it by heating.**

**Proper cleaning of radiator core is must for proper setting of Araldite or else it will come off.**

**Confirmation of Proper Sealing**

- \* After the sealing work is over, assemble the radiator properly.
- \* Subject the assembled radiator to leakage test.



**If the problem of leakage persists, it is advisable to replace the radiator with new one.**



**16.10.0.4 Radiator Installation**

- \* Ensure that all the openings of the radiator are closed properly except the inlet.
- \* Install the radiator on the vehicle ensuring proper alignment, damping etc. as applicable.
- \* Connect the inlet and outlet pipes and clamp them.
- \* Fit the fan shroud.

Fill the radiator with proper quantity of fresh coolant as recommended.

**16.10.0.5 Do's and Don'ts****Do's**

Always use the clinching tool for removing and refitting the radiator tanks.

Always drain the radiator fully before removing it from vehicle.,

Always refill the radiator with coolant recommended by the manufacturer.

Always check tank packing before reassembly of tank to core.

**Don'ts**

Never open the pressure cap when the radiator is hot.

Don't use acid for cleaning the tubes and tanks.

Don't use manual force for cleaning clogged tubes.

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## 16.11 TURBOCHARGER

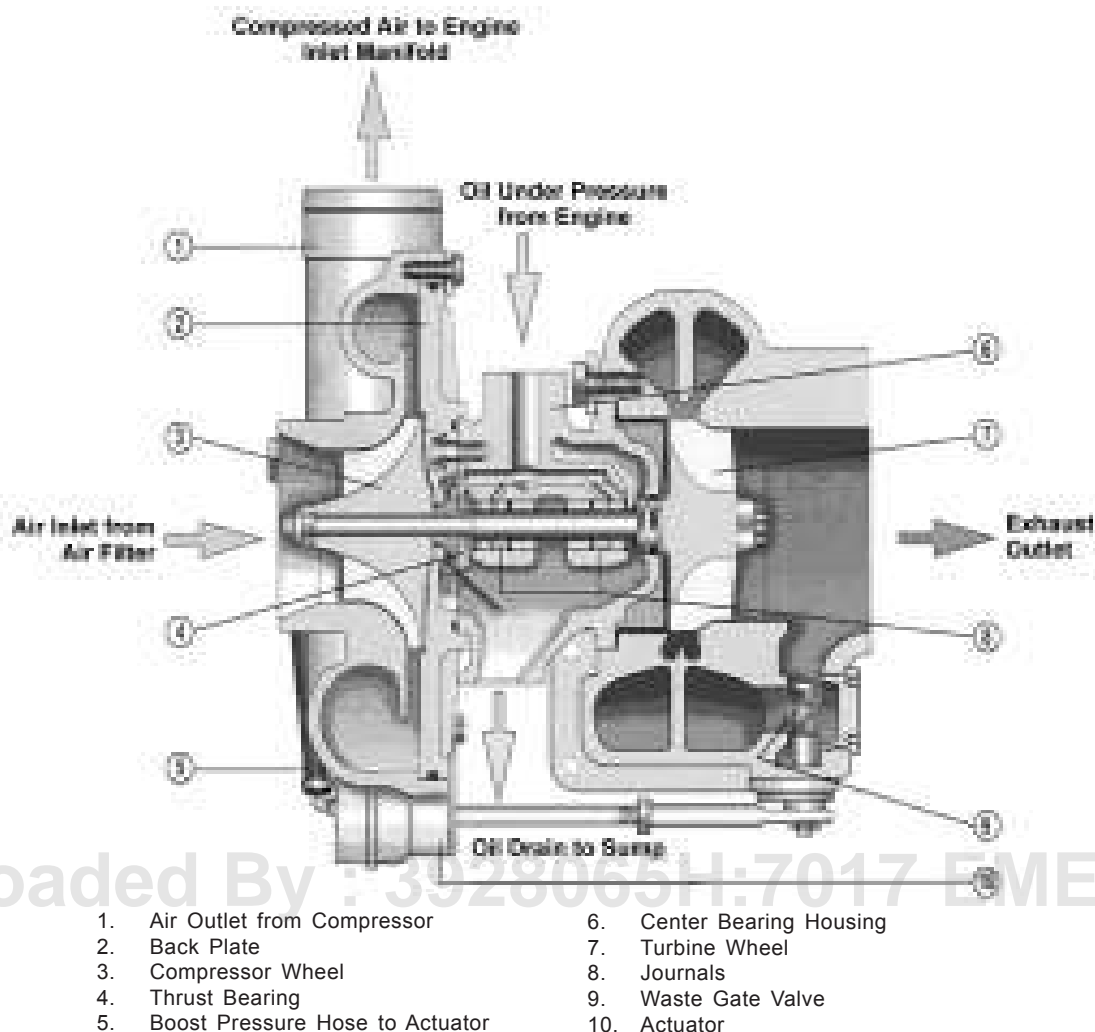


Fig. 1 Turbocharger with Waste gate

### 16.11.0 General

In exhaust gas turbocharging, the thermal energy in the exhaust gas, which would normally be wasted, is used to drive a turbine.

The turbine drives a compressor, which draws in filtered air and feeds this, at a higher pressure, to the engine.

This enables more fuel to be burnt with a greater mass of charge air, increasing engine power output.

Better air availability enhances better combustion, thus leading to lower fuel consumption and less emission.

#### 16.11.0.0 Design and Operation

Turbocharger is operated on the exhaust gas, which is normally wasted.

Turbocharger consists of:

1. Turbine wheel
2. Turbine housing

3. Compressor wheel

4. Compressor housing

5. Journals

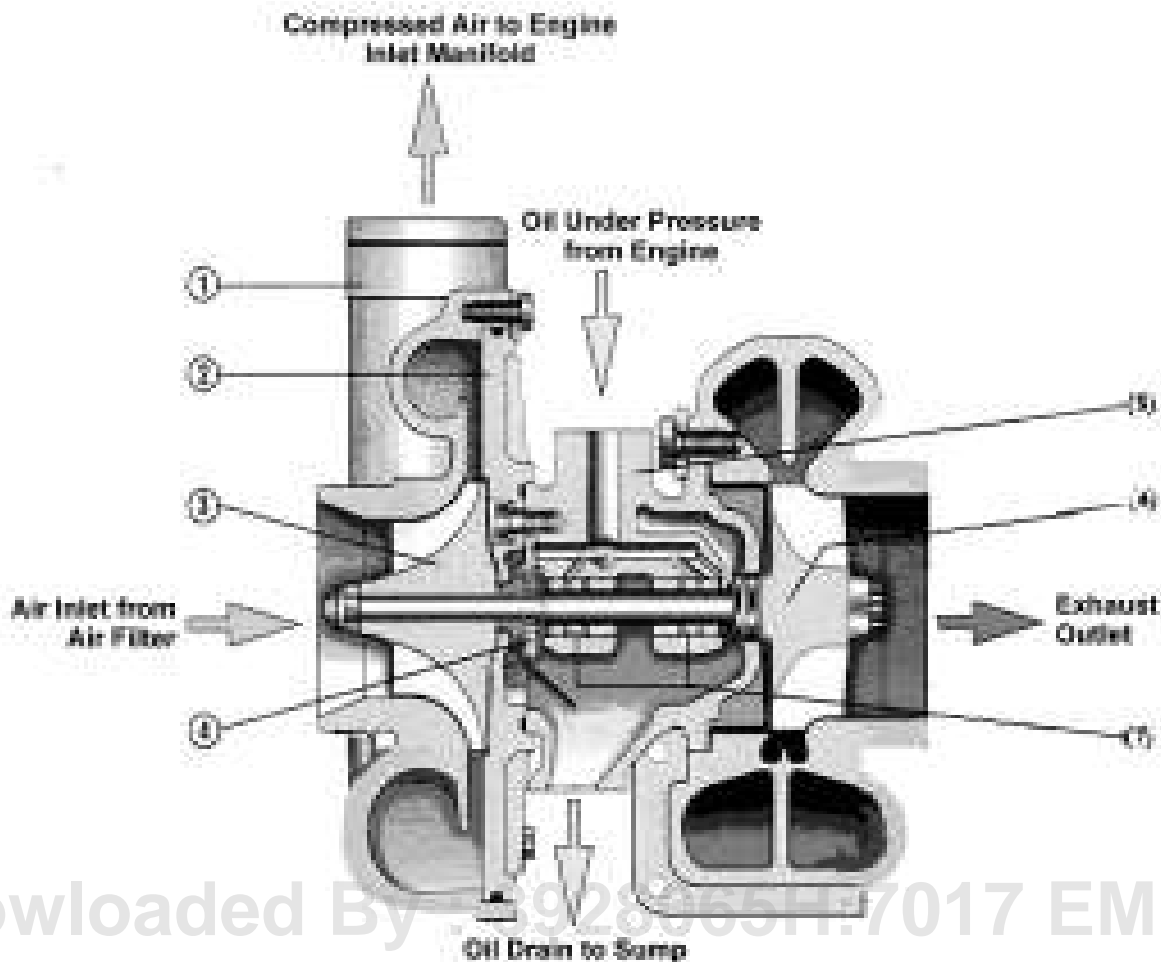
6. Bearing housing

7. Waste gate ( When provided)

8. Actuator (moved by the boost pressure opens or closes the waste gate valve)

Exhaust gas is used to drive the turbine wheel. Turbine wheel rotates the compressor wheel, which is mounted on the same shaft. Compressor wheel sucks the clean air through the air filter. The clean air is compressed and sent into the engine.

Due to more air in the engine more fuel can be burnt. Due to more fuel and more air, we get more power from the same engine. When waste gate valve is



- |                               |                           |
|-------------------------------|---------------------------|
| 1. Air Outlet from Compressor | 5. Center Bearing Housing |
| 2. Back Plate                 | 6. Turbine Wheel          |
| 3. Compressor Wheel           | 7. Journals               |
| 4. Thrust Bearing             |                           |

Fig. 2 Turbocharger without Waste gate

fitted, at higher engine speeds the waste gate limits the exhaust gas flow through the turbine by diverting a portion of the exhaust gas direct to the exhaust pipe.

#### 16.11.0.1 Benefits of Turbocharging

Lower fuel consumption

Lower emission

Better torque characteristics

Lower weight and a smaller engine package

Lower engine noise

Altitude compensating

#### 16.11.0.2 For Enhancing Turbocharger Life

Turbocharger needs CLEAN ENGINE OIL & CLEAN AIR (from the air filter.) for it's proper functioning and durability for the following reasons.

1. Oil contaminated with dirt or foreign material will wear the journals and journal seating area.
2. Dirt in the oil also blocks the oil holes in the journals (bearings) and bearing housing leading to oil starvation to the turbocharger.

3. Filtered oil at required pressure is essential to lubricate and cool the journals.
4. The clearances between the rotating parts are very close(in microns)
5. Turbocharger rotor assembly rotates at high speeds up to 1,00,000 rpm at the rated engine power. Therefore turbocharger rotating parts are balanced to very high accuracy for optimum performance.
6. Since turbocharger compressor wheel is made of aluminum alloy rotating at very high speeds, dust, sand or any foreign particle entering in to the turbocharger compressor housing will damage the compressor wheel blades, which will lead to turbocharger failure.
7. Damaged blades will lead to imbalance in the rotor assembly resulting in shaft or bearing failure.



### 16.11.0.3 Preliminary Checks

If your Turbo engine does not run the way it Should,

**Do not start your Search For Defects at the Turbocharger.**

Check for the following:

- Is the clutch slipping?
- Does the vehicle brake drag?
- Is the throttle opening fully?
- Is the air filter system blocked?
- Is the compression of the engine low?
- Is the fuel injection system correct?
- Does the crankcase breather system function?
- Is the exhaust pipe blocked/ damaged?

After the above inspection now you can look at the turbocharger for cause of trouble.

Please do not try to service or repair the Turbocharger yourself.

Consult TEL Service centre along with AL Service engineer.

If all parameters outside turbocharger are satisfactory as per the checklist given earlier, inspect the turbocharger.

Disconnect compressor inlet and turbine outlet pipes and visually examine both the wheels. If no fault is found remove turbocharger from the engine and send it for detailed inspection by TEL Service Centre. (Please refer to serviceable parts while overhauling.)

### 16.11.0.4 Serviceable Parts\* of Turbocharger

- Core assembly kit
- Overhaul kit
- Secondary kit
- Gasket kit
- Actuator Assembly kit (For Waste gated turbocharger)
- Boost pressure Hose kit (For Waste gated turbocharger)

#### Core Assembly Kit

Description	Qty	
	For Non-Waste Gated Turbo	For Waste Gated Turbo
Core assy	1	1
Segment (CS)	4	3
Bolts	8	8
Segment (TS)	3	3
Bolts	6	6

#### Overhaul Kit

Description	Qty	
	For Non-Waste Gated Turbo	For Waste Gated Turbo
Journal	2	2
Snap Ring	4	4
Thrust Plate	1	1
Thrust Ring	1	1
Piston Ring T.S	2	2
Piston Ring C.S	1	1
O' Ring (Big)	1	1
O' Ring (Small)	1	1
Socket Head Bolt	4	4
Washer	4	4
Shaft Nut	1	1
Bolt Hex. (C.S)	8	8
Segment (T.S)	3	3
Bolt Hex. (T.S)	6	6
Segment (C.S)	4	3
Sealing Ring	-	2
Tube Clamp	-	2
Boost Pressure Hose	-	1
Locking plate	-	1

#### Secondary kit

Sl. No.	Description	Qty
1.	Flinger Sleeve (Single Piece Type)	1

#### Gasket Kit

Sl.No.	Description	Qty
1	Gasket (Oil Inlet)	1
2	Gasket (Oil Outlet)	1
3	Gasket (Turbine inlet)	1

#### Boost Pressure Hose Kit

SL. No	Description	Qty
1	Boost pressure Hose	1
2	Tube Clamp	2
3	Sealing Ring	2
4	Connecting Adaptor	1
5	Hollow screw	1

#### Actuator Assembly kit

SL. No	Description	Qty
1	Actuator Assembly + Tube clamp + Boost pressure hose	1
2	Tube clamp	1
3	Connecting Adaptor	1
4	Sealing ring	2
5	Hollow screw	1
6	Locking plate	1

\* These are serviceable parts recommended for use only by TEL Authorised Service Centres for repair / overhaul of Turbochargers.



### 16.11.1 Precautions to be taken for Turbocharger Installation

Check air cleaner (filter element) and its connecting pipes for blockage, distortion etc, and should be cleaned / replaced.

Check and clean engine intake and exhaust manifold pipes. The oil feed and drainpipe to the turbocharger should be examined for dirt, cracks, distortion, etc. pipes should be thoroughly cleaned before fitment. If found damaged it should be replaced.

Remove any tape or cover used as temporary cover to the pipe inlet.

Examine the engine oil and the oil filter condition.

Replace the oil and the filter element if necessary. (Adhere to Ashok Leyland's recommendation for correct grade & change period).

Use recommended new gaskets for fitment of the turbocharger to the engine. Do not apply gasket sealant (Shellac, Anabond, grease etc.,) at the oil inlet and the oil outlet flanges for pasting the gaskets.

Do not use a strainer type gasket. ( This is a temporary gasket used only for the initial testing in the Factory)

Ensure correct fitment of the turbocharger to the engine (rotate the turbine shaft and check for its free rotation).

Fitment of inlet and outlet pipes (to turbocharger) under strain may result in turbocharger failure.



**After long storage before starting the engine, fill-up the oil feed hole of the turbocharger with clean engine oil to ensure lubrication during start-up.**

**Crank the engine till you notice oil pressure in the gauge before you start the engine.**

**Start the engine and idle for two minutes before accelerating the engine.**

**Check the engine oil pressure.**

**Do not run the engine if oil pressure is found less than that recommended.**

**When the engine is running, check all air, oil and exhaust connections for leaks.**



**Do not accelerate the engine immediately after start.**

**Idle the engine for at least two minutes after start and before the engine is stopped.**

### 16.11.2 Do's and Don'ts

#### Do's

- \* Regular change of engine oil / oil filter.
- \* Regular change / cleaning of air filter element.
- \* Check for oil pressure at engine idling condition. (Minimum oil pressure to be as per recommendation during idling.)
- \* Idle the engine for two minutes after starting the engine.
- \* Idle the engine for two minutes before switching off the engine.
- \* Periodic cleaning of crankcase breather is necessary to allow free flow of oil from turbocharger outlet.
- \* Regularly check all air, oil and exhaust connections for leaks and abnormal dust / oil / carbon build up.

#### Don'ts

- \* Don't run the engine with low oil pressure.
- \* Don't put the engine under full load immediately after starting. (Always run the engine/vehicle at moderate speed and load for a few minutes before going to full load and speed.)
- \* Don't switch off the engine under full load.
- \* Don't run the engine with DAMAGED
  - Oil feed and drain pipes
  - Pipes between air filter and turbocharger
  - Exhaust pipes
- \* Don't run with Leaky connections from the air cleaner to the turbocharger and turbocharger to the inlet manifold.



**Don't open the Turbocharger yourself.**

**Please contact the Ashok Leyland Authorised Dealers for any turbocharger problems.**

**As the turbocharger is precision built, assembled and tested by highly skilled personnel, we do not recommend opening of the Turbocharger for servicing by unauthorised persons.**

**However, if need be, please contact Turbo Energy Ltd Service centres for assistance for servicing Turbochargers.**

**16.11.3 Turbo charger trouble shooting**

Possible Cause	Engine Lacks power	Black smoke	Blue Smoke	Turbocharger noisy	High oil consumption	Oil leak from compressor side	Oil leak from turbine seal
Dirty air cleaner	✓	✓	✓				✓
Restricted compressor intake duct / piping	✓	✓	✓	✓			✓
Restricted air duct from compressor to intake manifold	✓	✓		✓			
Air leak in pipe from air cleaner to turbocharger				✓			
Air leak in pipe from compressor to inlet manifold	✓	✓	✓	✓			
Air leak from inlet manifold	✓	✓	✓	✓			
Foreign object in exhaust manifold (from engine)	✓	✓	✓	✓			✓
Restricted exhaust system	✓	✓					✓
Exhaust manifold cracked, gaskets blown or missing	✓	✓		✓			
Gas leak at turbine inlet/exhaust manifold joint	✓	✓		✓			
Gas leak in exhaust piping				✓			
Restricted turbocharger oil drain line			✓			✓	✓
Restricted/blocked/distorted crankcase breather			✓			✓	✓
Turbocharger bearing housing sludged or coked			✓			✓	✓
Fuel Injection System defective / incorrectly adjusted	✓	✓					
Engine valve timing incorrect	✓	✓					
Worn engine piston / piston rings / liners	✓	✓	✓			✓	
Eroded valves and / or pistons	✓	✓	✓			✓	✓
Excessive dirt build up on compressor wheel and housing	✓	✓	✓	✓		✓	✓
Boost pressure control swing valve / poppet valve doesn't close/damaged	✓	✓					
Boost pressure pipe to actuator leaking / damaged	✓						
Piston ring sealing defective			✓			✓	✓
Turbocharger journal (bearing) defective	✓	✓	✓	✓	✓	✓	✓
Foreign body damage on compressor / turbine wheels	✓	✓		✓	✓		
Insufficient oil supply to turbocharger	✓	✓		✓	✓		



## 16.12 Maintenance Programme

### MAINTENANCE SCHEDULE

- Maintenance Schedule that follows is for normal road operating conditions.
- More frequent attentions will be necessary to vehicles working under adverse conditions such as city applications and ghat or hilly terrains.

#### Key to Maintenance schedule

- 3 - Applicable to specific maintenance interval, given as column heading

MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks
<b>I.</b>	<b>HA4CTI3N Engine</b>					
<b>A.</b>	<b>General</b>					
1.	Check and adjust valve clearance on cold engine	✓			80	
2.	Check and tighten front and rear engine mounting / other peripheral bolts				16	
3.	Check and tighten cylinder head nut / bolts for correct torque in correct sequence				88	
4.	Check vibration pulley for any damages and replace if necessary				80	
<b>B.</b>	<b>Lubrication system</b>					
1.	Check and top up engine oil if necessary. Also check oil leakages at the time of top up			✓		
2.	Change engine oil and oil filter element					
<b>a. For Tipper application - At 10,000 km or 250 hrs of operation whichever is earlier</b>						
<b>b. For Longhaul / Other applications - Every 16,000 km</b>						
3.	Clean oil cooler				80	
4.	Check engine oil pressure (min. 1 kg/cm <sup>2</sup> at idling and 80°C engine temperature)	✓	✓			
<b>C.</b>	<b>Cooling System</b>					
1.	Visually inspect cooling fan / drive for any damages and replace/rectify		✓		40	
2.	Inspect fan clutch / hub for dust if necessary clean				80	
3.	Check and tight fan mounting bolts	✓			80	
4.	Check coolant level and top up if necessary . Also check for coolant leakages at the time of top up		✓			
5.	Check radiator hoses and clamps for leakages and tightness	✓		✓	80	
6.	Check fan belt tension / condition and adjust / replace if necessary	✓			40	
7.	Check radiator stay rod and radiator mounting bolts	✓			80	
8.	Drain cooling system and fill recommended coolant	Every 200000 km for haulage and every 4000 hrs for tipper				
9.	Replace cooling system hoses, clips and radiator rubber pads for radiator mounting & stay rod. To be replaced along with coolant change.					
<b>D.</b>	<b>Fuel System</b>					
1.	Replace fuel strainer (Fleet Guard)				40	
2.	Replace fuel filter unit (Fleet Guard)				25	
3.	Check water separator and drain if necessary			✓		
4.	Check fuel tank mounting strap for tightness and replace rubber packing if damaged	Every 48000 km or once in 6 months whichever is earlier				
5.	Check and tighten F.I.P. mountings					
6.	Clean Fuel tank and suction strainer				48	
7.	Adjust Fuel Injector Nozzle opening Pressure				80	First 16000 km also.
8.	Recalibrate fuel pump				160	
9.	Check and replace fuel hoses if necessary				160	
10.	Check injection timing				80	



**16.12 Maintenance Programme**

MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks
<b>E.</b>	<b>Air Intake System</b>					
1.	Check vacuum indicator and replace primary filter element whenever the vacuum indicator shows redband		✓			
2.	Replace air cleaner secondary filter element - At the time of every third replacement of primary filter element					
3.	Check air inlet hose for any puncture/damage		✓		40	
4.	Check for any blockage / breakage at rainhood assembly		✓		40	
5.	Check Turbocharger mounting	✓			40	
6.	Check charge air cooler for any blockage of fins and clean the cooler if necessary	✓			32	
7.	Check charge air cooler hoses for any damage				80	
8.	Check exhaust manifold and silencer for leaks and tightness	✓			40	
9.	Check intake and exhaust manifold mounting fasteners	✓			40	
<b>F</b>	<b>Electronic Diesel Control</b>					
1	Check for engine full acceleration (Throttle response)		✓			
2	Check tightness of all mating connectors and ensure they are connected properly	✓			40	After body building if sold as chassis.
3	Check and secure wiring harness away from temperature zones on the engine/vehicle	✓			40	
4	Check functioning of EDC and sensors with diagnostic tool	✓			80	
5	Check tightness of engine speed sensors and clean the sensor tip for any dirt/dust deposits	✓			40	
6	Check functioning of warning EDC light		✓			



**EDC SYSTEM (VP37)**  
**(FOR HA6DTI3N, HA4CTI3N & HA57L135/  
HA57L135LT H SERIES BS III ENGINES)**



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## 12.0 ELECTRONIC DIESEL CONTROL SYSTEM - OVERVIEW

Towards legislative requirement, Current engine development is aimed at lowering of harmful exhaust gas emissions. To meet the above demand, the importance on fuel injection and engine management system has increased, specifically with regard to

1. High fuel injection line pressure
2. Water/coolant Temperature dependant fuel quantity delivery - for starting
3. Control of close idling speed
4. Determined fuel quantity and timing in Engine start phase to suit geographical/ climatic conditions.
5. Integral timing function adjusting start of delivery as a function of engine speed to meet the emission norms.
6. Regulated fuel quantity in ref to load and Engine speed.
7. Metered fuel quantity to control and maintain free acceleration smoke.

The EDC (Electronic diesel control) system is capable of meeting the demands outlined above.

In EDC system, the driver has no direct control over the injected fuel quantity through the accelerator pedal.

The injected fuel quantity is based on

1. The vehicle response desired by the driver communicated through the accelerator pedal sensor with the help of ECU.
2. The engine operating conditions
3. The engine operating coolant temperature
4. Boost pressure
5. Engine speed

EDC system is also capable of data exchange with other electronic systems such as Automatic transmission through CAN (Control Area Network).

### EDC system is subdivided into

1. **Sensors**  
Detects the engine operating conditions and the driver's demand. They convert physical variables into electrical signals.
2. **Electronic control unit (ECU)**  
Processes the information received from the sensors. It controls the actuators through electrical output signals. It also provides interfaces with other systems like diagnostic tool, ABS etc.
3. **Actuators**  
Convert the electrical signal from the ECU into physical variable.

## 12.1 CONTROLS

### Open and Closed Loop Electronic Control

#### Open Loop

The actuators are operated by the ECU output signals which the ECU has calculated using the input variables, stipulated data, characteristic maps, and algorithms without any feedback.

#### Close loop control

The actual value at the output is continually monitored against the desired value, and as soon as a deviation is detected this is corrected by a change in the actuator control. The advantage of close loop control lies in the fact that disturbances from outside are detected and taken into account.

In our system close loop control is used for fuel quantity actuator and timer solenoid.

#### Fuel - Injection control

In order that the engine can run with optimum combustion under all operating conditions, the ECU calculates exactly the right injected fuel quantity at right time in different conditions. Here the values of various parameters are considered.

#### Start quantity

The injected fuel quantity is calculated as a function of coolant temperature and cranking speed. Start quantity is realised until the engine reaches idling speed of  $600 \pm 25$  rpm.

#### Drive mode

When the vehicle is in drive mode, the injected fuel quantity is a function of the accelerator pedal position and engine speed. This operates the engine in safe mode. The Map designed in the ECU considers various conditions like high fuel temperature, high coolant temperature, etc. Hence the system will operate the engine safely.

#### Engine Idle speed control

When the accelerator pedal is not pressed, the system has low idler governor function which will ensure smooth driving of vehicles. For instance, with the engine cold the idle speed is maintained by adjusting to the desired fuel quantity in ref to water temp and the set speed is maintained similarly at increased water temp.

**Engine Maximum speed control**

This control ensures that the engine shall not to be run at excessive speeds. To avoid damage to the engine, the engine manufacturer stipulates a permissible maximum rotational speed that may only be exceeded for a very brief period. Beyond that an error recording is registered. In our case the recorded speed is 3100 rpm.

**Intermediate set -speed control**

Intermediate speed control enables to run the engine at constant speed for applications like crane, ambulances / trucks mounted with generator sets.

**Cruise control**

Enables to drive the vehicle at a constant speed by selection of a separate switch. This has not been applicated as it is not of pre selective on vehicle and Vehicle owners are skeptical considering sleep mode of the driver and it is purely a requirement driven feature.

**Vehicle speed limiter**

The vehicle speed limiting function in the ECU limits the vehicle's maximum speed to a set value. This can be set by the customized Diagnostic tool.

**Injected fuel quantity limit**

Max fuel quantity has been predetermined and set at factory. Deviation to that will have the following effect

- Excess emission
- Excessive soot
- Higher Free Acceleration smoke.
- Mechanical overloading due to high torque.

**Engine exhaust brake function**

When the Exhaust brake is applied, In general, the injected fuel quantity is either reduced to zero or to the idle fuel quantity. This function is not applicated currently.

**Altitude compensation**

In order that the injected fuel quantity is reduced at high altitudes, the sensor mounted in the ECU measures the atmospheric pressure. Atmospheric pressure also has an effect upon boost pressure control and fuel limitation. This eliminates the problem of turbo overspeed & white smoke.

**Start of injection control**

Start of injection has a critical effect on power output, fuel consumption, noise, and emissions. The desired value for start of injection depends on engine speed and injected fuel quantity. With the help of Needle movement sensor in the First cylinder control is achieved.

**12.2 DIAGNOSTICS**

ECU integrated diagnostics belong to the basic scope of electronic engine management systems. During normal vehicle monitoring algorithms checks operation, input and output signals and the overall system is checked for malfunctions and faults. If faults are discovered in the process, these are stored in the ECU memory. When the vehicle is checked in the workshop, this stored information is retrieved only by a diagnostic tool through a serial interface and provides the basis for rapid and efficient trouble shooting and to attend repair.

**Diagnostic Interface**

There is a serial interface between diagnostic tool and ECU. This is effected with KWP2000 protocol. This OBD connector is as per SAEJ1939 standard. A standard universal diagnostic tool also can be used to read the stored error codes.

Dearborn diagnostic tool refers the DTC (Diagnostic Trouble Codes) and the universal tool like Crypton-ACT II address P codes in reference to SAE standard.

**Operating concept****Input signal monitoring**

These checks serve to uncover not only sensor faults, but also short-circuit to the battery voltage and ground, as well as open circuits in line. The following processes are applied.

- Monitoring the sensor's power supply
- Checking that the measured values are within the correct range
- If auxiliary information is available, the same is subjected to a plausibility check
- Important sensors (such as accelerator pedal sensor) are designed with redundancy to monitor the signal output for the limp home mode operation in case of abnormal conditions.

**Output Signal Monitoring**

In addition to the connections to the ECU, the actuators are also monitored using the results of these checks open circuits and short circuits in the lines and the connections can be detected in addition to the actuator faults. The following processes are applied here :

- The circuit is checked for open circuit and short circuits to battery voltage and to ground.
- The actuators' influence on the system is checked for plausibility.

**Monitoring the internal ECU functions**

In order that the functional integrity of the ECU is ensured at all times, monitoring functions are incorporated in the hardware and in the software.

These check the individual ECU components (e.g. the micro controller, flash - EPROM, RAM). Many of the checks are performed immediately the engine is switched on. During normal operation, further checks are performed regularly so that the defect /malfunctioning of a part is detected.

### 12.3 LIMP HOME FUNCTIONS

This function enables the vehicle to reach the workshop for service attention, in case of any sensor failure / malfunctioning.

Maximum engine speed during this condition will be 1000 - 1200 rpm. The table given below indicates the details of sensor failure and its effect on the vehicle.

Sl. No.	Description	Effect on the Vehicle
1	Water Temperature sensor malfunction	Loss of pickup / acceleration and loss of engine power, since full load fuel quantity is limited to 80%. Cold start ability is disturbed.
2	Boost pressure sensor Malfunction	Less pickup due to loss in engine power as fuel quantity is limited.
3	Engine speed sensor failure	Engine stops
4	No Needle lift pulse	Emission affected. Vehicle continues to run.
5	Vehicle speed sensor fails	Vehicle performance will not be affected in case of normal operation. During top speed function, vehicle will run with default setting by indicating loss of pickup to the driver.
6	Accelerator pedal Sensor Malfunction	Engine idling speed will be increased to 1200 rpm. No further increase in engine rpm will be felt by the driver while pressing the pedal.
7	Brake Switch	During mechanical stuck / binding of accelerator pedal sensor and when brake is pressed, limp home function is activated. Max. engine speed during this condition is set to 1200 rpm

### 12.4 BS III ENGINE START PROCEDURE:

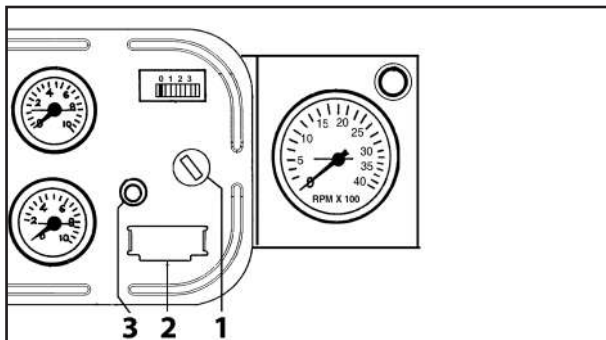
Before starting ensure that the gear is in neutral position and the parking brake is applied.

To reduce transmission drag on cold vehicles, depress the clutch pedal.



**If it is required to start the vehicle in a garage or workshop, ensure that adequate ventilation is provided.**

#### Engine Start Procedure



1. Ignition Switch (KeyType-combined with ECU)
2. Diagnostic Connector (With Cap)
3. Diagnostic Lamp

Insert the Ignition key, turn clockwise for 24V supply on to the vehicle electrical system and electronic control unit and then turn further to crank the engine.



**In case the engine does not start, Switch off the Ignition switch and wait for 5-10 sec and then restart.**

**In case of diagnostic lamp blink/ON: Error to be read through tester and cleared/rectified.**

### 12.5 ENGINE STOP PROCEDURE

To stop the engine, switch OFF the Ignition, by turning the ignition switch with couplers anti-clockwise once.

#### Dos and Don'ts:

Idle the engine always about 2 mins after starting and before switching off.

Do not switch-off the engine through gears.

Do not operate the starter motor for more than 10 sec. continuously. Wait for 30-60 Seconds before trying again.

Do not Park / leave the Vehicle with Ignition switch in ON position.



**12.6 TROUBLE SHOOTING GUIDELINES**

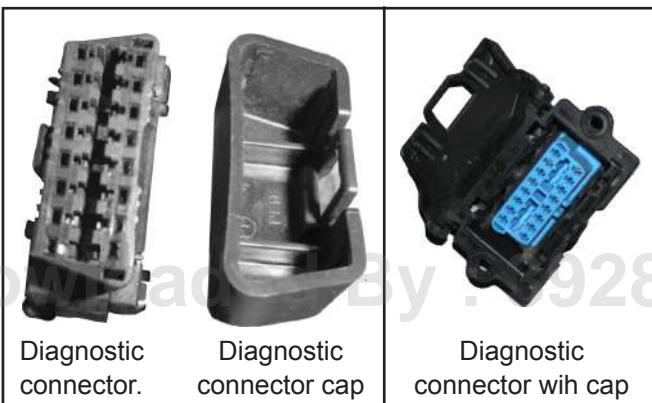
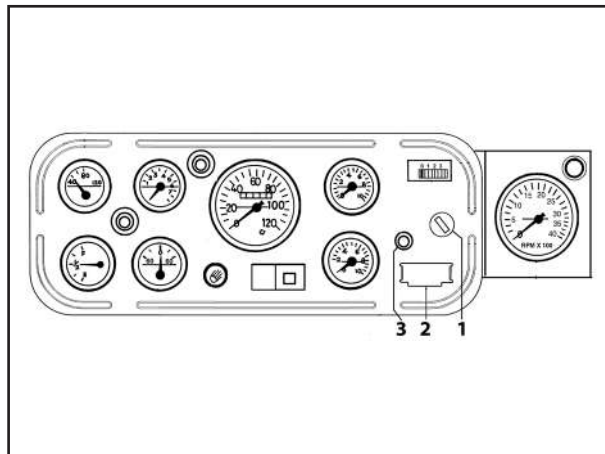
Use Dearborn diagnostic equipment or Crypton Diagnostic tool for reading the Error recorded in the ECU. The diagnostic socket is provided in the instrument panel.

**Diagnostic Connector**

This is a 16 pin D type connector provided with cap for On Board Diagnostics (OBD II). Diagnostics tool / tester with the mating connector to be plugged in to this 16 pin connector for trouble shooting, current data monitoring and erasing the fault codes stored in the ECU memory.



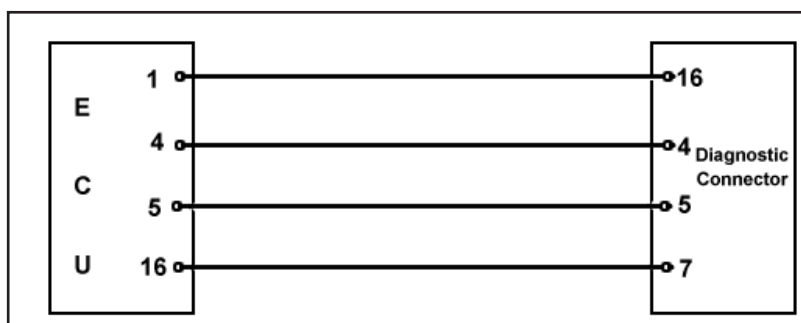
**Always ensure that the diagnostic connector is covered with cap when not in use.**

**Diagnostic connector Female (Wiring Harness side)****Location on the Vehicle**

1. Ignition Switch (Key Type - combined with ECU)
2. Diagnostic Connector (Provided with Cap)
3. Diagnostic Lamp

In case of no power supply to the diagnostic tester check the following

- Condition of 5 amp fuse on fuse and relay box
- Continuity of the wires between ECU and the diagnostic connector on the instrument panel.

**DIAGNOSTIC CONNECTOR****Pin Configuration & Connection Details****Diagnostic Connector Pin configuration**

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16

Once the defective circuit is identified with the help of the diagnostic tool, please refer the service instruction pertaining to that sensor / actuator circuit. Please refer chart for further guidelines.



## REFERENCE CHART FOR FAULT CODE IDENTIFICATION

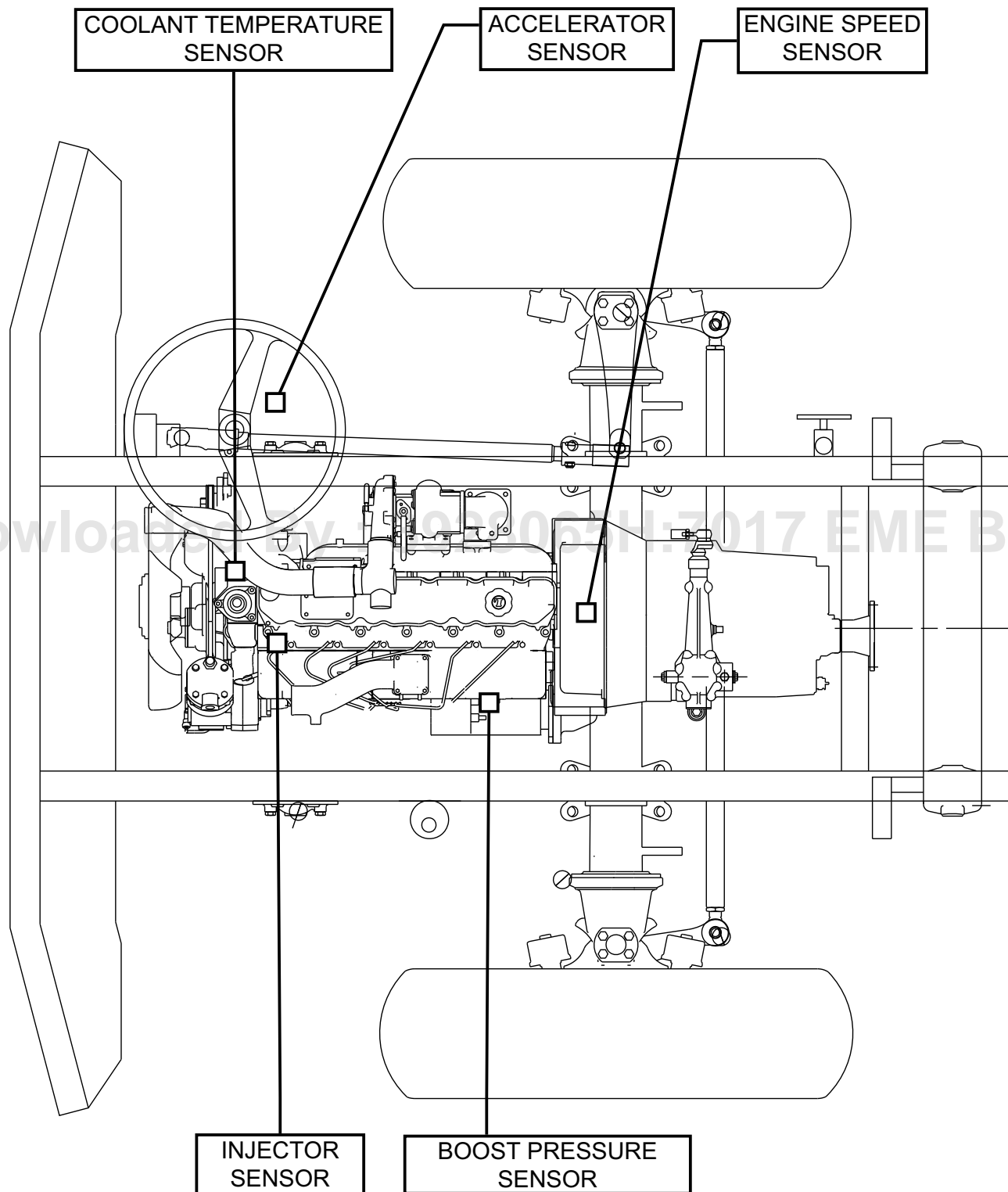
Dearborn / Pragathi code	Crypton code	Component involved
P0235	P0237, P0238, P1162	Boost pressure sensor
P0105	P0107, P0108	Atmospheric pressure sensor - ECU
P0314	P0300, P0301, P0302, P0303, P0304, P0305, P0306	Misfiring - Injectors
P0571	P0572, P0573, P0624, P0504	Brake switch
P105A	P1061, P1062, P1063	Diagnostic lamp
P0725	P0219, P0728, P0727	Engine speed sensor
P1063	P1064, P1065	Electrical shut off solenoid
P1009, P1012, P10E1, P10AB, P1000, 1075, P1051, P107E,	P1010, P1013, P1014, P1142, P1143, P1112, P1113, P1114, P1001, P1002, P1003, P1004, P1076, P1077, P1078, P1052, P1053, P1054, P1055, P1085, P1080	ECU related
P0500	P0501, P1108, P1109, P1110	Vehicle speed sensor
P1099, P0180, P10A2, P1087	P1100, P1101, P1115, P1116, P1082, P1083, P1081, P1103, P1104, P1105, P1106, P1088, P1089	FIP Related
P1024	P1025	Main relay shut off time high -ECU
P102D	P1034	Ignition switch
P106C	P1073, P1074	Needle movement sensor
P120, P220	P0222, P0223, P0224, P0221, P0122, P0123, P0124, P0121, P2299, P2135	Accelerator pedal sensor
P0560	P0562, P0563	Battery voltage
P0115	P0116, P0117, P0118, P0119	Coolant temperature sensor
P1090	P1091, P1092	ECU
P0617		Starter control short circuit error
P0817		Starter control open circuit error
P0704		Clutch switch plausibility error

## 12.7 INSPECTION/CHECKING OF PARTS &amp; CONNECTIONS AGAINST COMPLAINT

## Required Instruments:

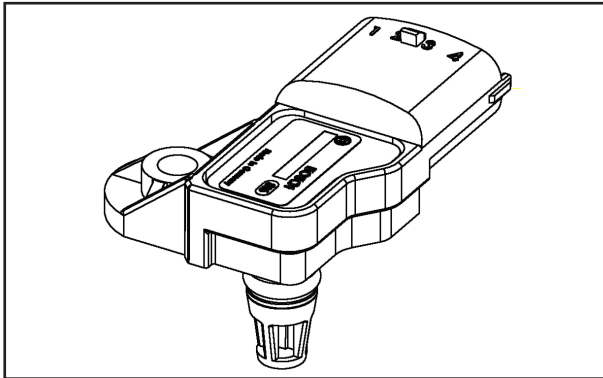
- Diagnostic Tool (Dearborn / Crypton)
- Laptop / Desktop PC -in case use of Dearborn Diagnostic tool
- Analog / Digital Multimeter
- Test sockets with Flying leads - If required.
- Removal & Fitment of Sensors & Connectors - Circuit.

### SENSOR LOCATIONS



## 12.8 SENSORS

### 12.8.0 Boost Pressure cum Temperature Sensor



#### Functions and Working

The sensor serves to measure the absolute intake manifold pressure. The pressure Sensor Element consists of a Silicon diaphragm, which contains Piezo resistive Semiconductor. The Pressure acts on the diaphragm causes change in electrical resistance in Circuit thus change in Output voltage.

#### Installation

- The pressure nozzle project into the intake-manifold and is sealed by using an O-ring, ensuring leak proof. Smear lubricant on O-ring (non-acid paraffin oils) during fitment.
- Maximum tightening torque of screws: 4-6 Nm

#### Specifications:

Operating Voltage - From ECU	: 5V DC
Max. Absolute Pressure (System)	
For 6 Cylinder Engines	: 2.5 to 3 bar
For 4 Cylinder Engines	: 3 bar

#### Fault Path

Group Error code (DTC) : P0235

DTC code	Description
P0237	Signal low
P0238	Signal high
10FA	Supply voltage too low
10FB	Supply voltage too high
10FC	Plausibility vs. Atmospheric pressure sensor

#### Effect of fault in Vehicle

- Loss of power / vehicle speed limited to 40-50 kmph as it would refer to the default value of 1.050 bar as set in the application.

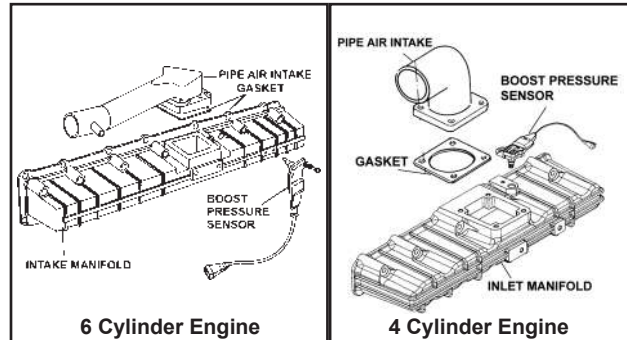
#### Possible cause of fault

- Open circuit of signal wire / Earth wire & Short Circuit of Signal Wire to Earth wire.
- Boost Pressure sensor defective
- Loose connection of end fittings in the sensor side as well as in the ECU Side

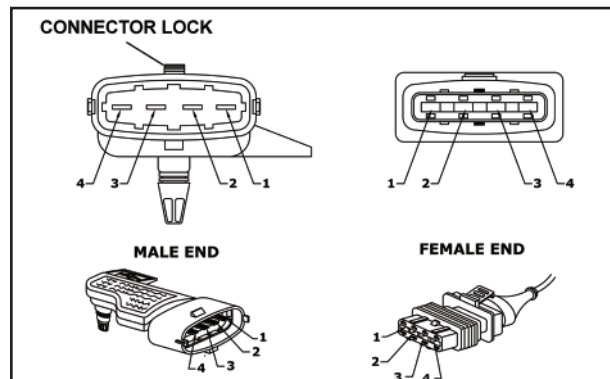
#### Service Recommendation

- Check resistance and continuity
- Measure the resistance between Pin 1 & 2 (Refer Table 1) at sensor end male connector.
- Measure the voltage between pin 1 & 4 for boost pressure sensor supply Voltage (5V DC) at sensor end male connector.

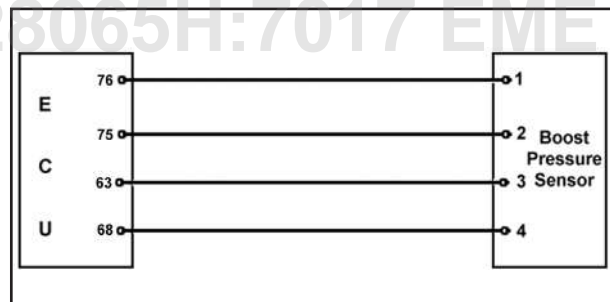
### Boost Pressure sensor location



### Connectors



### Pin configuration & Connection Details



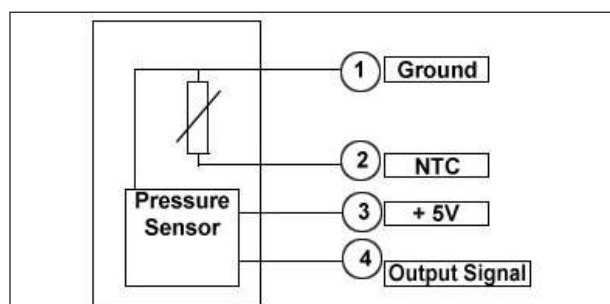
Pin No: 2 - NTC Thermal Resistor Air Temperature Sensor is not used / Applied in AL - 122 Kw / AL - 88 Kw EDC System).

### RESISTANCE VALUES

TABLE 1

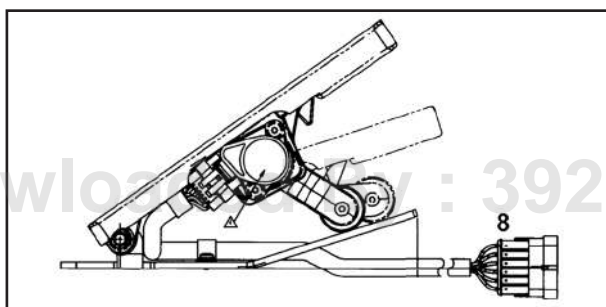
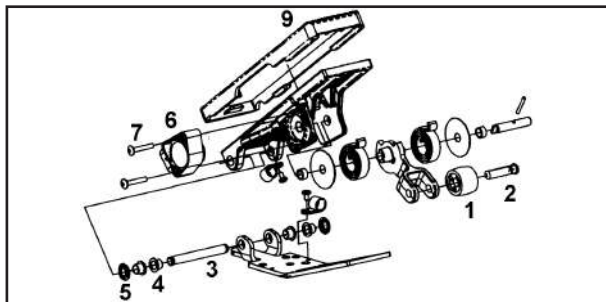
Ambient temp. in °C	Resistance in ohms		
	Minimum	Nominal	Maximum
20 ± 1	2308	2500	2726
30 ± 1	1586	1715	1853
40 ± 1	1113	1199	1291
50 ± 1	729	851	913

### Circuit Diagram



**12.8.1 Accelerator Pedal Module****Function and working:**

The Sensor serves to measure demand from the driver and communicates to the ECU. It detects the pedal position by means of hall effect sensor and transfers this information to the ECU in terms of Voltage. It consists of two hall effect sensors for measuring the position of accelerator pedal module from 0% travel position to 100% travel position. The second sensor is incorporated as redundant and reports error in case of malfunction of the first sensor. Voltage across redundant sensor is almost half of the 1st sensor.

**Accelerator pedal Module - Floor Mounted Type**

- |                 |           |                    |
|-----------------|-----------|--------------------|
| 1. Roller       | 4. Bush   | 7. Mounting Screws |
| 2. Roller Shaft | 5. Nut    | 8. Wiring Harness  |
| 3. Tridle Pin   | 6. Sensor | 9. Tridle Cover    |

**Installation:**

The accelerator pedal sensor is mounted on accelerator pedal module.

Tightening torque of the retaining screws: 9 Nm. Pedal return spring has to be maintained and replace in case of breakage. Ensure proper gap between pedal and the roller of the sensor lever and maintain 95 - 100% of pedal sensor displacement with use of Diagnostic tool by setting the max. adjustment screw provided on the pedal module.

**Specification:**

Operating voltage : 5 V DC  
Temperature range : - 40 to 80°C

**Fault Path**

Group error code (DTC): P0120, P0220

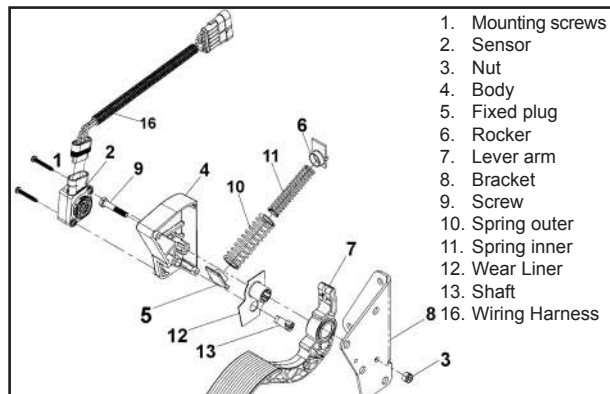
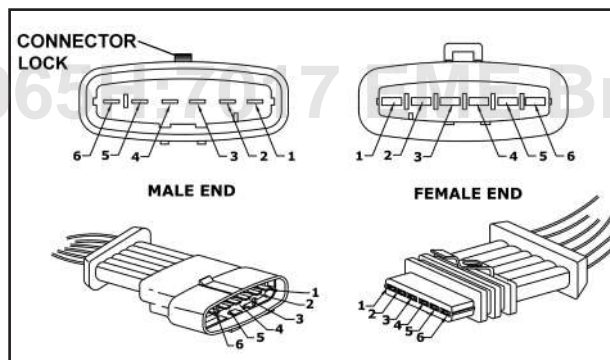
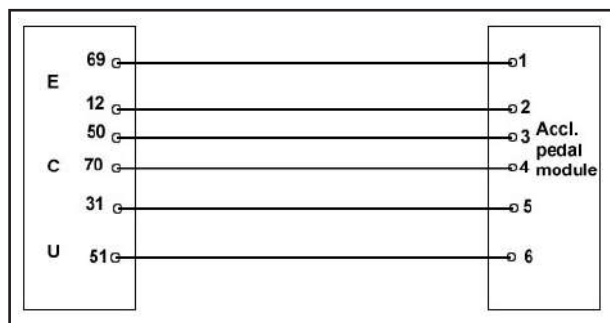
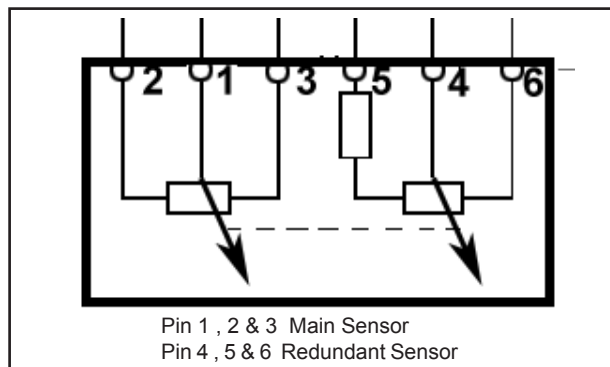
DTC Code	Description
P0122	Input Signal low
P0123	Input Signal high
P0124	Supply voltage too low
P0121	Supply voltage too high
P2299	Plausibility error with brake
P2135	Plausibility error with redundant accelerator pedal position sensor 2

**Redundant sensor**

P0222	Signal low
P0223	Signal high
P0224	Supply voltage too low
P0221	Supply voltage too high

**Effect of Plausibility fault**

Engine idling rpm will get increased to 1200 rpm and set. No further increase in Engine rpm irrespective of Pedal movement.

**Accelerator pedal Module - Pendant Type****Connectors****Pin configuration and connection details****Circuit diagram**



**Fault Diagnosis**

Sl. No	Possible causes of fault	Service Recommendation
1	Line interruption	Check continuity between 1 & 69, 2&12, 3 & 50, 4&70, 5&31 and 6 &51 of Sensor & ECU Respectively.
2	Short circuit of Supply Voltage wire to earth wire	There should not be any Continuity between Pin 2 & 3 (Pot1) and Pin 5 & 6 (Pot2). Check for it.
3	Open circuit of Supply Voltage wire / Earth wire	Check continuity between 1 & 69, 2 & 12, 3 & 50, 4 & 70, 5 & 31 and 6 &51 of Sensor & ECU Respectively.
4	Sensor Defective	Measure voltage at sensor output terminal for both main and redundant sensors.

**12.8.2 Engine Speed Sensor****Function and working:**

Engine speed sensor is an inductive type. It is mounted on the flywheel housing. Electric pulses are generated when the formed slots on the flywheel pass thro the sensor axis.

The Electric pulse - Frequency (Sine Wave) generated by the sensor is proportional to the engine speed.

**Installation:**

The sensor is to be mounted perpendicular to the surface of the flywheel housing using respective mounting aluminum plate. Use recommended aluminium mounting plate according to the flywheel.

Do not use force / Hammer to fit the sensor. After Fitment ensure seating of the sensor mounting face.

Tightening torque of the mounting Screws: 6 - 10 Nm.

**Specification:**

Resistance : 860 ohms  $\pm$  10% at 20 °C

**Fault path**

Group error code (DTC): P0725

Error Code	Description
P0219	Over speed-detection
P0728	Dynamic plausibility
P0727	Static plausibility

**Effect of fault**

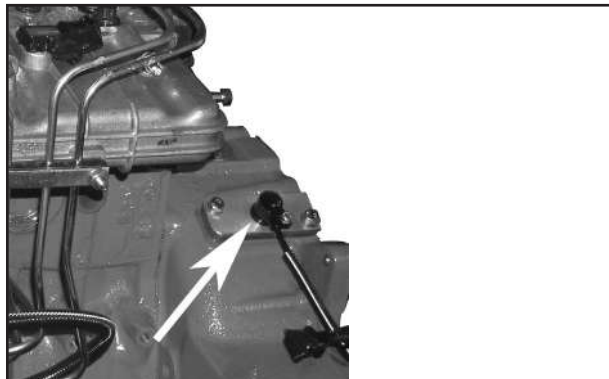
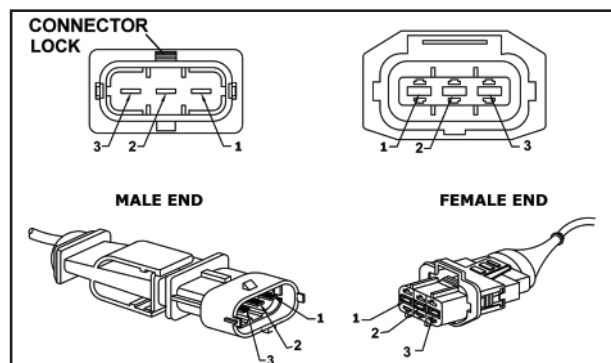
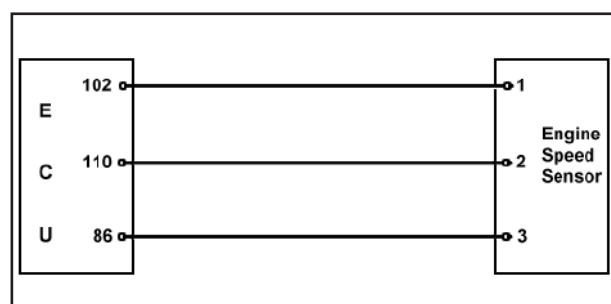
Engine shut down

**Possible cause of fault**

- Engine Over speed during Overrun operation
- Defective sensor
- Open Circuit of Signal Wire / Short circuit to earth
- Line interruption
- Increase in air gap (Spec: 1 to 2 mm)
- Dust accumulation on the sensor tip

**Service recommendation**

- Measure resistance between pin 1 & 2
- Check continuity between Pin no 110 and 2 and Pin no 86 and 3.
- Keep Sensor tip free from dust, grease / oil and iron particles

**Engine speed sensor location****Sensor****Connectors****Pin Configuration & Connection Details**

**12.8.3 Coolant Temperature Sensor****Function and working:**

It is a thermistor, mounted on coolant return line from cylinder head. A semiconductor Material changes its resistance when exposed to variable temperature source. Resistance decrease as temperature Increase (NTC type)

**Installation:**

Tightening torque : 20 - 24 Nm

**Specifications :**

Temperature range : -40/130°C

Rated voltage : Operation by pull up resistance of 1 Kilo Ohms in ECU

**Fault path**

Group code (DTC) : P0115

**DTC Code (Crypton) Description**

P0117	Signal low
P0118	Signal high
P0119	Temperature too low
P0116	Signal implausible (dynamic)

**Effect of fault:**

In case of sensor failure,

- 1) It has been programmed to switch over to default value of 96°C. The Default Value Specified in the control unit for such cases can lead to a fuel Quantity reduction and may produce white smoke output during cold start.
- 2) This reduction in fuel quantity will show an activated effect of limp home function - Refer Limp Home Function.

**Possible cause of fault:**

- Voltage Supply Line interruption
- Signal wire Short circuit to earth wire
- Sensor defective

**Service instruction**

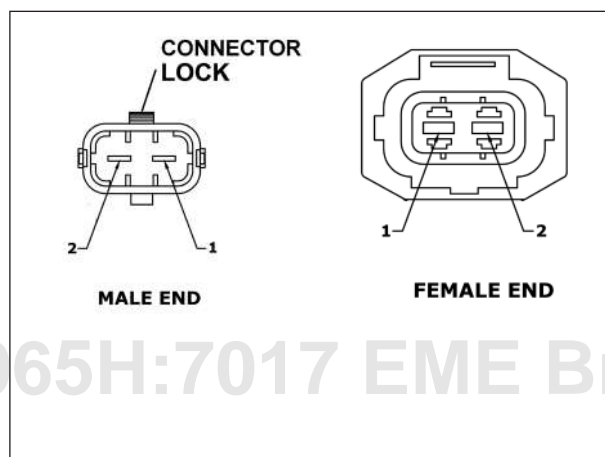
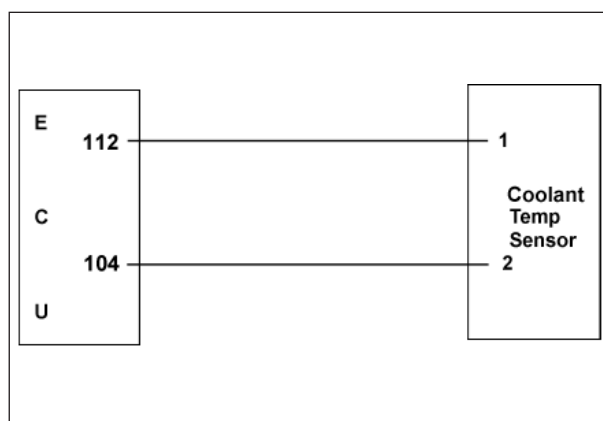
Measure Resistance between Pin 1 & 2

At 20°C - 2.315 to 2.649 Kilo Ohms

At 40°C - 1.118 to 1.231 Kilo Ohms

At 80°C - 0.313 to 0.332 kilo Ohms

Measure Voltage between Pin 104 & 112 and at the connector of the wiring harness near to sensor : > 4V

**Coolant Temperature Sensor****Connectors****Pin Configuration & Connection Details**



### 12.8.4 Needle Movement Sensor (NBF)

#### Function and working:

The needle movement sensor is to detect beginning of injection by means of Lift of the needle .

A ferromagnetic core attached to the needle disturbs the flux created by the coil.

The needle movement induces a voltage pulse in that coil, which is sensed by ECU and considered as start of injection.



**Injector to be handled carefully without causing any damage to the Connector and the attached cable.**

**Ensure proper positioning of the first injector mechanical clamp. This is to avoid damage to the cable due to undue mechanical stress.**

**Ensure fitment of corrugated sleeve on the first injector to avoid damage.**

**Ensure clamping of cable after refitment of Injector.**

#### Installation:

First cylinder Injector is fitted with Needle movement sensor. Remaining cylinders are fitted with normal injectors.

#### Fault path

Group code (DTC) : P106C

DTC Code	Description
P1073	Signal low
P1074	Signal high

#### Effect of fault:

Selected timing as per the defined map with fixed values shall prevail at all speed range. The performance may not be as that of normal.

Smoke and misfire

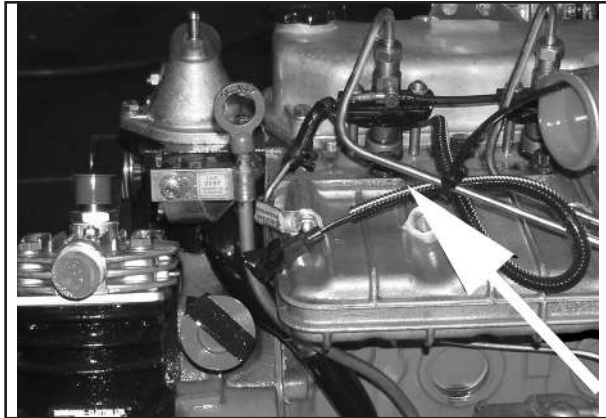
#### Possible cause of fault

- Supply voltage line interruption
- Signal wire short circuit to earth / negative
- Needle movement sensor defective

#### Service instruction:

- Measure the resistance between pin 1 & 2 at sensor  
- about 100 +/-10 ohms (20 °C)
- Check continuity between point no. 109 and 1 & 101 and 2.
- As the effect disturbs the control of emission, complaint to be attended.

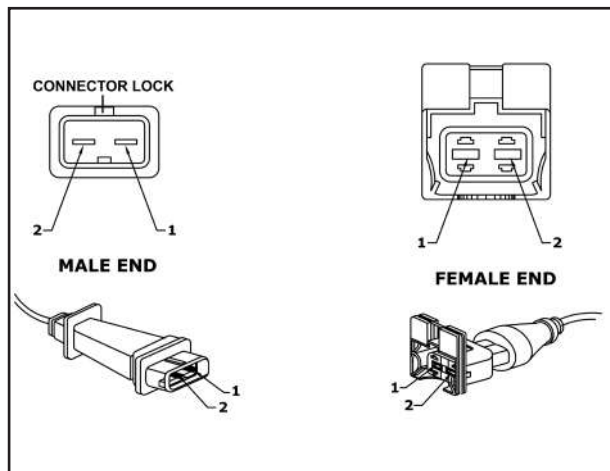
#### Needle Movement Sensor location



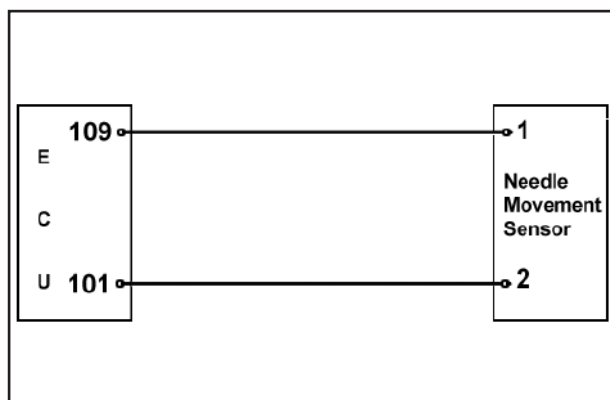
#### Needle Movement Sensor



#### Connectors



#### Pin Configuration & Connection Details



**12.8.5 Vehicle Speed Sensor****Function and working:**

Working on Hall effect principle, produces 8 pulses per revolution, Pulse output is used for calculating the distance traveled and speed of the vehicle. Refer Table to determine the exact speed for different configurations. System provides correct speed for the tyre and RAR configuration.

**Installation:**

Vehicle speed sensor is mounted on the gearbox at Speedo drive output or remote mounted on frame and connected with a short drive cable.

**Specifications:**

Operating Voltage : 4.5v to 28V

Supply Current : 9mA

Output Current : 25mA

Direction of rotation : Clockwise and Anti-Clockwise

**Fault path**

Group code (DTC): P0500

**DTC code      Signal high**

P1108      Frequency too high

P0501      Signal high - Open Circuit

**Effect of fault:**

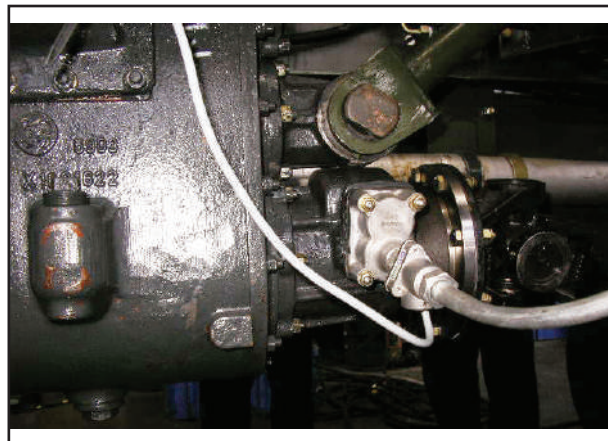
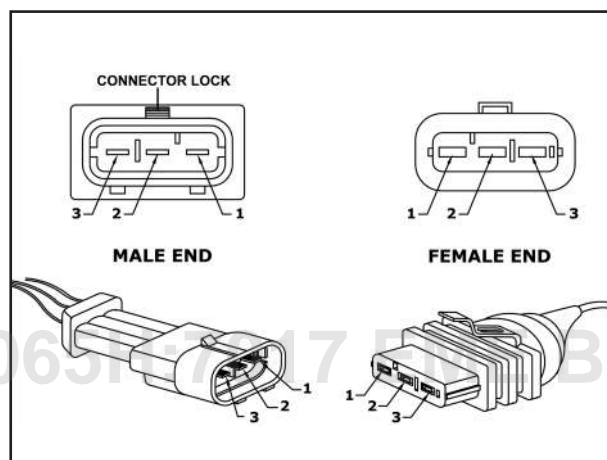
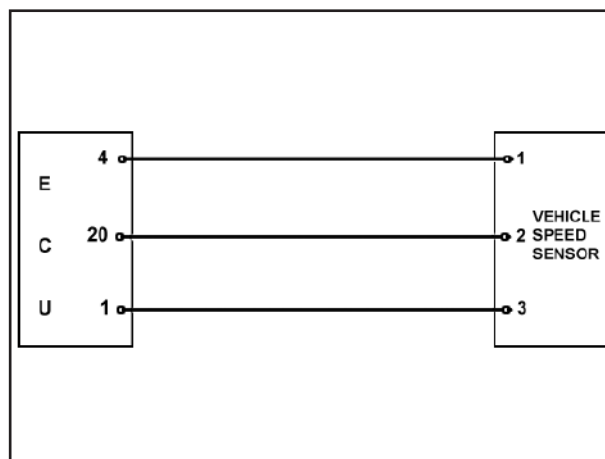
Nil - As such. To be decided after activating the vehicle set speed limitation.

**Possible cause of fault:**

- Output Short circuit to earth / Negative
- No input Supply voltage ~ 0 to 24V
- Sensor defective

**Service instruction:**

- 1) Check for Supply voltage (12V) across terminal 1 & 2 of the male end - Wiring Harness side
- 2) Check for continuity between Sensor Ground and Battery negative / Earth
- 3) Check matching of Power Supply signal and ground between Sensor and wiring harness.

**Vehicle Speed Sensor****Connectors****Pin Configuration & Connection Details****TABLE - 1**

Combination	Speedo Ratio 1:1.545					
	RAR 6.167 Tyre 9 x 20	RAR 6.167 Tyre 10 x 20	RAR 5.833 Tyre 9 x 20	RAR 5.833 Tyre 10 x 20	RAR 5.57 Tyre 9 x 20	RAR 5.57 Tyre 10 x 20

Rear Axle ratio and Tyre size has been provided since VSS senses Speedo speed. Gearbox ratio is not relevant.

## 12.9 SWITCHES

### 12.9.0 Brake switch

#### Function and working:

The switch is of electro-pneumatic type. Switch is mounted on the dual-control Valve. It indicates the altered voltage level from the switch and output is fed to ECU as information. Switch operates for pressure greater than 0.5 Bar. This information is used by the ECU to activate the limp home mode in case of defective accelerator pedal sensor.

#### Installation:

Ensure there is no air leak after fixing.

Tightening Torque: 15 - 18 Nm

#### Specifications:

Four Terminals with NC and NO Contact

Supply & Output Voltage : 12VDC

In the vehicle, an additional brake switch relay is provided and this will be operated when service brake switch is activated. ECU will sense this dual contact signal.

#### Fault path

Group code - DTC : P0571

DTC code	Description
P0504	Plausibility with accelerator pedal sensor
PO61E	Plausibility with second brake switch after ECU initialization
P0573	Input signal high
P0572	Input signal low

#### Effect of fault:

Limp home function (Engine runs at 1000 rpm) is activated in conjunction with defective accelerator pedal sensor.

Disconnected / absence of Brake switch will record DTC - P0504 and will not produce limp home function or Disturbance to normal operation when accelerator pedal sensor is in good working condition.

#### Possible cause of fault:

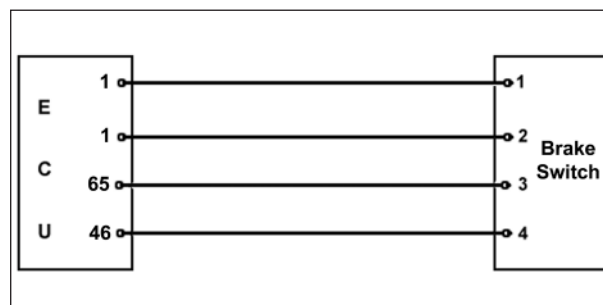
- Defective switch
- Open/short circuit of Supply voltage - 12V

#### Service Instruction:

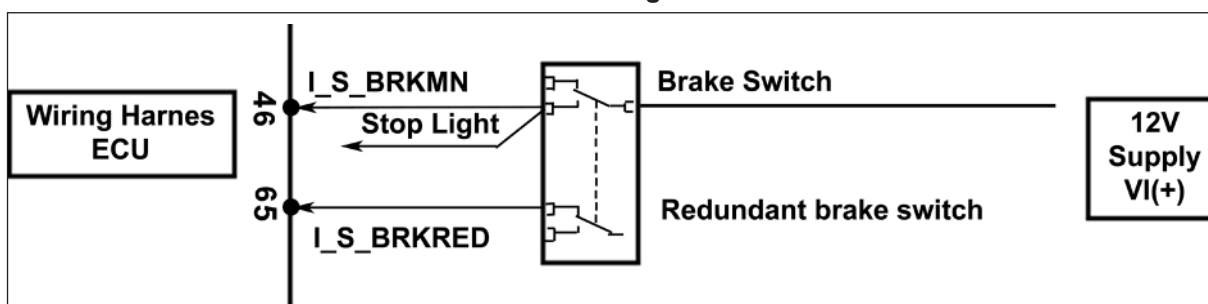
Check voltage as given below

- Pedal pressed pin 46 & ground - 12V
- Pedal pressed pin 65 & ground - 0V
- Pedal normal position pin 46 & ground - 0V
- Pedal normal position pin 65 & ground - 12V

#### Pin Configuration & Connection Details



#### Circuit Diagram





### 12.9.1 Clutch Pedal Switch

**Function and working:**

It is mounted on the clutch cross shaft housing mounting bolts. It is used to detect the gear ratio. Currently it is not applied.

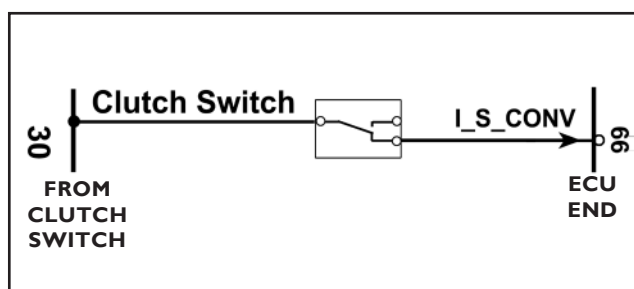
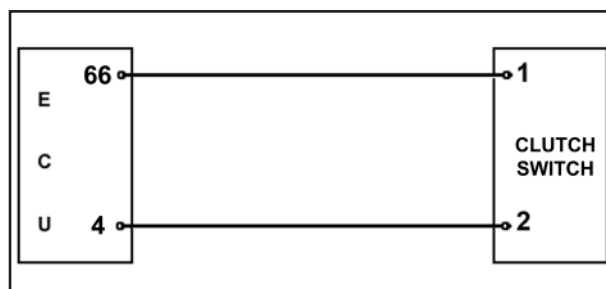
**Installation:**

Ensure correct setting of the switch to make positive opening and closing of the contact in the switch.

**Checking Procedure**

Pedal Released - 12V

Pedal Pressed - 0V

**Circuit Diagram****Pin Configuration and Connection details**

### 12.10 ACTUATORS

#### 12.10.0 Fuel shut off solenoid / ELAB

**Function and Working**

It is a solenoid switch located on the distributor head of the fuel injection pump. The solenoid receives power supply (12V) from the ECU. When it is energized fuel will be supplied to the engine.

**Installation:**

Max. Tightening torque of Terminal nut: 2 Nm

**Group Error code (DTC) : P1063**

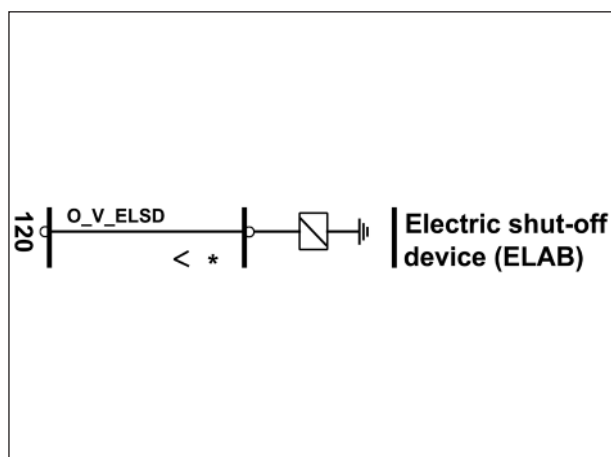
DTC	Description	Effect
P1064	Output Circuit Defect	Engine will not start - No fuel
P1065	Plausibility in ref. to start test	Repeated test cycle interruption till plausibility is corrected. Error is reported - No effect.

**Cause of fault**

- Defective solenoid
- Open / short circuit
- Loose connection

**Service information****Check**

- 12V supply for the solenoid.
- Resistance 7.4 Ohms at 20°C (body earth)
- Continuity of cable from Point no 120 of ECU to solenoid.

**Circuit Diagram**

### 12.10.1 Diagnostic Lamp

#### Function

Diagnostic lamp is provided on the instrument panel. In event of any errors reported by the ECU in course of operation of the vehicle, the diagnostic lamp glows, indicating that there are errors reported in the system and recorded by the ECU. Only selected errors, which can have a direct effect on the engine / vehicle performance, are reported to the diagnostic lamp.

Depending on the criticality of the error reported, the ECU could either switch off the engine or change to limp home mode. Details of the errors can be viewed with the help of the diagnostic tool.



**Diagnostic lamp is only an indicator of any error reported.**

#### Group Error code - DTC : P105A

DTC code	Description
P105C	Lamp - Open Circuit
P105B	Lamp - Short Circuit
P105D	Plausibility Error

#### Effect of fault

No effect of fault. No visual indication for the driver in case of any error reported in the EDC System.

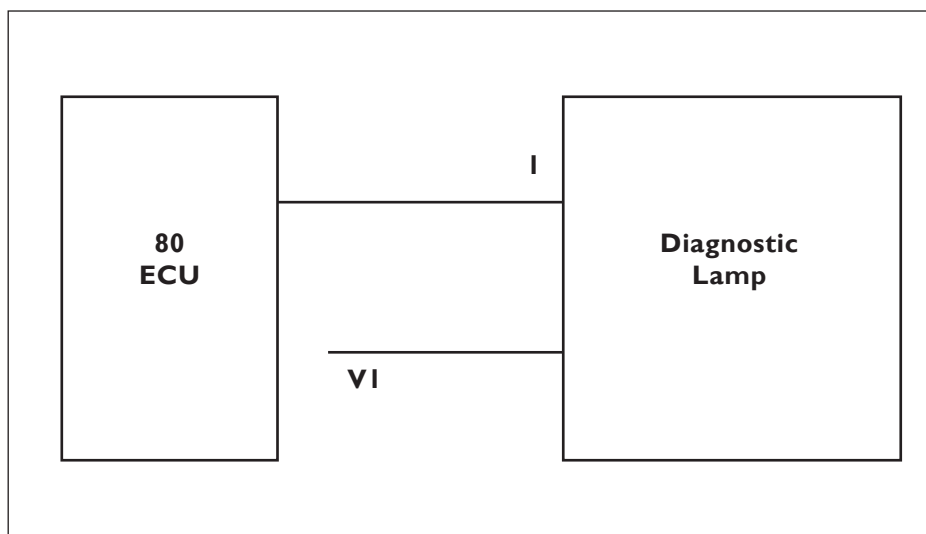
#### Cause of fault

- Loose connection
- Short circuit / Open Circuit

#### Service instruction

Use multimeter and measure voltage and continuity.

#### Pin Configuration and Connection details



**12.10.2 Fuel Timing Actuator (Timer Solenoid)****Function and working:**

The solenoid valve controls the start of injection. The pump interior pressure is dependant upon pump speed. Similar to the mechanical timing device, this pressure is applied to the timing piston device. A clocked solenoid valve modulates this pressure on the timing device pressure side.

With the solenoid valve permanently opened (pressure reduction) , start of injection is retarded, and with it fully closed (pressure increase) , start of injection is advanced. In the intermediate range , the on/off ratio (the ratio of solenoid valve open to solenoid valve closed) can be infinitely varied by the ECU.

**Specifications:**

Resistance : At 25°C ± 10 : 13.3 to 16.3 Ohms

Supply Voltage : 12V

**Group Error Code - DTC P1087**

DTC code	Description
P1088	Short Circuit
P1089	Open Circuit

**Effect of fault**

Timing as per the defined map with fixed values shall prevail at all speed range. The performance may not be as that of normal. Emission would be affected. Fault to be rectified.

**Possible cause of fault**

- Defective solenoid
- Loose connection
- Short circuit / cable cut

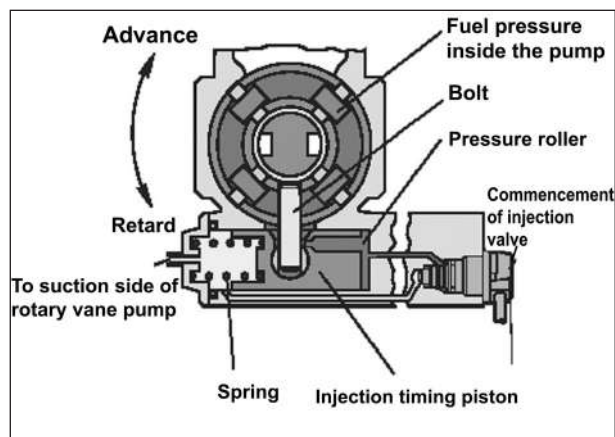
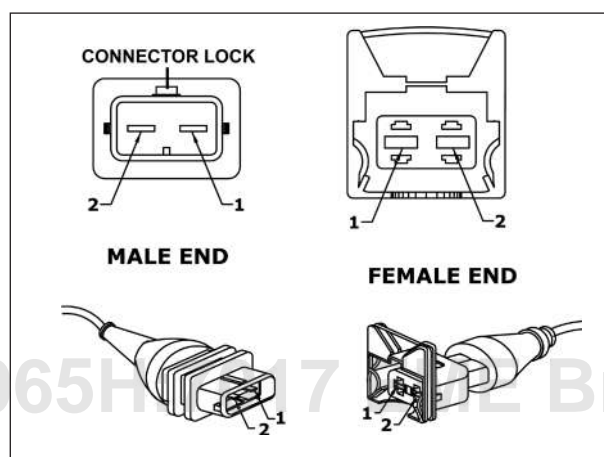
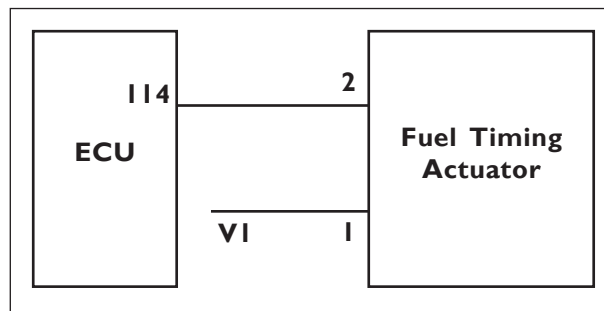
**Service instruction:**

Check resistance between pin 1 & Pin 2 of the connector available at the FIP end

Check continuity between point no 1 & V1 and point no 2 & 114.



**In case of defective timer solenoid send the FIP to Mico dealer for Warranty / Service attention. For removal and refitment of the pump refer the procedure given under fuel actuator.**

**Fuel Timing Actuator****Connectors****Pin configuration & Connection Details**



### 12.10.3 Fuel Quantity Actuator

#### Function and Working

The solenoid actuator (rotary actuator) engages with the control collar through a shaft. Similar to mechanically governed rotary fuel injection pump, the cut off ports are opened or closed depending upon the control collar's position. The HDK unit ( Fuel quantity Adjuster ) is integrated in the pump .The task of the adjuster is to generate the correct quantity from the Control Signal from ECU. It is a inductive type electric motor which adjusts the position of the control collar and thus regulates quantity continuously from Zero to Max. delivery in reference to Fuel map. It is a closed loop control by monitoring the position of the Control collar.

#### Effect of fault

Dearborn Error Code	Effect of Fault	Error Path
P10A2	Engine will shut down	Fuel Qty actuator - Negative and positive governor deviation in hot and cold condition
P10B4, P1099	Engine will shut down	Fuel actuator Governor feedback signal
P0180	Drop in engine power –Limp home mode	Fuel temperature sensor

#### Cause of fault

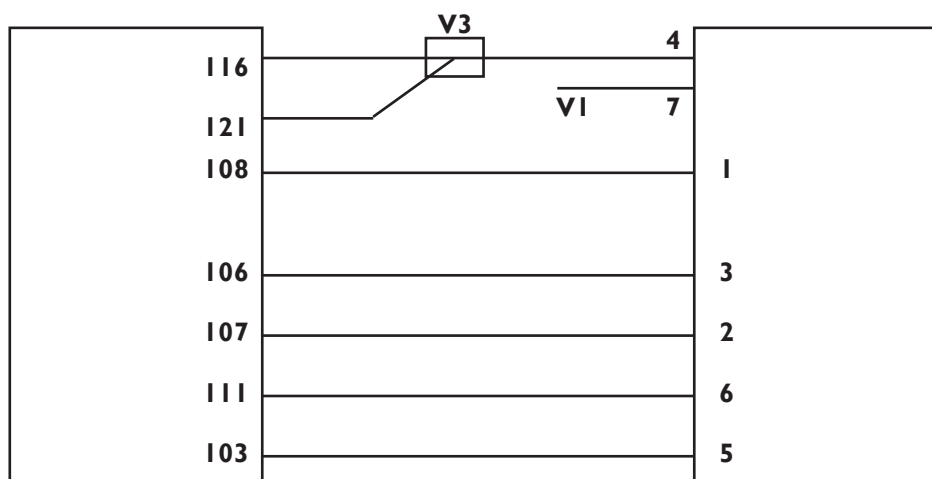
- Defective actuator
- Defective temperature sensor
- Control collar stickiness
- Loose connection at connector end

#### Service instruction:

Check resistance at 15 - 35°C

FIP end connector	Resistance value
Pin no 4 & 7	0.35 – 1.0 Ohms
Pin no 1 & 3	5.8 – 6.5 Ohms
Pin no 2 & 3	5.8 – 6.5 Ohms
Pin no 1 & 2	9.7 – 12.9 Ohms
Pin no 5 & 6 (fuel temp)	At 25°C 0.5 – 3.5 KOhms
	At 60°C 0.15 – 1.05 KOhms

#### Pin configuration & Connection Details





**To Remove and Refit Fuel Injection Pump and To Adjust the Injection Timing**

In case of defective fuel actuator remove the FIP and send to Mico dealer for warranty / service attention.

Use special Tool 0102019 - Wrench for Engine Cranking.

**A. Removal of FIP from Engine:**

1. Isolate battery.
2. Remove high pressure pipe connections, remove over flow pipe connection from the fuel injection pump.
3. Remove the speed sensor holder fitted on the flywheel timing window (For 6 Cylinder Engines only) . Also remove connectors and cables from the FIP.
4. Bring the no.1 cylinder at TDC on compression stroke by rotating the crank pulley suitably (Hint: there is no need to remove the rocker cover. At the first cylinder compression the double groove in the Inj. Pump drive coupling, which can be felt with hand from the open rear end of the Inj. Pump drive housing, will be 12 O'clock position).
5. Loosen the 3 nuts mounting the FIP onto the injection pump drive housing, and remove the FIP. There is no need to remove the injection pump drive housing.

**B. Bench Calibration:**

1. Remove the splined bush by a suitable tool.  
  
The FIP can now be put on bench for calibration.
2. After bench calibration, fix the splined bush and torque tighten to the specified value.
3. Ensure position of the double tooth of the splined bush at 12 O'clock position.
4. The FIP is now ready for fitment onto the engine.
5. Ensure that the inlet adaptor on the FIP fuel inlet, Overflow ('OUT') Banjos are fitted back onto the FIP after bench calibration.



**For latest Calibration chart refer MICO dealer.**

**C. To Refit the Fuel Injection Pump and adjusting the Fuel Injection Timing (6 Cylinder Engine)**

1. Bring the no.1 cylinder at TDC on compression stroke. ( Hint: there is no need to remove the rocker cover. At the first cylinder compression the double groove in the Inj. Pump drive coupling, which can be felt with hand from the open end rear end of the Inj. Pump drive housing, will be 12 O'clock position).



2. Check the FIP mounting Gasket in good condition.



3. Fit the FIP onto the engine aligning the double tooth with the double groove in the injection pump drive coupling (Hint: at the correct timing the double tooth on the splined bush would be 12 O'clock position).



4. Tighten the 3 FIP mounting nuts, by pushing the pump towards cylinder block.



5. Remove the dummy plug on the distributor head and fix the special tool.
6. Rotate the engine in the opposite direction of rotation. Stop the rotation when the pointer of the dial indicator stops moving.
7. Set Zero on the dial.
8. Rotate the engine in the direction of rotation and align the 1/6 mark on the engine flywheel to the flywheel housing ref.



9. The dial indicator should now read pre-stroke specified for the engine.
10. If not, loosen the three nuts holding the FIP to the housing-inj. Pump drive and turn the FIP towards or away from the engine so that the dial reads the required pre-stroke value.

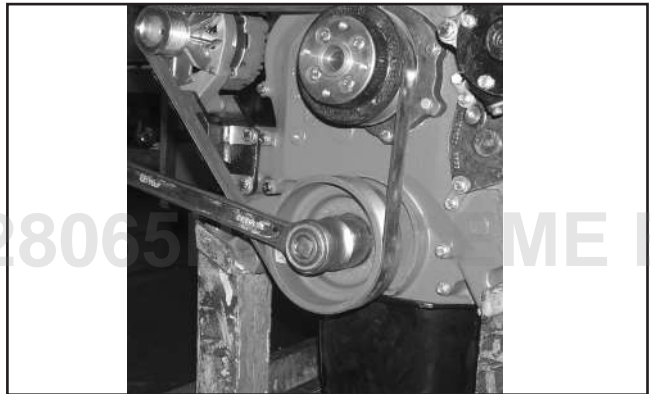
11. Tighten the three nuts to torque (25 + 10 Nm) secure the FIP firmly.
12. Remove the dial indicator and fit the dummy plug.
13. Fit the over flow pipe, fuel inlet / outlet pipes, high pressure pipes and FIP support bracket properly.

Clean the speed sensor tip and fit the speed sensor holder and torque tighten the fixing bolts to 10 - 15 Nm.

Ensure proper connections of governor, timer and shut off solenoid connectors.

#### D. To Refit the Fuel Injection Pump and adjusting the Fuel Injection Timing (4 Cylinder Engine)

The static timing spec for HA4CTI3N is  $0.3 \pm 0.02$  mm plunger lift at TDC.



1. Bring the no.1 cylinder at TDC on compression stroke by rotating the crank pulley suitably ( Hint: there is no need to remove the rocker cover. At the first cylinder compression, the double groove in the Inj. Pump drive coupling, which can be felt with hand from the open end rear end of the Inj. Pump drive housing, will be 12 O'clock position).



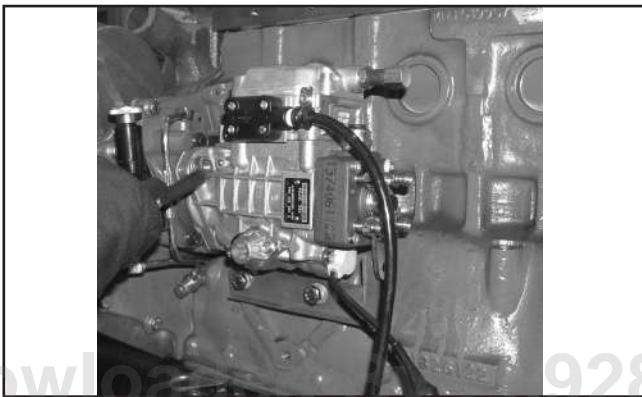
2. Check the FIP mounting Gasket.

Engine Spec	Static Timing (When No.1 cylinder is on compression stroke)
HA6DTI3N MKI	$0.2 \pm 0.2$ mm plunger lift at TDC.
HA6DTI3N MKII	$0.8 \pm 0.2$ mm plunger lift at TDC.
HA57L135 HT	$0.6 \text{ mm} \pm 0.2 \text{ mm}$ plunger lift at TDC.
HA57L135 LT	$0.8 \text{ mm} \pm 0.2 \text{ mm}$ plunger lift at TDC.

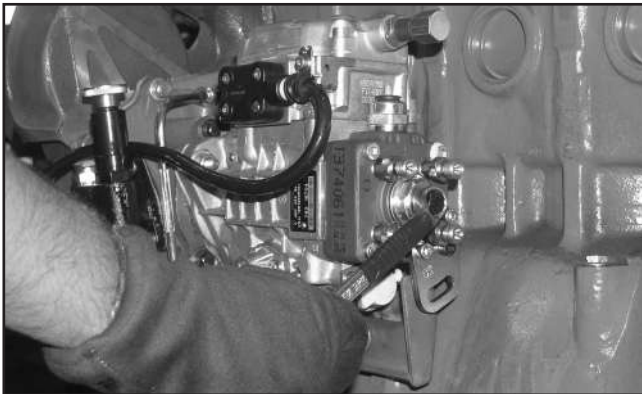




3. Fit the FIP onto the engine aligning the double tooth with the double groove in the injection pump drive coupling (Hint: at the correct timing the double tooth on the splined bush would be 12 O'clock position).



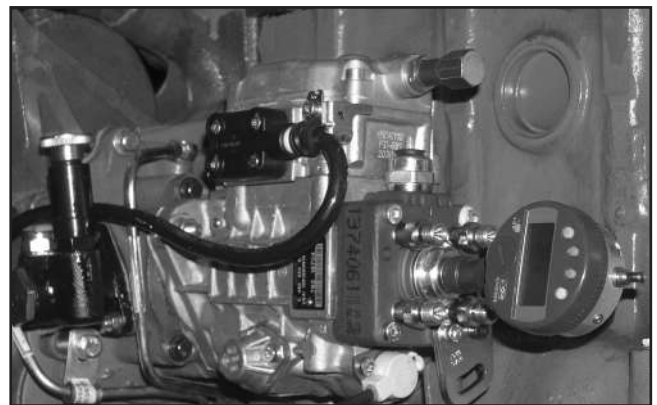
4. Tighten the 3 FIP mounting nuts, by pushing the pump towards cylinder block.



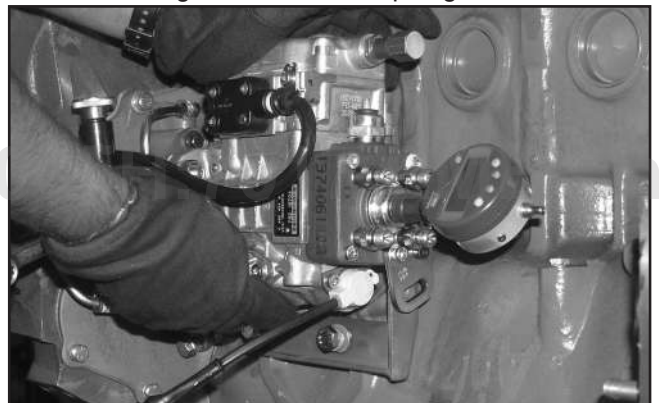
Remove the dummy plug from the distributor head.



5. After removing the dummy plug from the distributor head, fix the special tool.



6. Rotate the engine in the opposite direction of rotation. Stop the rotation when the pointer of the dial indicator stops moving.
7. Set Zero on the dial.
8. Rotate the engine in the direction of rotation and align the 1/4 mark on the engine flywheel to the flywheel housing ref.
9. The dial indicator should now read pre-stroke specified for the engine.  
Static timing -  $0.3 \pm 0.02$  mm plunger lift at TDC.



10. If not, loosen the three nuts holding the FIP to the housing-inj. Pump drive and turn the FIP towards or away from the engine so that the dial reads the required pre-stroke value.



11. Tighten the three nuts to torque ( $25 + 10$  Nm) secure the FIP firmly.
12. Remove the dial indicator and fit the dummy plug.
13. Fit the over flow pipe, fuel inlet / outlet pipes, high pressure pipes and FIP support bracket properly. Ensure proper connections of governor, timer and shut off solenoid connectors.

**12.10.4 ECU - Related Group Error Codes:**

DEARBORN CODE	CRYPTON CODE	ERROR PATH
P1000	P1001, P1002, P1003, P1004	Error encountered during overrun monitoring during overrun monitoring. Recovery from an erroneous state.
P1009	P1010	Communication error between micro controller and EPROM – Should not come in Production Series ECU.
P1012	P1013, P1014	EPROM
P1051	P1052, P1053, P1054, P1055	A/D converter
P1090	P1091, P1092	Reference voltage high / low
P10E1	P1142, P1143	Error path changing over

**Service Information**

- Verify and confirm supply voltage to ECU.
- Clear the errors with diagnostic tool after attending to the error related EDC parts
- Switch off the ignition    ➡    Switch on the ignition    ➡    start the engine
- Look for the errors    ➡    If the above errors repeat then replace the ECU/If the errors of frequent repeatable in nature, refer with MICO

**12.11 DC-DC CONVERTER**

A DC-DC converter is a component, which converts the DC voltage from one level to another. It performs similar function of a transformer in AC circuits, i.e. steps down the voltage keeping the power constant. In the Electronic Diesel Control System, DC converter changes the 24V dc from the battery to 12V dc. This 12V dc is used as an input to the EDC system. This is required as the EDC system is designed for 12V. Below is the specification of the DC-DC converter required for the EDC system.

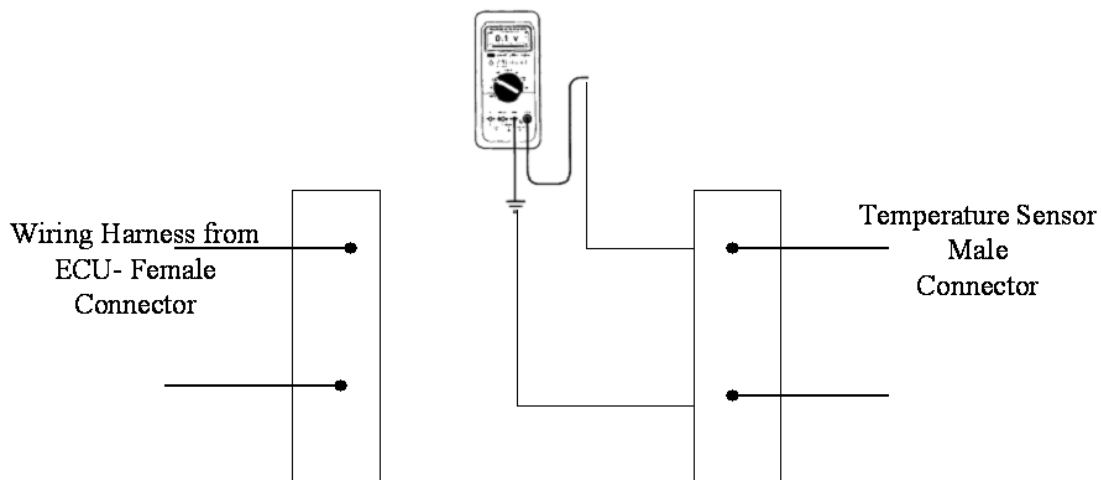
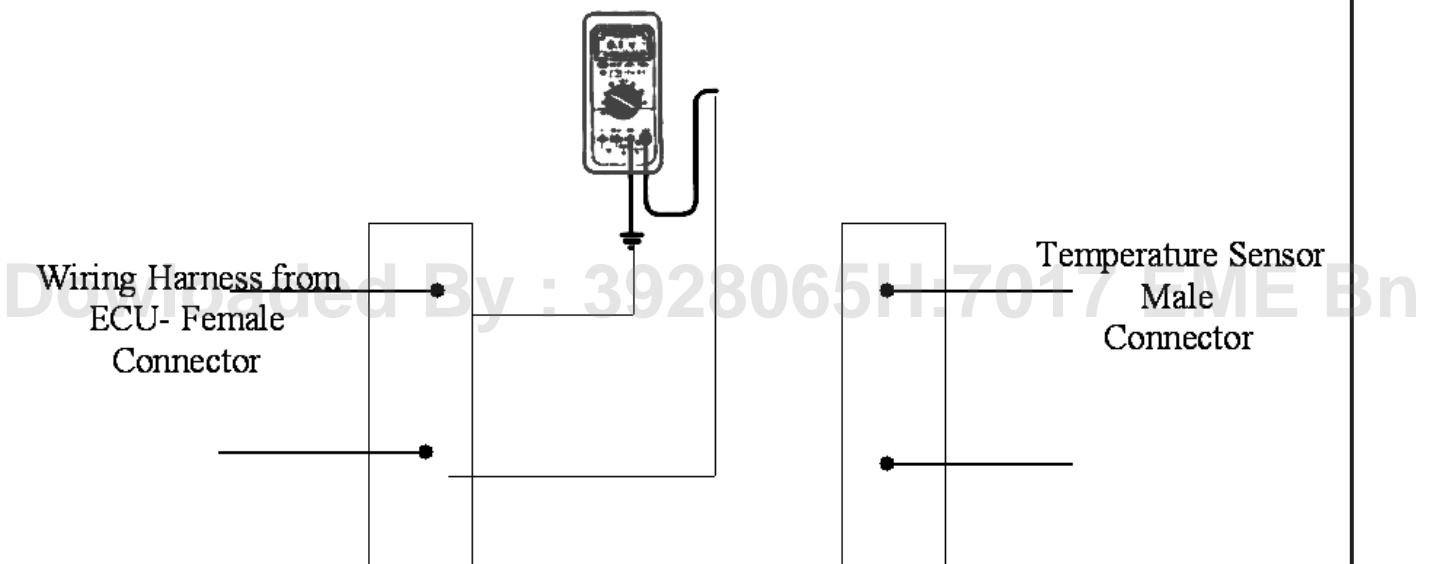
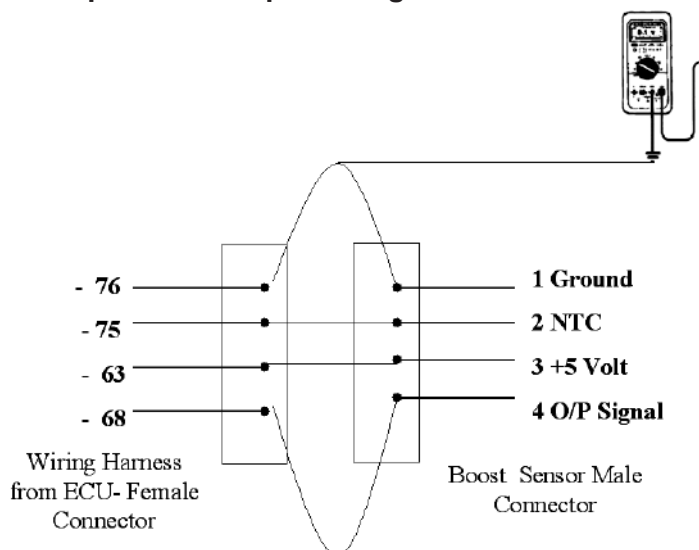
Sl. No.	Specifications	AL Requirements
1	Input Voltage range	14 - 36V DC
2	Output Voltage Range	12V DC
3	Output Voltage Regulation over input range	± 2%
4	Maximum output voltage ripple	200 mv
5	Maximum Output current (Continuous)	10A
6	Maximum Instantaneous Spike current	15A for 20 ms
7	Output Short circuit protection	Yes
8	Reverse Polarity protection	Yes
9	Over Voltage protection	Yes
10	Input load dump protection	Able to suppress load dump as per ISO 7637-2.
11	Conducted Disturbances	Withstand Positive spike of 100V for 50ms Repetition rate:5Hz for 5000 times Withstand Negative spike of -100 V for 2ms. Repetition rate:0.2Hz for 5000 times

**12.12 DO'S AND DON'TS FOR SENSORS**

Sl. No.	Sensor	Do's and Don'ts
1	Engine speed 0 281 002 214 (DG- 6)	<ul style="list-style-type: none"><li>- Replace damaged O-Ring.</li><li>- Fix with only partially self-sealing cylindrical screw M6X12.</li><li>- Do not keep near any strong Magnetic Materials.</li></ul>
2	Boost pressure 0 281 002 514 (LDF6T)	<ul style="list-style-type: none"><li>- The pressure sensor must not fall to concrete ground from more than 1m height.</li><li>- After removing the pressure sensors have to be stored in their original packing to avoid introduction of foreign substances in the pressure ports.</li><li>- Do not install the sensor with a hammer.- Replace damaged O-Ring.</li><li>- Do apply screws, tightening torques, and wiring harness connector only strictly in accordance with the offer drawing.</li><li>- Label on the sensor should not be removed or damaged.</li><li>- Dipping of sensor in any kind of liquids is not allowed.</li></ul>
3	Water temperature	<ul style="list-style-type: none"><li>- After removing temperature sensor, existing Aluminum washer is to be carefully cut / removed (without damaging the brass threading on the sensor) and taken out.</li><li>- Replace new Copper washer</li></ul>

**12.13 GUIDELINES FOR CHECKING SENSORS AND COMPONENT**

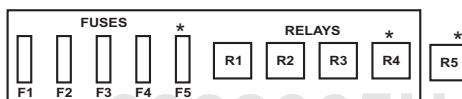
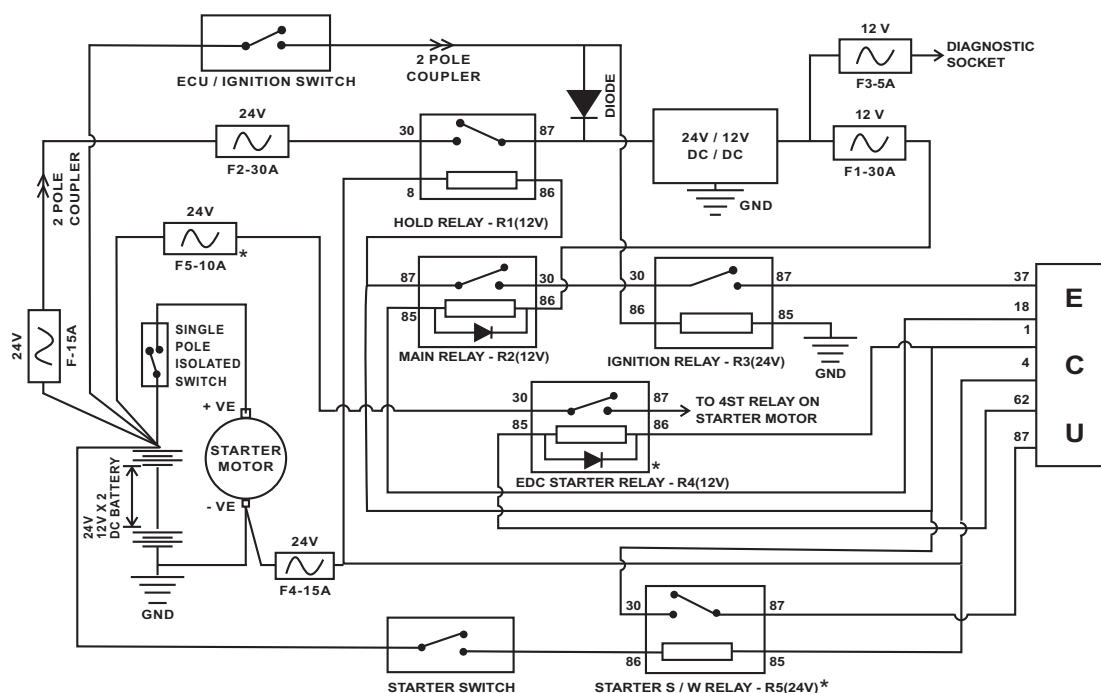
1. Checking Voltage / Resistance at Component or ECU end - Allowed with proper instrument & care.
2. Few test to be carried out with Ignition 'OFF'/'ON' and Engine running mode condition to confirm the fault and after erasing the error.
3. Avoid Checking at ECU end. In case of utmost requirement ensure ECU body is always connected to Starter Negative.
4. Measure resistance of the sensor at the Connector end and on the connector at the ECU end after connecting the respective sensor. Given resistance values are as measurable at the sensor end. While measuring resistance at the ECU connector end with sensors connected, the resistance of the wire will get accounted.
5. Care to be taken not to short the supply voltage / Sensor Output with earth / Negative.

**Example of checking Temperature Sensor****Disconnect the Socket and check the Resistance****Example of checking Input voltage****Disconnect the Socket and check the Input voltage****Example of checking boost pressure output voltage without disconnecting the socket by using 'Y' connector**

**Measurement at ECU with Help of Break out Box or Using 'Y' Connector at Wiring Socket are shown in figures.**



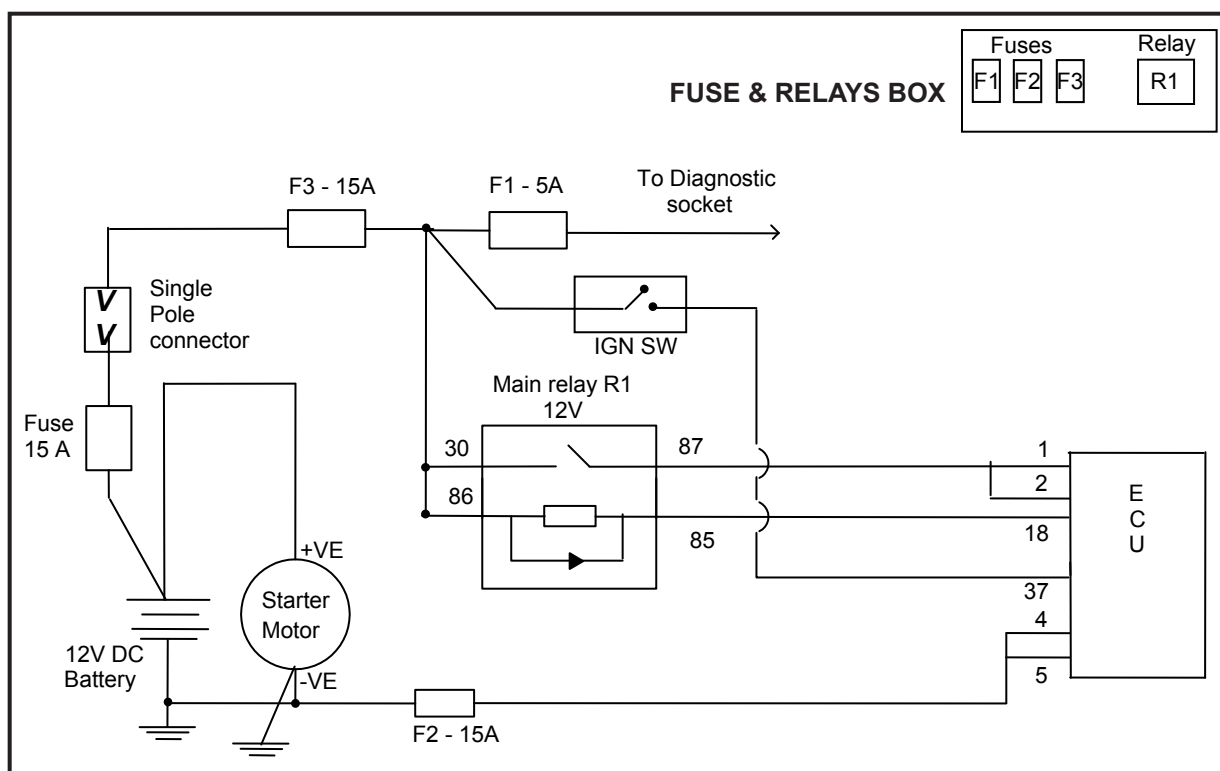
## 12.14 RELAY AND FUSE INTERCONNECTION DIAGRAM (24V)



FUSE &amp; RELAYS BOX

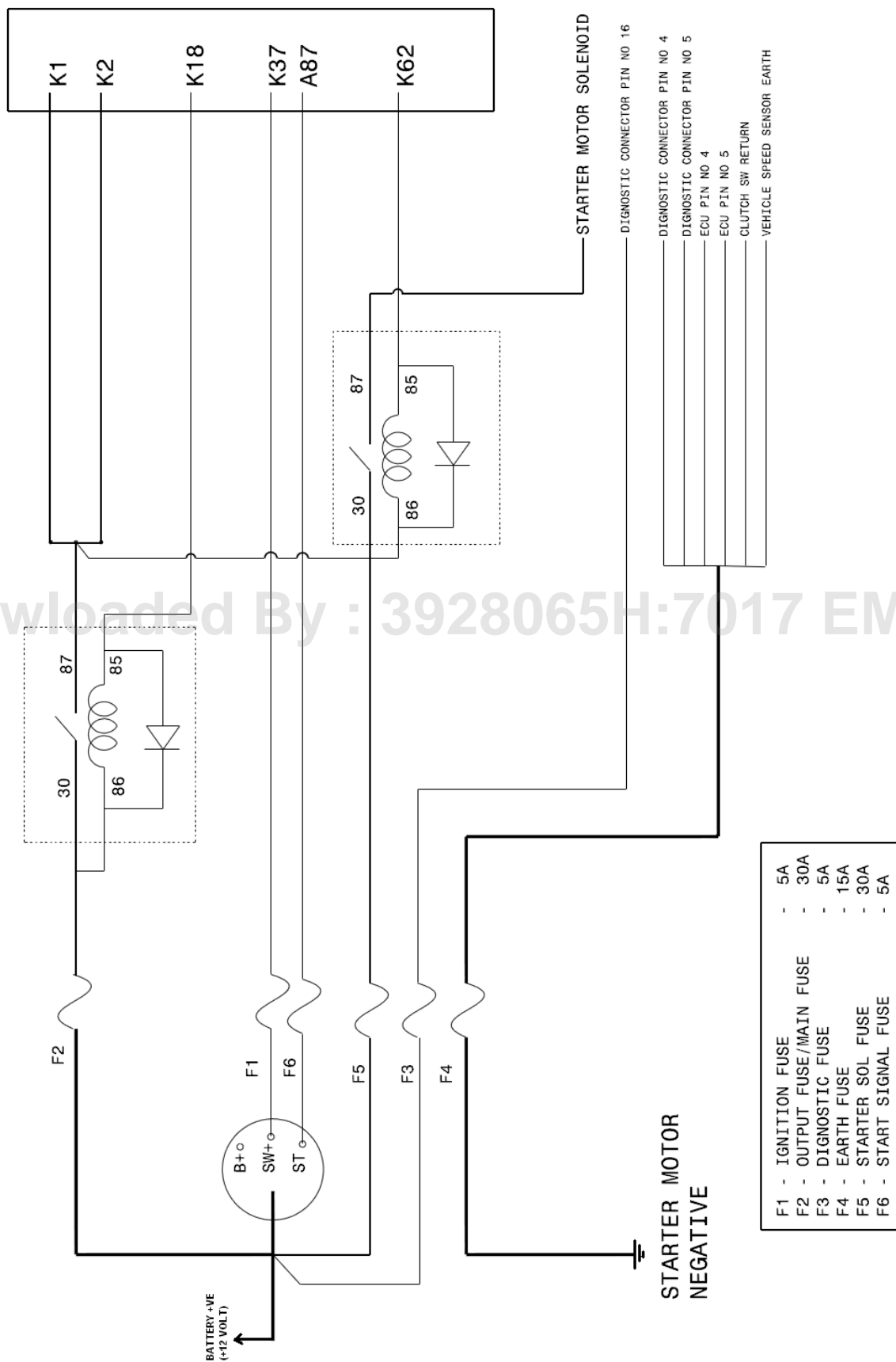
\* - ONLY FOR 124 KW MARK 2 APPLICATION

## 12.15 RELAY AND FUSE INTERCONNECTION DIAGRAM (12V)





## 12.16 RELAY AND FUSE INTERCONNECTION DIAGRAM (12V) WITH 2 RELAY CIRCUIT





**12.18 DO'S AND DON'TS (DURING REGULAR SERVICE AND BODY BUILDING):**

- Check the battery condition regularly and keep the battery in a healthy condition.
- No undue pressure to be applied on the ECU during service.
- Ensure proper connectivity of ECU/Sensor connectors with wiring Harness and maintain harness clamps.
- Keep the ignition switch 'OFF' while removing & Fitment of the battery connections in the vehicle.
- ECU must be connected or disconnected to the wiring harness only when the ignition switch is in OFF position.
- Electrical tapping not allowed: Tapping should not be taken as this can severely affect the performance of the ECU and Sensors (additional current drawn by the new load will drain the battery faster / damage the DC/DC Converter).
- Do not relocate the ECU from the given location.
- Correct Tightening torques should be used for mounting the ECU.
- Ensure paint removal on the surface before connecting the DC negative connection of EDC system.
- Care should be taken while washing the vehicle. Do not splash water directly on to the ECU, Accelerator pedal module and other electrical components.
- Diagnostic connector should not be left hanging loose and should be handled with care. The protective cap is to be removed only at the time of connecting diagnostic tester.
- Reverse polarity protection: Care needs to be taken while removing and connecting the battery connection during body building
- No intermittent connector in the EDC wiring system should be practiced.
- Correct tightening torques should be used for mounting the ECU and other electrical/electronic parts on EDC panel.  $8 \pm 2$  Nm torque (M6 - 8.8 Gr).
- Mounting position of the ECU should not be changed.

**12.19 HINTS DURING THE BODYBUILDING PHASE:**

Extreme care should be taken while assembling the body on the chassis with respect to the ECU.

- 1.1 The ECU should be disconnected from the harness and a dummy cap/cover with plastic bags should be put on the ECU connector. There should be no ingress of water through the wiring harness on the ECU.
- 1.2 The ECU as such should be covered in a box so that if any washing is done, the ECU will be protected.
- 1.3 Maximum cleanliness in the work area and the tools should be employed. Check to see if the ECU has become dirty during the body building phase especially at the connector end and pins. Use a soft clean & dry paint brush to remove the dust.

**Ashok Leyland specific:**

Ensure that the intermediate connector (supply +ve and -ve for ECU) between the DC to DC converter and wiring harness is properly locked and intact.

**EDC System**

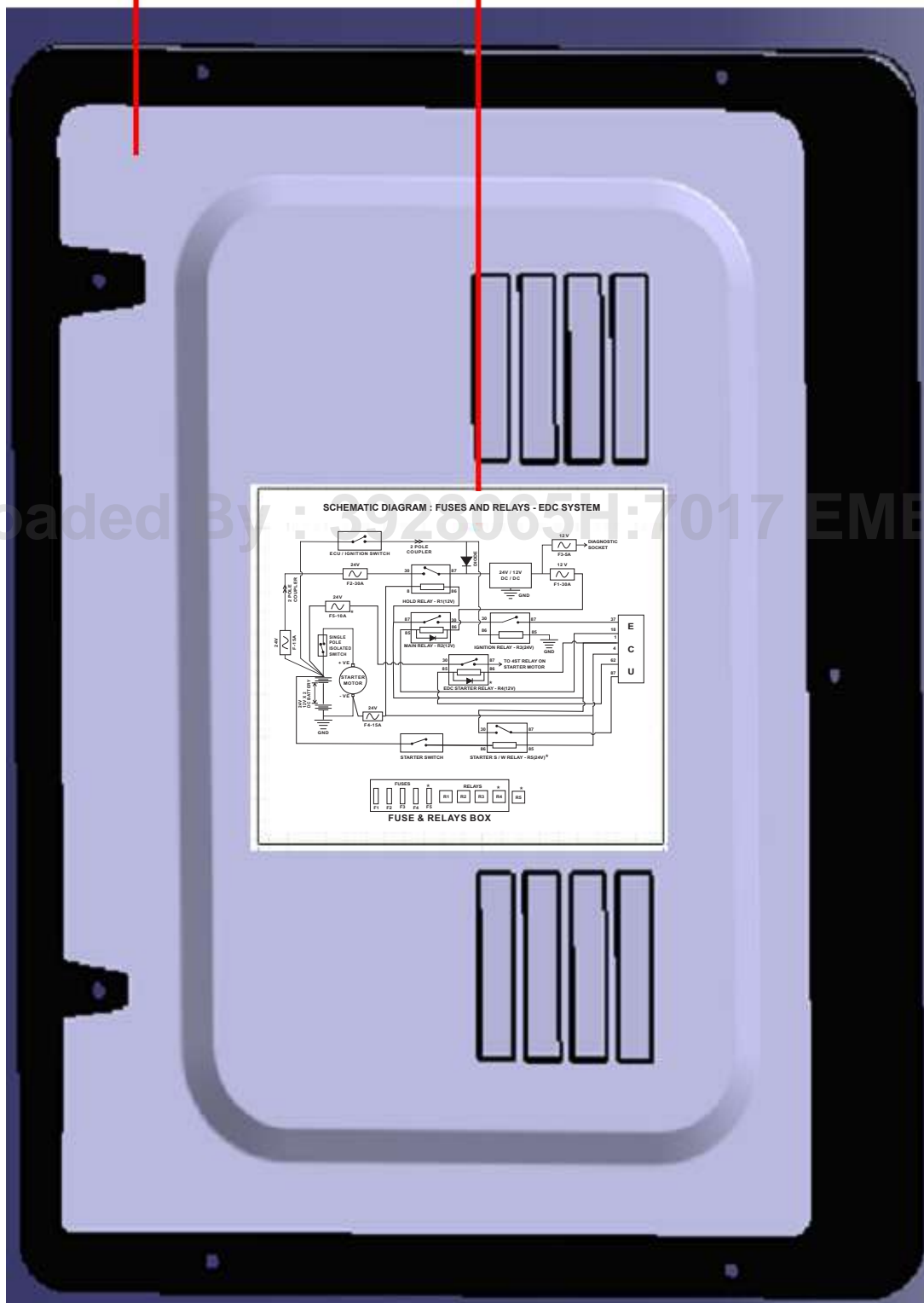
Have a clear space in front of the EDC panel cover for easy removal and fitment of electrical/electronic parts of EDC panel.

**Instructions**

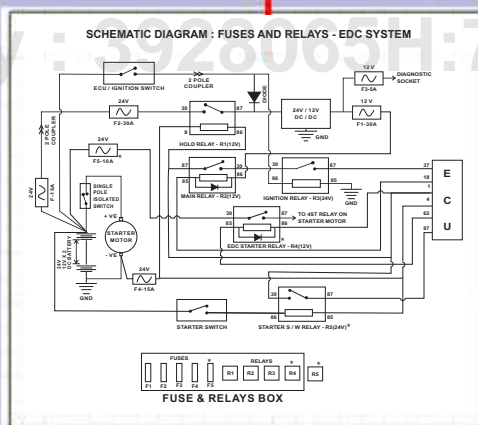
1. Before and during welding
  - Disconnect battery terminals (Positive and Negative terminals of 24V supply).
  - Disconnect Two connectors of the ECU and have the panel cover refitted.
  - Avoid falling of hot weld spatters on wiring harness, sensors and Accelerator Pedal Module.
  - Do not use Accelerator Pedal as a support during body building.
  - Avoid falling of any sharp/Heavy objects on the accelerator pedal module and its connecting wire.
  - Do not disturb the clamps of EDC System wiring harness unless it is very essential, but ensure it is replaced/refitted properly.
2. Do not disturb/remove the connected EDC Negative connection of the system. EDC negative is connected at the following places
  - a. Starter Motor Negative
  - b. EDC pane 1
  - c. Earth Strap to be connected for ELAB ground.
3. Do not remove or cut wires of the EDC system wiring harness. No extension or intermediate joints are permitted.
4. Before connecting the engine wiring harness, the battery terminals (Both positive and negative terminals) are to be disconnected.
5. Make sure that the lock of the connectors are fitted properly.
6. Clip/clamp the wiring harness every 500 mm.
7. Wrap insulation tape wherever the tapings has been taken. Make sure that no part of the wire is left un-insulated.

EDC PANEL  
COVER (BACK  
VIEW)

CIRCUIT  
DIAGRAM  
STICKER



SCHEMATIC DIAGRAM : FUSES AND RELAYS - EDC SYSTEM



FUSE & RELAYS BOX

# **DIAPHRAGM CLUTCH**



**ASHOK LEYLAND**

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## 310 DIA DIAPHRAGM CLUTCH

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**21.0 GENERAL****21.0.0 Diaphragm Clutch Type and Sl. No.**

Manufacturers make is punched on the cover plate.

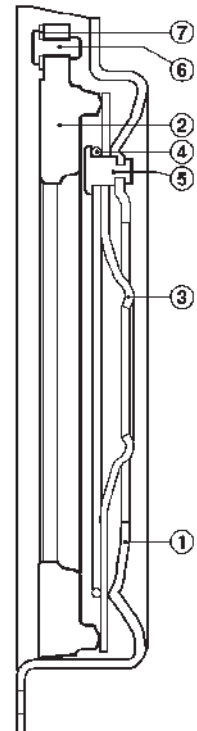
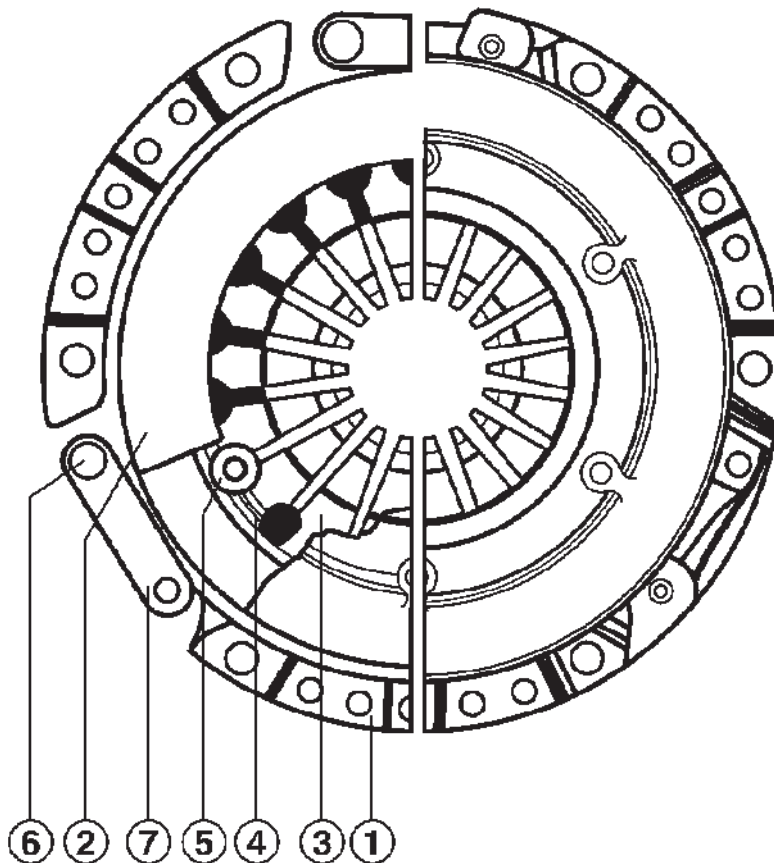
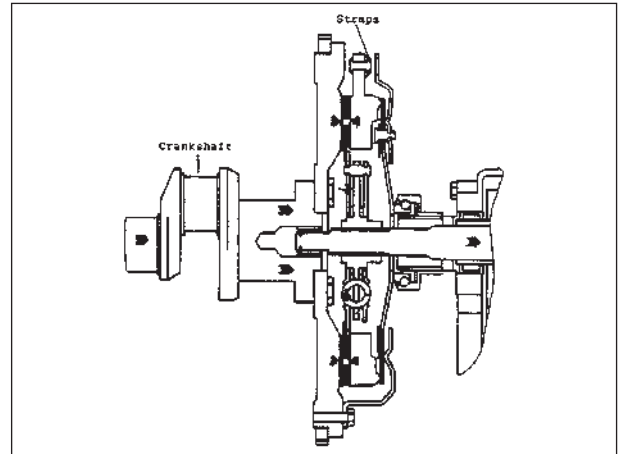
**21.0.1 Design and Operation**

Diaphragm clutch design consists of the following parts.

1. Clutch Cover
2. Pressure plate
3. Diaphragm Spring
4. Fulcrum rings
5. Fulcrum rivets
6. Rivets to attach drive straps to clutch cover and pressure plate
7. Drive straps

**FUNCTION**

The flywheel is bolted firmly to the crankshaft. As there are 2 friction surfaces i.e. Flywheel face and Pressure plate face, the torque is transmitted through these surfaces based on the co-efficient friction( $\mu$ ). In the case of the cover assembly the torque transfer is from the flywheel into the cover, which is bolted to the flywheel. Through the drive straps, into the pressure plate and to the facing on the clutch disc.



Representative Diagram - Diaphragm Spring Clutch



The diaphragm spring clamps the pressure plate against the clutch disc to achieve positive lock-up with the flywheel. The clutch disc transmits the entire engine torque to the transmission via a splined connection to the transmission input shaft.

When the driver depresses the clutch pedal, the release bearing actuates the diaphragm spring. The diaphragm spring is supported on a fulcrum ring attached to the clutch cover. The diaphragm spring pivots on this fulcrum ring, so that the outside diameter moves away from the pressure plate. This causes the preloaded drive straps to pull the pressure plate away from the clutch disc, interrupting torque transmission. When the driver releases the clutch pedal, the outer portion of the diaphragm spring acts on the pressure plate which clamps the clutch disc between the pressure plate and the flywheel.

#### Advantages of Diaphragm Clutch

In the diaphragm spring clutch, the lever portion performs the release function. In spite of the high clamp load requirements, the diaphragm spring's unique characteristic curve provides the low release loads demanded by today's comfort-minded drivers. Finally, when coupled with an appropriately tuned cushion segment in the clutch disc, the diaphragm spring clutch offers excellent engagement performance and exceptional start-up comfort.

1. Reduced clutch pedal effort
2. Optimum clamping load maintained regardless of wear on the clutch disc.
3. Uniform clamping load over facing
4. Diaphragm spring unaffected by centrifugal forces as in the case of coil springs.
5. Compact and fewer parts.
6. Better dynamic balance due to rotational symmetry.
7. High fatigue life of diaphragm spring.

#### 21.0.2 Description of Leading Components

**Cover** - made of pressed steel, and form in such a way as to allow for the assembly of the diaphragm spring and pressure plate internally.

**Driving Straps** - connects the cover to the pressure plate. And is design in such a way as to allow for the retraction of the pressure plate during clutch release.

**Diaphragm Spring** - made from spring steel with between 16 to 24 fingers depending on design. Fingers are to allow for the in and out movement of spring during clutch engagement and disengagement. The outer ring applies the clamping force.

**Pressure plate** - made of high quality cast iron to reduce wear on the friction surface, and of sufficient mass to absorb the heat generated during clutch engagement. Included is a pivot point on which the diaphragm acts.

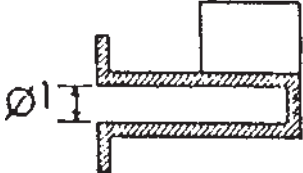
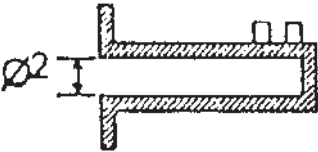
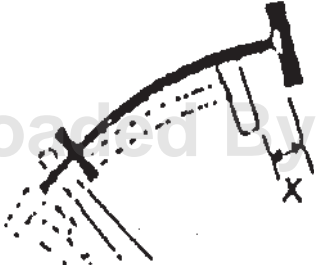


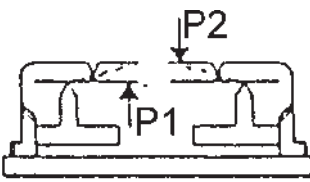
**Rivets (Conventional)** - There are normally 6 rivets to secure the pressure plate to the driving strap and drive strap to cover (3 each)

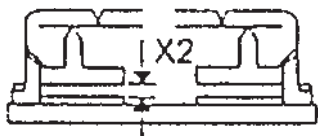
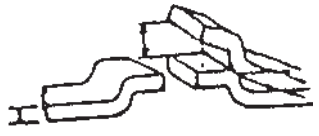
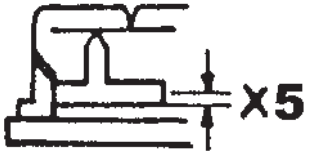
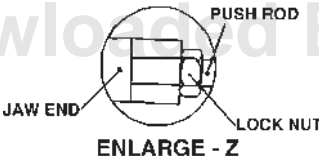
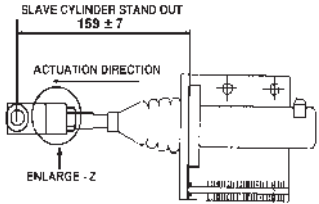
**Fulcrum Rivet** - This is a special rivet and is used to secure the diaphragm to the cover in such a way, that the diaphragm is still able to pivot.

**Pivot Rings** - These are special wire rings welded to form a circle and are to act as pivots for the diaphragm spring.



## 21.0.3 Data

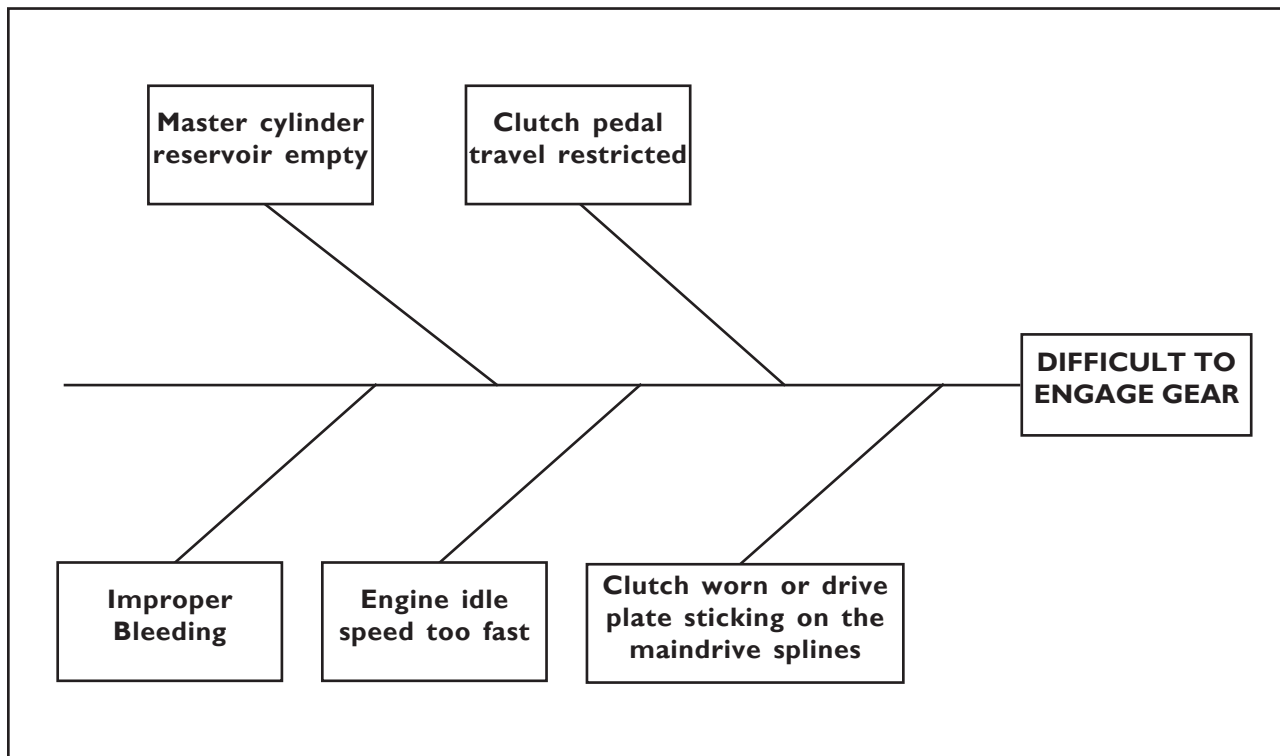
Sl. No.	Figure	Description	Value
		<b>Type</b> - Single plate dry type Diaphragm Clutch - Hydraulically operated	
1		Master cylinder diameter (1) (AS type)	7/8"
2		Slave cylinder diameter (2)	7/8"
3		Clutch pedal play (X)	1/8"
4		Clutch plate diameter (3)	310 mm
5		Clutch plate thickness - free (X <sub>1</sub> ) Clutch plate thickness - clamped (X <sub>1</sub> ) Change clutch plate when (X <sub>1</sub> )	10.8 ± 0.5 mm without load 10.0 ± 0.3 mm with load 6.6 mm
6		Diaphragm spring force a. Fitted condition (P1)	840 ± 30 kg

Sl. No.	Figure	Description	Value
7		b. Peak (P2) Lift of pressure plate for 12 mm travel of finger (X2)	$940 \pm 30$ kg 2.0 mm (minimum)
8		Finger tip run out less than or equal to  Finger thickness more than or equal to	0.8 mm  3.4 mm
10		Thickness of pressure plate Max. skimming allowed (X5)  <b>NOTE:</b> Do not skim as assembly. Pressure plate has to be removed and then skimmed.	1.00 mm
12		Ensure push rod is to be flushed inside the jaw end.	
11		Slave Cylinder Push Rod stand out (with new flywheel, disc and cover assembly) When the stand out becomes 118 mm, replace the clutch disc.	$159 \pm 7$ mm.

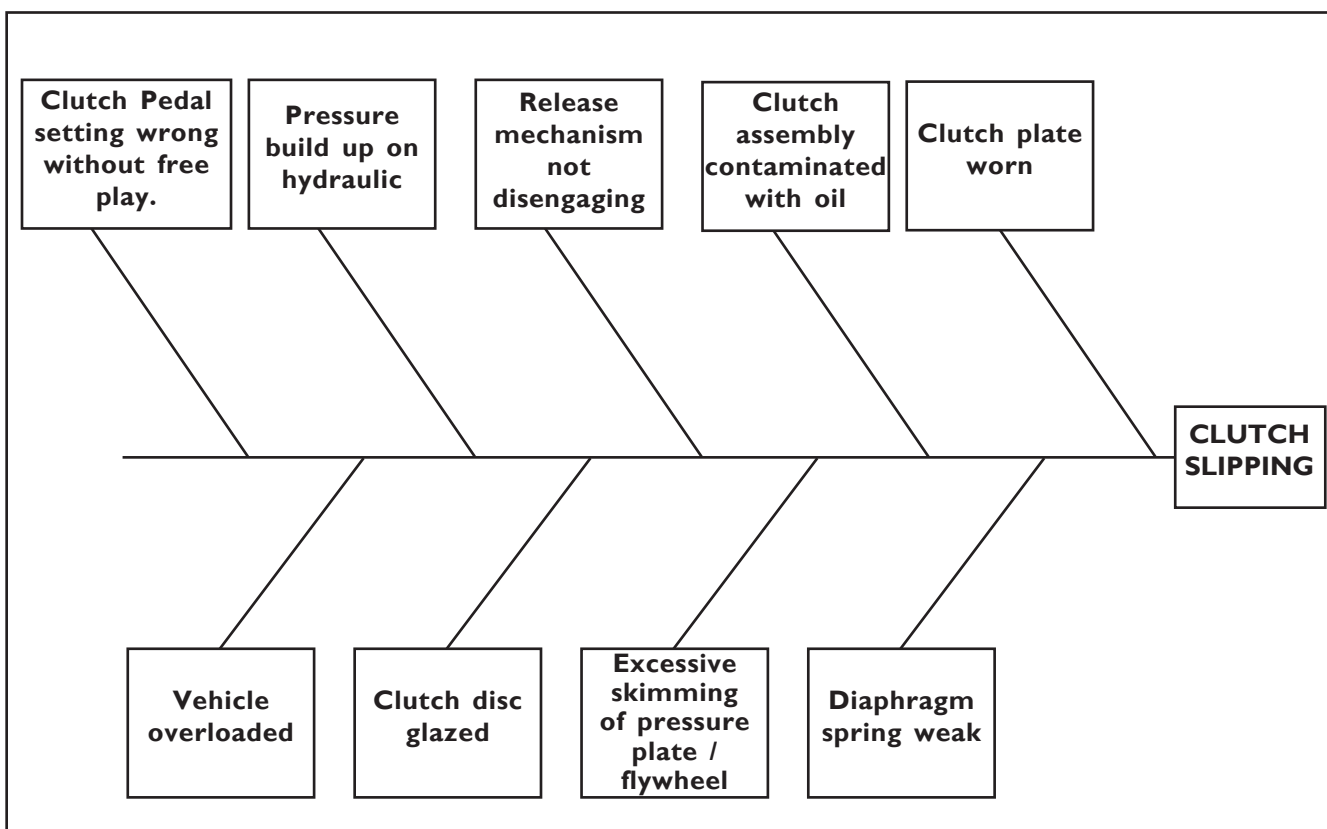


#### 21.0.4 Clutch Preliminary Checks

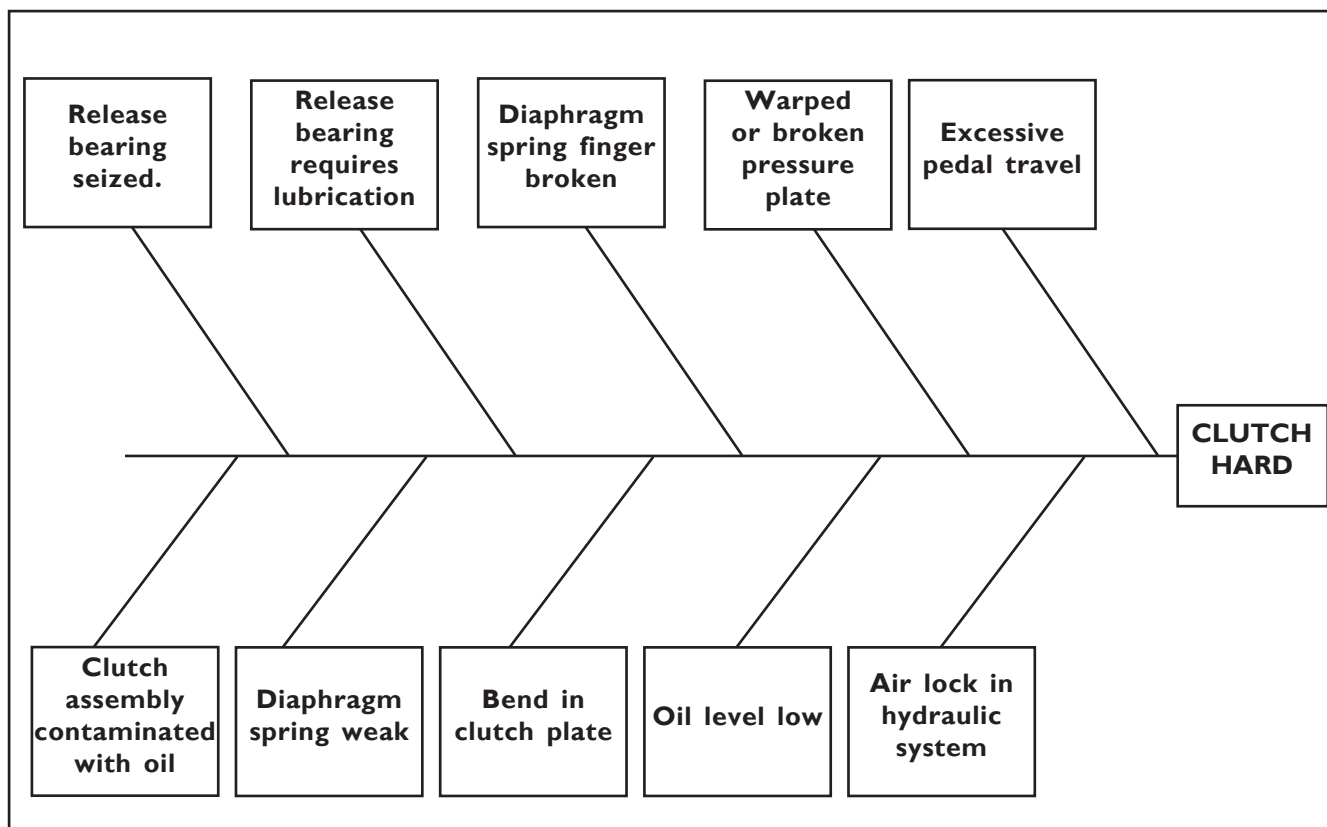
It is mandatory to carry out few preliminary check on Clutch before dismantling from the vehicle. The following cause and effects can lead to overhauling decision.



Cause and Effect Diagram - Difficult to engage gear



Cause and Effect Diagram - Clutch Slipping



Cause and Effect Diagram - Clutch Hard

**21.1 TO REMOVE AND REFIT DIAPHRAGM CLUTCH FROM VEHICLE**

To remove gear box from vehicle disconnect propeller shaft connection, connection parts and remove the gear box assembly carefully.

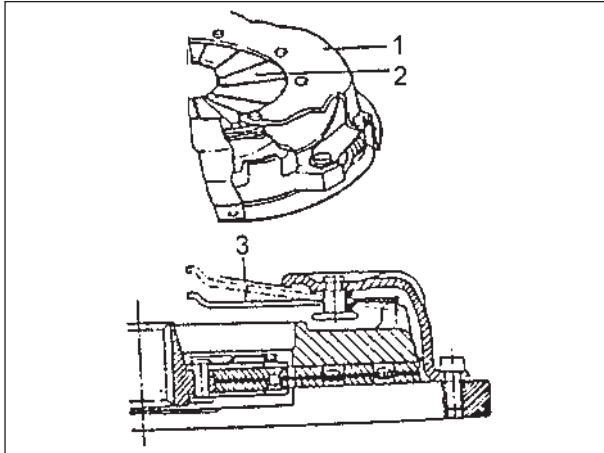
Unscrew bolts holding the clutch assembly to the engine flywheel and withdraw the clutch assembly.

Perform the above in reverse order to refit the clutch assembly.

Use Special Tool 0201006 - Centraliser Clutch ZF Gear Box.

**21.2 TO OVERHAUL****21.2.0 Disassembly****Inspection of the Assembly Before Taking Out From Flywheel**

Check the space available (3) between the cover housing and diaphragm spring (2)

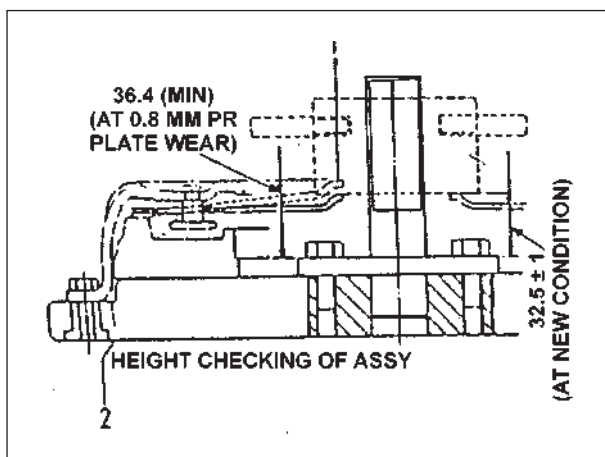


If the gap (3) available is less than 0.78 mm @ max disc wear or more than 7.94 mm max @ diaphragm finger sagging condition then the clutch assembly has to be taken out.

**Inspection of Cover Assembly Fitted on Special Tool 0202001 - Fixture Diaphragm**

Mount the assembly on to the fixture (2)

Check the height of the finger tips (1) from the base of the fixture as shown.

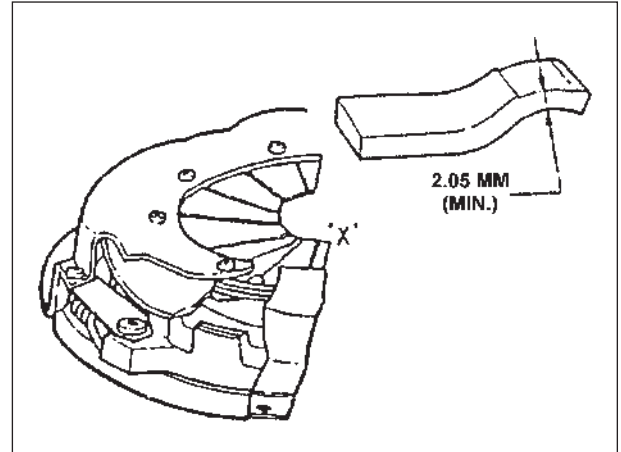


If necessary change pressure plate or diaphragm spring.

**Inspection of Diaphragm Spring****Diaphragm Spring**

Measure the run out on the finger tips. The run out on the finger tips should not to exceed 1.0 mm

Measure the wear on the finger tips (x)



The minimum thickness of the finger tips (1) is not to be less than 2.05 mm.

**Inspection of Pressure Plate, Strap and Fulcrum Ring****Pressure Plate**

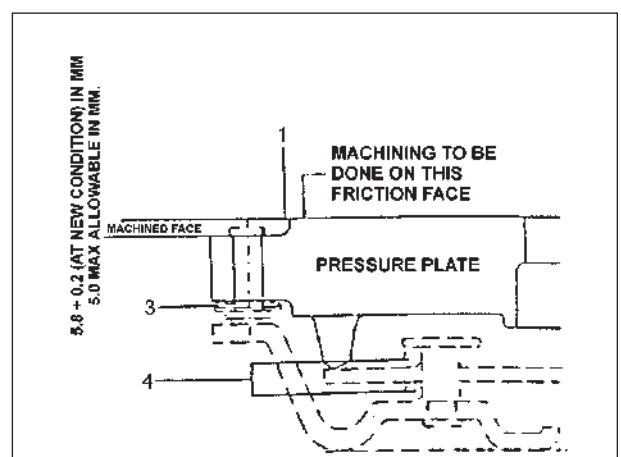
Measure the wear on the pressure plate friction (1) surface. The dimensions should be as shown in figure.

**Strap**

The straps (3) should be in good condition on visual inspection

**Fulcrum rings**

Shake the assembly lightly. No metallic rattling sound indicating the breakage of fulcrum ring (4) should be heard.



### Removal of Pressure Plate and Strap

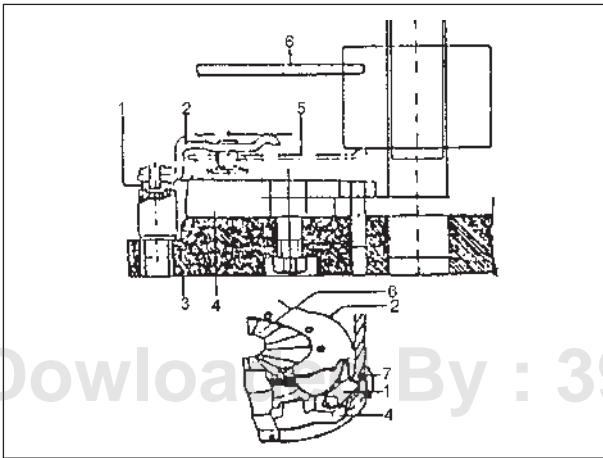
One end of strap (1) riveted to cover (2) and other end to pressure plate (4).

Make suitable marking on cover and pressure plate for reassembling in same position.

Place the assembly on the fixture (3) and tighten the diaphragm spring (5) using the handle (6).

Drill out the four rivets (7) one by one.

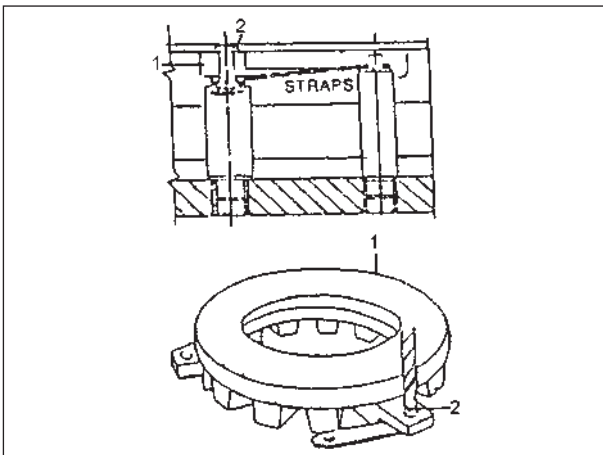
During drilling care should be taken to see that the strap holes are not enlarged.



Remove cover (2) with Diaphragm (5) and pressure plate (4).

### Removal of Pressure Plate From Strap

Place the pressure plate (1) on the fixture as shown Drill out the four rivets (2).



During drilling, drill should not touch the pressure plate.

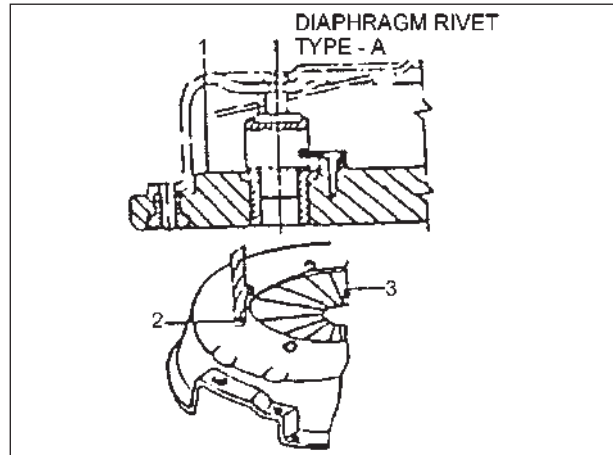
### Removal of Diaphragm From Cover

Place the assembly on the fixture (1) so that rivets seat on the bunks.

Tighten the diaphragm spring (3) using the handle.

Drill out the rivets.

Repeat for other 6 rivets (2).



While drilling drill bit should not touch the cover.

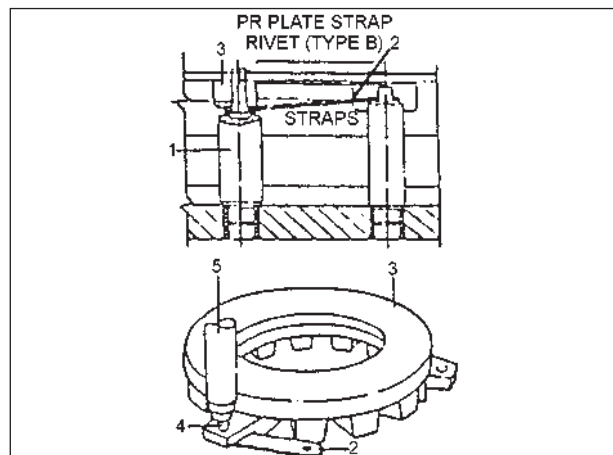
### 21.2.1 Assembly

#### Pressure Plate To Strap Riveting

Place the rivets on rivet supports (1) and keep the straps (2) in position.

Place the pressure plate (3) over the straps such that the rivets enter the holes.

Form the rivets (4) one by one using the punch (5).



Forming diameter of rivets should be between 11 - 11.5 mm using hydraulic press of 8 - 10 Tons.



## Cover To Diaphragm Riveting

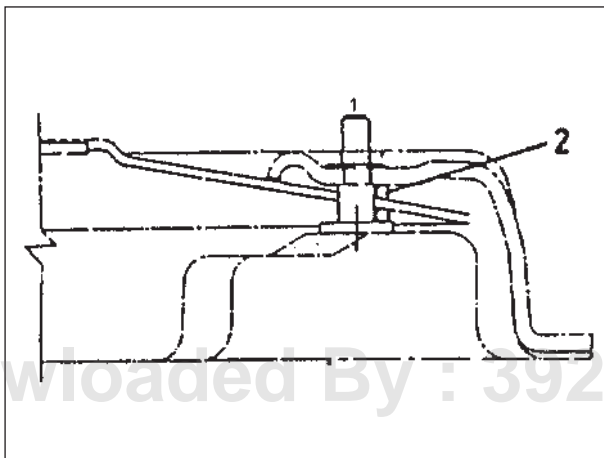
### Locating of Diaphragm Spring With Cover

Place the six guide screws on locating bunk.

Place one fulcrum ring so that the welded portion comes in between rivets. Place the diaphragm spring over the ring.

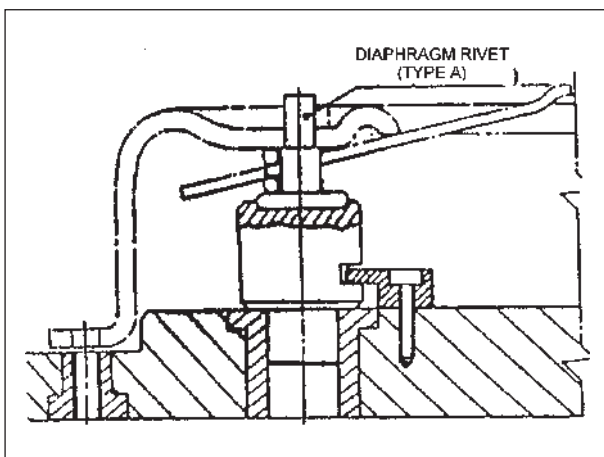
Place another fulcrum ring (2) over the diaphragm spring such that welded portion is diametrically opposite to the other ring.

Place the cover housing so that the guide screws pass through the holes.



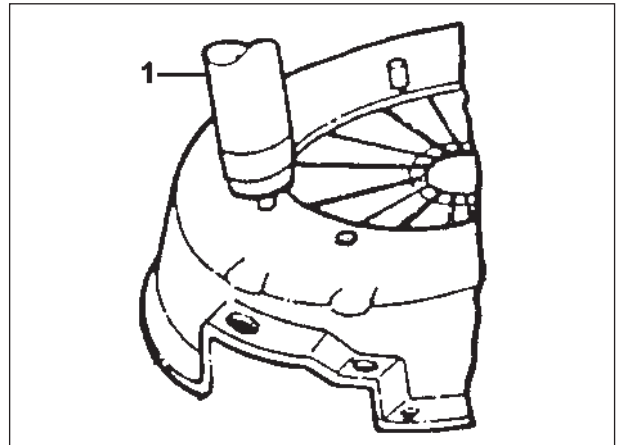
Tighten the guide screws and take out the sub-assembly.

Place six rivets on the rivet supports.



Place the sub-assembly such that the rivets pass through the rivet holes in the cover.

Form the rivets using the punch (1) and hydraulic press. Forming diameter is to be maintained between 11.5 - 12 mm.



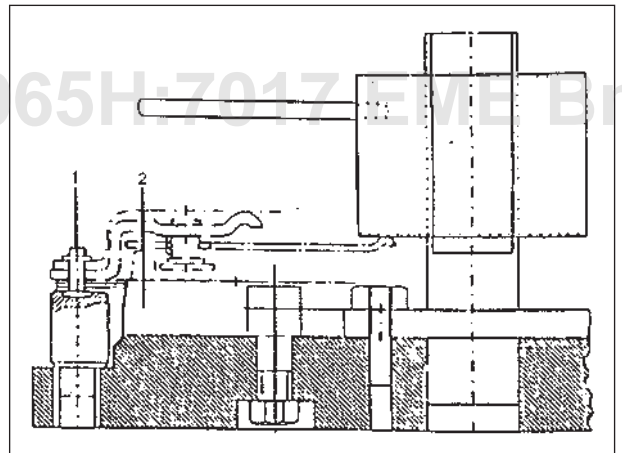
Repeat for other six rivets.

### Final Riveting

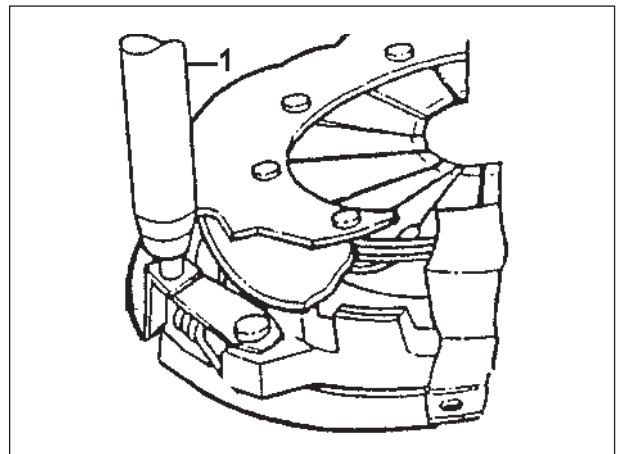
Place the dowel pins in position.

Place the rivets (1) on the bunks.

Place the pressure plate (2) so that the rivets pass through the strap holes.



Coat the diaphragm seating position with molycoat grease. Position the cover and diaphragm suitably so that the markings made before dismantling matches. Tighten the springs using the handle.

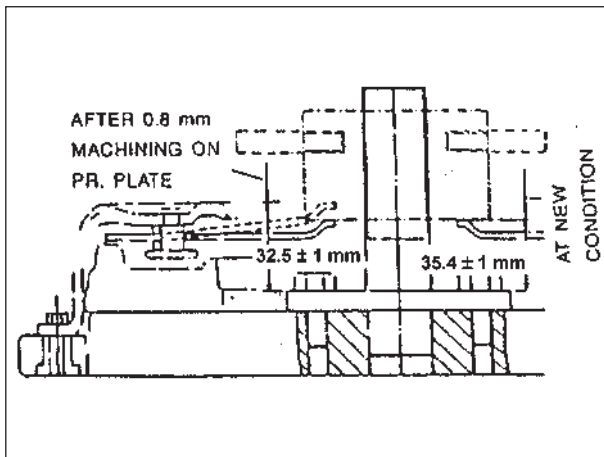


Form the rivets one by one using the punch (1).  
Forming diameter of the rivets is to be maintained at 11.5 - 12 mm. Use by press of 6 - 7 ton capacity.

### Inspection After Riveting

Mount the assembly on the fixture:

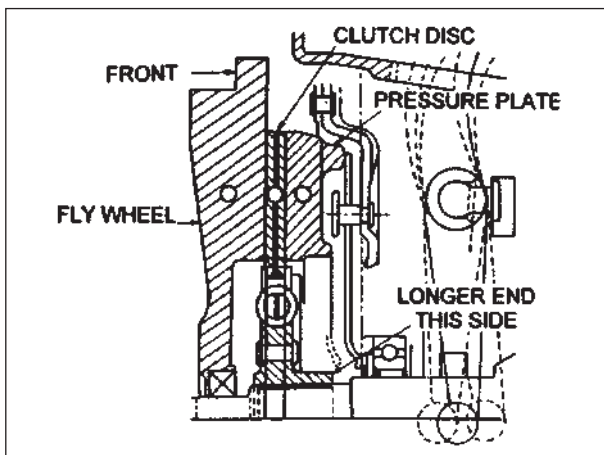
Check the height of the finger tips from the base of the fixture as shown.



35.4 ± 1 mm - @ New condition

32.5 ± 1 mm - After machining the pressure plate 0.8 mm.

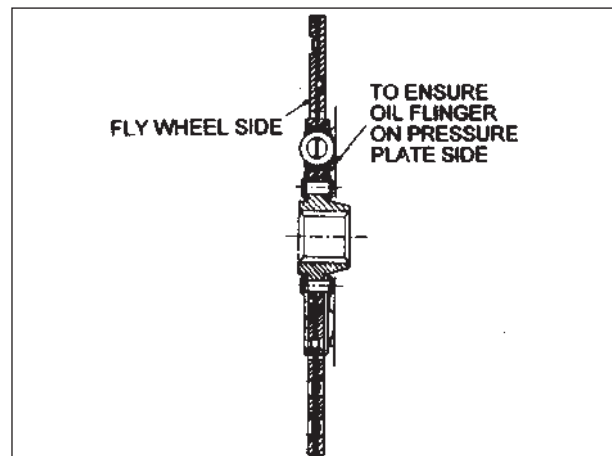
### INSTALLATION OF CLUTCH DISC



Ensure that the flywheel must be with the face of clutch disc lettered as "Flywheel Side", in the case of installing a new clutch disc.

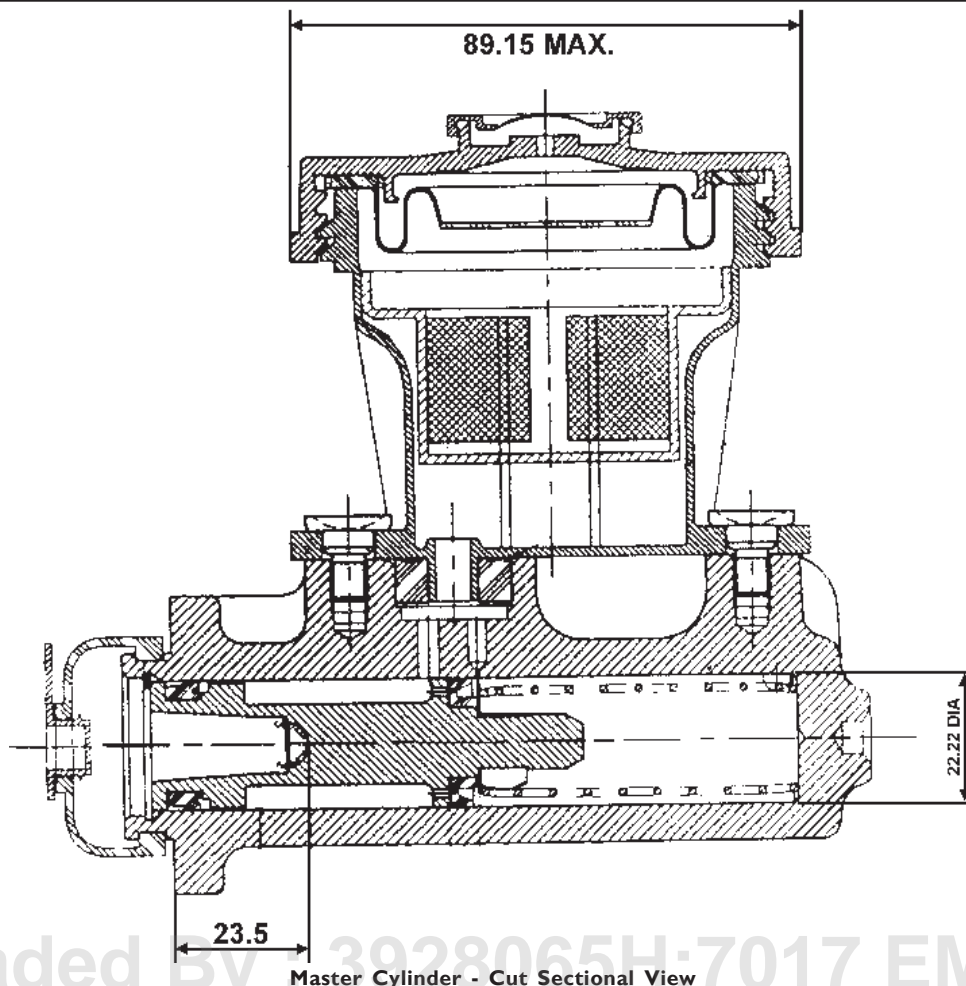
However in the case of refixing an old clutch disc, the lettering may have disappeared and hence check as below.

Hub tail (longer end of clutch plate hub) is to be kept towards the rear (GB side).



The oil flinger on the clutch plate to be ensured on the pressure plate side (i.e. G.B. side).

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## 21.3 HYDRAULIC SYSTEM

### 21.3.0 Master Cylinder

#### 21.3.0.0 Description

When the clutch pedal is depressed, the master cylinder push rod which is directly connected to the clutch pedal, pushes the master cylinder piston sufficiently for the pressure seal to pass the cut off port. Further movement of the piston displaces fluid under pressure from the cylinder and transmits it through the hydraulic pipe to slave cylinder, which in turn operates the clutch release fork through the push rod. When the clutch pedal is released, due to the action of the clutch diaphragm fingers, the fluid from the slave cylinder is pumped back to the master cylinder.

#### 21.3.0.1 Removal

Connect a bleed tube to the slave cylinder bleed screw after removing the rubber dust cap. Loosen the bleed screw by 1/2 to 3/4 turn and pump out the clutch fluid into a suitable container by operating the clutch pedal.

Disconnect the outlet pipe connection from the master cylinder.

Disconnect the push rod linkage from the clutch pedal. Remove the master cylinder mounting bolts/nuts. The master cylinder can now be taken out along with the push rod.

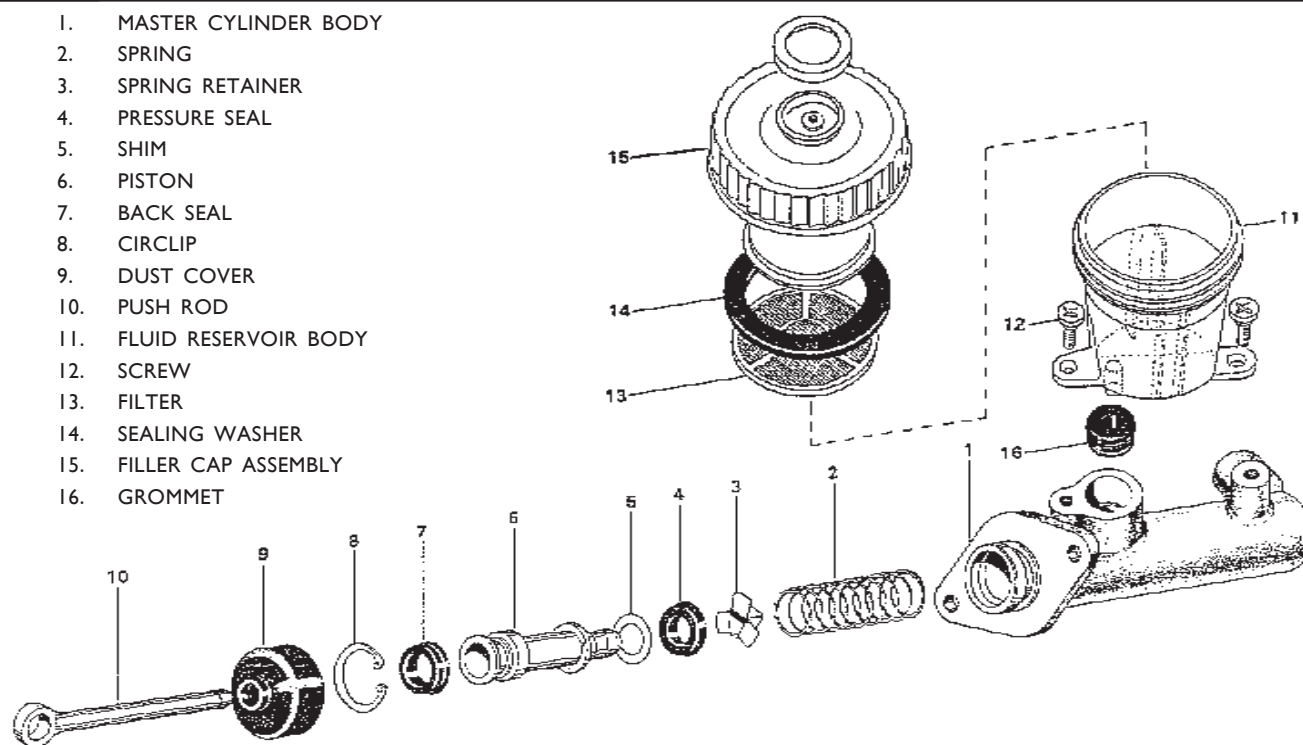
#### 21.3.0.2 Dismantling

Clean the master cylinder externally. Unscrew the filler cap and drain-out any surplus fluid. Hold the master cylinder in a vice fitted with soft jaws. Take care not to distort the barrel.

Remove the fluid reservoir mounting screws (12) with the help of Phillips headed screwdriver. Take out the fluid reservoir (11) from the master cylinder.

Remove the grommet (16) from the master cylinder inlet port. Remove the push rod (10). Remove the dust cover (9). Depress the piston (6) with the push rod and remove circlip (8). The internal parts can now be removed in this order. Piston with back seal (7), pressure seal (4), spring retainer (3) and piston return spring (2).

Remove the spring (2) from the spring retainer (3). Remove the spring retainer (3) from the piston. Remove the pressure seal (4), shim (5) from the piston. Remove the back seal (7) from the piston groove carefully stretching it over the end flange using either by fingers or by using a blunt edged screw driver or brass rod.



Exploded View of Master Cylinder Assembly (AS Type)

Discard all the rubber parts and seal shim. Clean all the other parts and master cylinder body thoroughly in fresh brake and clutch fluid or alcohol and place them on the clean tray or sheet of paper.

NEVER CLEAN THE MASTER CYLINDER OR INTERNAL PARTS WITH DIESEL, KEROSENE OR PETROL.

Ensure that the recuperating hole and the feed hole visible through the inlet port of master cylinder are clean by blowing with dry compressed air.

Remove the filler cap assembly (15) from the reservoir. Remove the filter (13) from the filler cap after taking out the baffle.

Ensure that the breather hole in the filler cap is clean after removing the small cap on the top.

Clean the filter (13) by blowing dry compressed air. Clean the reservoir in isopropylene alcohol.

UNDER NO CIRCUMSTANCE SHOULD THE HOLES BE POKED WITH A SHARP INSTRUMENT

### 21.3.0.3 Examination

Examine the bore of the master cylinder. If it is not scored, ridged or corroded and is smooth to touch, the master cylinder can be rebuilt using parts from Leyparts master cylinder repair kit. If there is the slightest doubt as to the condition of the bore, a new master cylinder assembly must be fitted.

It is recommended that a new piston is fitted at every overhaul. If you should use the same piston, ensure that the piston is free from rust, ridges and burrs and all the recuperating holes in the piston are clear. If the recuperating holes are blocked the blocks can be removed by blowing dry compressed air.

If in doubt replace the piston. Ensure that the piston return spring is in good condition. Renew if necessary.

WHEN EVER THE MASTER CYLINDER IS SERVICED, USING PARTS FROM GENUINE LEYPARTS REPAIR KIT IS STRONGLY RECOMMENDED.

**21.3.0.4 Assembling**

Once properly inspected, assemble the master cylinder as follows.

1. Dip the piston (6), back seal (7), seal shim (5), pressure seal (4), spring retainer (3) in fresh hydraulic fluid.
2. Lubricate the cylinder bore liberally with fresh hydraulic fluid.
3. Using fingers only, fit the back seal (7) on to the piston groove in such a way that the seal lip is facing towards the stem end of the piston.
4. Fit seal shim (5), pressure seal (4) the seal lip facing the spring, on the stem end of the piston.
5. Fit the spring retainer (3) in such a way that the prongs are towards the seal and ensure it is well seated on the stem.
6. Dip the spring (2) in fresh hydraulic fluid and fit one end of the spring on to the spring retainer (3).
7. Now push the piston assembly spring leading into the bore.
8. Depress the piston slightly by push rod (10) and fit circlip (8).
9. Check the piston for free movement when depressed.
10. Smear the inside of dust cover (9) with vegetable based rubber grease and fit it on to the master cylinder. Ensure its lip is well seated on the cylinder groove.
11. Smear vegetable based rubber grease on the push rod stem seating in the piston and on the eye hole.
12. Dip the rubber grommet (16) in fresh hydraulic fluid and fit it on to the master cylinder inlet port.
13. Fit the hydraulic fluid reservoir body (11) with the fluid nozzle in the rubber grommet and align the mounting holes with the mounting threaded holes on the master cylinder body.
14. Fix the screw (12) and tighten them to a torque of 5.6/6.8 Nm.
15. Place the filter on the reservoir.
16. Fit a new rubber gasket and the baffle on to the filler cap. And also assemble the small cap on to the top.
17. Screw in the filler cap assembly on to the fluid reservoir (11). Now, the master cylinder can be fitted on to the vehicle.

Fit the master cylinder on to the vehicle in the reverse order of removal.

Reconnect the outlet pipe connections.

**21.3.0.5 Clutch Pedal Free Play**

It is essential that the free play is checked regularly and corrected as necessary.

Clutch pedal free play - 4 to 7 mm. This dimension has to be maintained by adjusting pedal stopper bolt.

**21.3.0.6 Hydraulic Clutch Actuation Adjustment**

1. Clutch pedal free play - 4 to 7 mm. This dimension has to be maintained by adjusting pedal stopper bolt.
2. The initial stand out of slave cylinder push rod is  $159 \pm 7$  mm. which is achieved by slave cylinder bracket position. No specific adjustment required.
3. As the vehicle continues to run and the disc wears off, the stand out reduces.
4. When the stand out becomes 118 mm, replace the clutch disc.
5. After replacement of new disc, ensure initial setting of clutch and follow the above procedure.

**To Bleed The Hydraulic System**

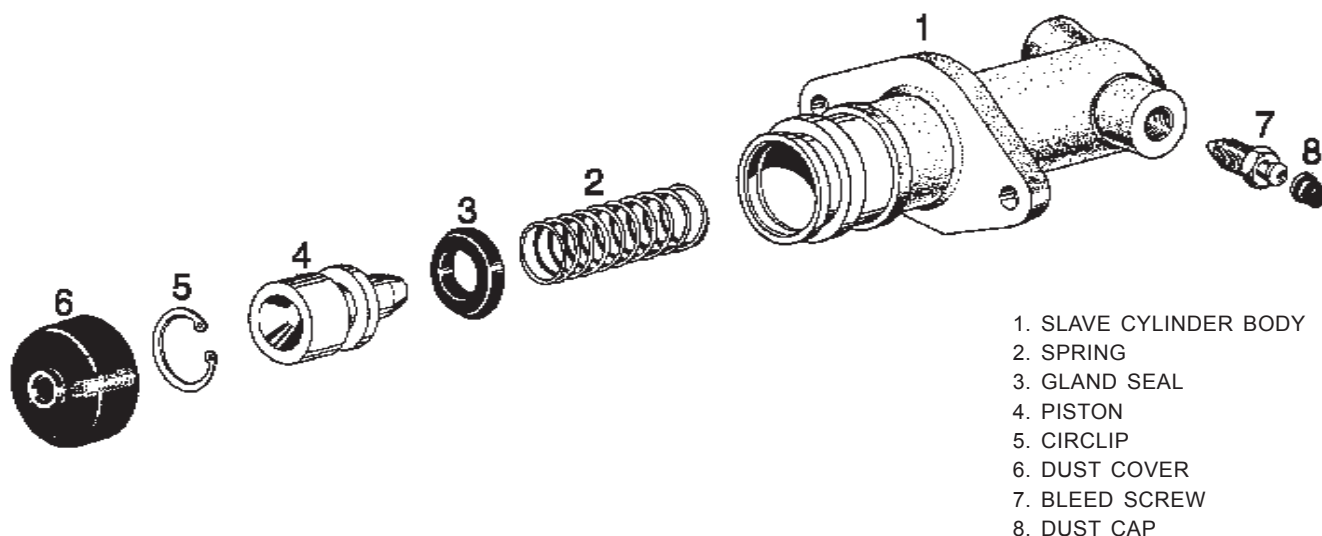
Bleeding the hydraulic system is not a routine maintenance job and should be necessary only when some portion of the equipment has been disconnected, the fluid drained off or it is suspected that air has entered in to the system.

Air will get into the hydraulic line if the level of fluid in the master cylinder reservoir is allowed to fall too low and leaks develop in the pipe unions. As a result the pedal will feel spongy or it may require a pump action, or even become completely inoperative. In such cases the bleeding should be done, as follows:

Remove the filler cap from the reservoir and arrange to keep the fluid level topped up throughout the bleeding operation. Remove the cap from the bleed screw on the slave cylinder / clutch booster and attach a transparent rubber bleeding tube.

Allow the free end of the tube to dip into a clean glass containing hydraulic fluid. Depress the clutch pedal fully and allow it to return. Continue the same for 5 times and then hold the pedal in depressed condition. Slacken the bleed screw and allow the oil in the system to escape. You can find air bubbles in the escaping oil through the transparent tube.





Exploded View of Slave Cylinder

Tighten the bleeding screw and repeat the above steps until you find pure oil escapes during slackening of bleeding screw (without any trace of air bubbles).

Finally tighten the bleed screw, remove the bleeding tube and refit the rubber cap on the bleed screw.

Fluid withdrawn during bleeding should be filtered and left to stand for at least 24 hours until it is clear of all air bubbles. The fluid can then be used for topping up the reservoir on future occasion.

### 21.3.1 Slave Cylinder

Slave cylinder is a simple construction consisting of a cast iron body incorporating a piston and seal.

The slave cylinder flange is mounted to the clutch housing bracket. When the clutch pedal is depressed, fluid in the master cylinder is forced under pressure into slave cylinder, actuating its push rod, which operates the clutch mechanism.

#### 21.3.1.0 Removal

Connect a bleed tube to the slave cylinder bleed screw after removing its dust cap. Loosen the bleed screw 1/2 to 3/4 turn and pump out the hydraulic fluid into a suitable container by operating the clutch pedal.

Disconnect the Hose Banjo/Banjo bolt connection. Loosen and remove the mounting bolts. Now, take out the slave cylinder for overhauling.

#### 21.3.1.1 Dismantling

1. Hold the slave cylinder in a vice fitted with soft jaws, taking care not to distort the barrel.
2. Unscrew and remove the bleed screw (7).
3. Remove dust cover (6).
4. Depress the piston (4) and remove the circlip (5).

5. The internal parts can be removed in this order. Piston with seal (3) and piston return spring (2).

6. Remove the gland seal (3) from the piston groove carefully with fingers or with a blunt edged brass rod or connector.

7. Discard all the rubber parts. Clean all the parts and the cylinder body thoroughly in fresh hydraulic fluid or isopropylene alcohol and place them on a clean tray or on a clean sheet of paper.

NEVER CLEAN THE SLAVE CYLINDER OR INTERNAL PARTS WITH MINERAL OIL LIKE KEROSENE, DIESEL OR PETROL.

#### 21.3.1.2 Examination

Examine the bore of the slave cylinder. If it is not scored, ridged or corroded and is smooth to touch, the slave cylinder can be rebuilt using parts from genuine Leyparts repair kit. If there is the slight doubt as to the condition of the bore, a new slave cylinder assembly must be fitted.

Examine the piston, it should be free from rust, ridges and burrs. If in doubt replace the piston.

Ensure that the piston return spring is in good condition. If necessary replace.

#### 21.3.1.3 Assembling

1. Dip piston (4) and gland seal (3) in fresh hydraulic fluid.
2. Using fingers only fit the gland seal (3) on to the piston (4) in such a way that it sits squarely in the piston groove (the flat face of the seal towards the push rod end of the piston).
3. Lubricate the bore of the slave cylinder (1) liberally with fresh hydraulic fluid.
4. Fit the spring on to the piston stem.
5. Insert the piston assembly into the bore with the other end of spring leading into the bore.



6. Depress the piston (4) and fit circlip (5).
7. Check the piston for free movement when depressed.
8. Smear inside of the dust cover lip with vegetable based rubber grease and fit it on to the cylinder.
9. Fit bleed screw (7) and dust cap (8).

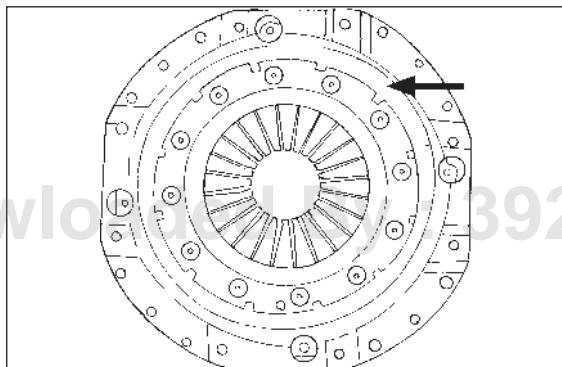
**DO NOT USE CHASSIS GREASE**

Refit the slave cylinder assembly in the reverse order of removal, and connect the hose with banjo, banjo bolt and new gaskets.

**21.3.1.4 Slave Cylinder Push Rod Stand out****DIAPHRAGM CLUTCH**

The diaphragm clutch mainly consists of the following parts.

1. Pressed steel cover
2. Diaphragm spring
3. Pressure plate
4. Driving straps
5. Connecting rivets



In diaphragm clutch, the clamping force is provided by diaphragm spring. Under the assembled condition of clutch assembly on the flywheel, the diaphragm spring gets almost flattened exerting clamping force on the clutch plate through clutch pressure plate. Thus the diaphragm trying to regain the conical shape exerts even pressure on to the pressure plate.

When clutch pedal effort is removed, the diaphragm spring returns back by its tension and makes the pressure plate to engage with clutch plate. Clutch pedal returns with the help of the return spring.

The following procedure is to be followed for hydraulic clutch actuation adjustment.

1. Clutch pedal free play - 4 to 7 mm. This dimension has to be maintained by adjusting pedal stopper bolt.
2. The initial stand out of slave cylinder push rod is  $159 \pm 7$  mm. which is achieved by slave cylinder bracket position. No specific adjustment required.
3. As the vehicle continues to run and the disc wears of, the stand out reduces.
4. When the stand out becomes 118 mm, replace the clutch disc.
5. After replacement of new disc, ensure initial setting of clutch and follow the above procedure.

**21.3.1.5 Bleeding the System**

The process of removing air from the hydraulic pipe line and cylinders is known bleeding and is necessary whenever any part of the system has been disconnected or the level of fluid in the fluid reservoir has been allowed to fall so low that air has been drawn in to the system. When seals are worn, it is possible for air to enter the cylinder with out any sign of fluid leaking, causing a spongy pedal which is the usual indication of air in the system.

It is vital that absolute cleanliness is maintained throughout the entire bleeding operation. Ensure that no dirt or grit enters the system, especially at the fluid reservoir.

All equipment to be used must be entirely free from mineral oil like diesel, kerosene etc to avoid contamination as it will deteriorate the rubber seals.

NEVER, UNDER ANY CIRCUMSTANCES, USE THE FLUID WHICH HAS BEEN BLEED FROM THE SYSTEM TO TOP UP THE FLUID RESERVOIR. AS IT MAY BE AERATED, HAVE TOO MUCH MOISTURE CONTENT AND/OR BE CONTAMINATED.

**21.3.1.6 Procedure**

Before commencing to bleed, follow the essential precautions. To bleed the clutch system, first carefully clean all dirt from around the fluid reservoir cap. Remove the filler cap, fill the reservoir with hydraulic fluid to the "MIN" marking level.

Remove the slave cylinder bleed screw dust cap and clean it. Attach the bleed tube to the bleed screw and place the other end of the tube in a glass jar containing sufficient hydraulic fluid to submerge the end of the tube.

Open the bleed screw  $\frac{1}{2}$  to  $\frac{3}{4}$  turn sufficient to allow the fluid to flow freely. Depress the clutch pedal slowly throughout the full stroke of the pedal and allow it to return slowly to its stop.

There should be an interval of three or four seconds before making the next stroke. This action should be repeated until bubbles of air cease to appear at the end of the bleed tube. Close the bleed screw immediately after the last downward stroke of the pedal. Whilst the pedal is thus held, securely tighten the bleed screw and remove the tube. Replace the dust cap on the bleed screw.

Ensure that the fluid level in the fluid reservoir does not fall low enough to cause air to be drawn into the system through the bleeding operation.

ALWAYS USE HEAVY DUTY HYDRAULIC FLUID AS RECOMMENDED TO MEET THE ABOVE REQUIREMENT



21.18

DIAPHRAGM CLUTCH

Service Manual

ASHOK LEYLAND

21.4

TIGHTENING TORQUES

	Spanner Size	Kgm	lb.ft
310 mm Cover assembly mounting bolts (M8)	13 mm	2.9	21

21.5

RECOMMENDED LUBRICANTS

Aggregate	Mini Ambient Temp. °C	Co-branded Lubricant	Approved Lubricant
		Gulf Oil India	Indian Oil Corporation
Clutch Pedal, Clutch withdrawal Bearing and Sleeve	-20	MP Grease Max NLGI 2	Servo Grease ALT
Hydraulic Clutch	-40	Gul Clutch Fluid Max	Servo Power Brake ALT

21.6

FILLING CAPACITY

Aggregates	Filling Capacity (ℓ)	Change Period (km)
<div>Hydraulic Clutch</div> <div>Clutch Hydraulic System</div>	1	40000

Specification and change period applicable for special, arduous duty & army applications refer service manual.

Note : Do not mix lubricants of different brands/grades

21.7

MAINTENANCE PROGRAMME

MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks	
A	Lubrication						
1	Lubricate clutch operating pedal shaft	✓				Weekly for tippers and monthly for all other applications.	
2	Lubricate clutch withdrawal lever	✓					
3	Lubricate clutch withdrawal bearing sleeve	✓					
4	Lubricate clutch linkages	✓					
5	Repack grease in clutch withdrawal bearing	At the time of clutch disc replacement.					
B.	Maintenance						
1	Check and adjust clutch pedal freeplay	✓				As required	
2	Check clutch fluid level, top up if necessary				8		
3	Overhaul clutch master cylinder				72		
4	Check stand out & replace clutch disc if necessary					As required.	
5	Change clutch fluid - for all other applications other than Tippers				40		
6	Change clutch fluid - For Tippers				1000 hrs		

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# **ZF GEAR BOX**

**S5-36 / S6-36 / OD Gear box**



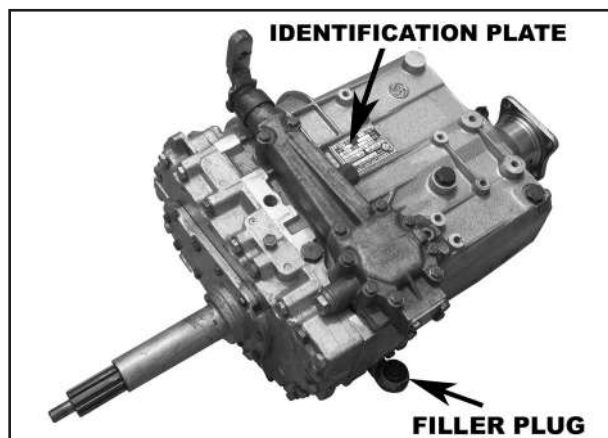
**ASHOK LEYLAND**

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**26.0 GENERAL****26.0.0 Gear Box Type and Serial Number**

The gear box serial number and type are punched on the name plate provided on the top side of the housing.

**26.0.1 Design and Operation**

All forward speeds are fully synchronized. The gearbox is coupled to the engine through a clutch and the gear selection is done by remote gear shift lever.

While the counter shaft gears are press fitted, the mainshaft gears are mounted on needle roller bearings.

During shifting operation, the speeds of the members to be coupled are synchronised by synchro packs. After synchronization, the sliding sleeve engages the main shaft gear and the synchro hub, which is fixed on the mainshaft, thus transmitting power through the output flange.

In 1:1 ratio speed gear, the counter shaft is not included in drive train, i.e., the input shaft and main shaft are coupled directly to each other.

Top speed gear is called overdrive in ZF S6-36 OD GB which is included in the drive train i.e. through input shaft, counter gear and main shaft gear.

For reverse operation, an idler gear is introduced in the power flow, to change the direction of rotation of mainshaft.

The sliding sleeves are operated by shift forks, which are actuated by shift rods. The shift forks are pivoted on Gearbox housing. The detent locks on change speed housing prevents the gear slippage. The interlock arrangement guarantees that only one speed can be engaged at a time.

**26.0.2 Description of Leading Components**

**Gear Box Casing** - of aluminium alloy casting with ribs all around to improve the structural strength.

**Connection Housing** - of aluminium alloy casting serves as end cover, dowel located on gear box casing.

**Gear Box Bearings** - the counter shaft is mounted on opposed taper roller bearings. The main shaft is mounted on cylindrical Roller Bearing at rear end and supported by a spigot bearing of front end, the input shaft supported by cylindrical roller bearing.

**Selector Housing** - comprises of change speed operating mechanism, primary detents and interlock arrangement.

**Main Shaft** - of forged steel machined with stress free sections. Accommodates all fixed elements (synchro packs) on intermittent splined lengths with circlip locks. The gears are mounted on needle roller bearings.

**Counter Shaft** - of forged steel with press fitted gears, supported by two opposed taper roller bearings.

**26.0.3 Features of MK II Gear box**

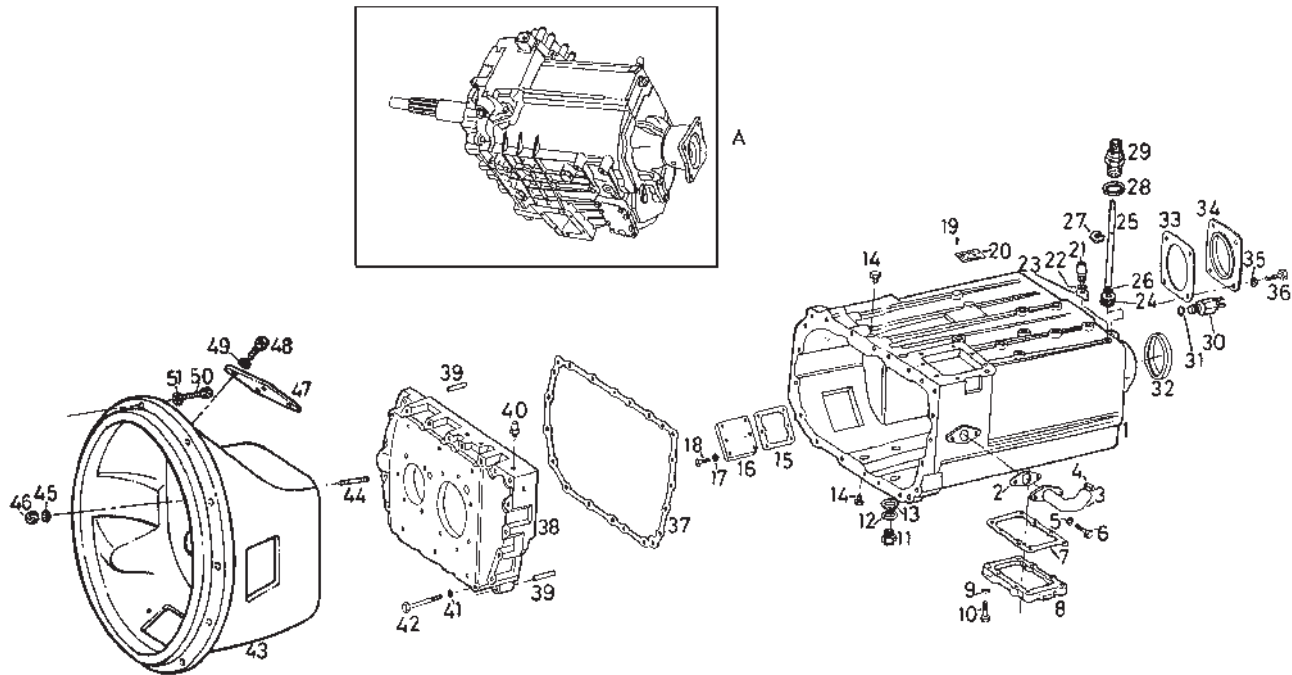
ZF synchromesh MK I gearbox has been uprated for improved life, increased input torque and to prevent gear slipping and called as MK II gear box.

The modification carried out are as follows:

- Ground Gears - Input shaft gear, Constant mesh and 1st gear (Integral) on Layshaft and Reverse idler gear - for ZF S636/1.5.

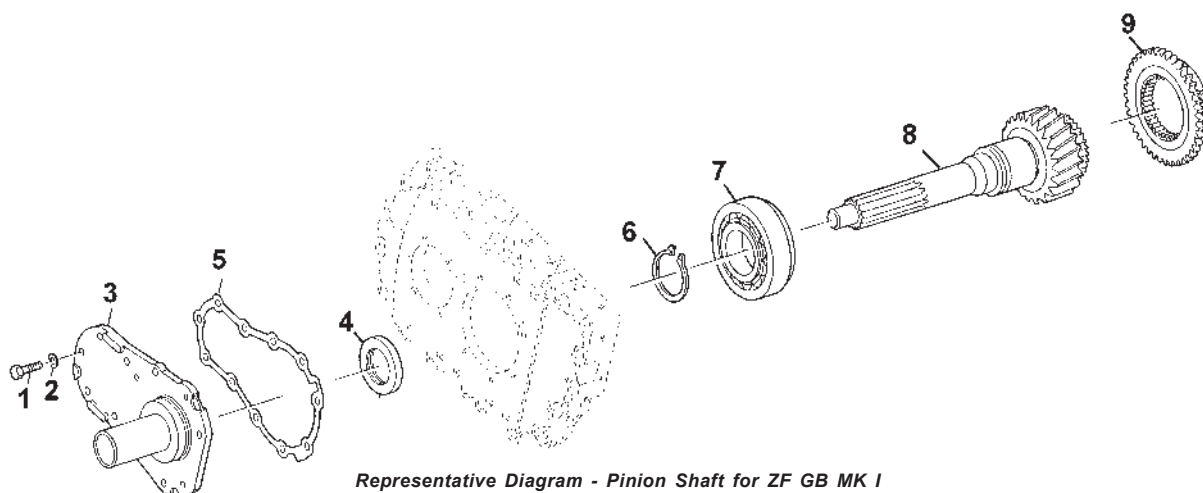
Additional 4 gears are ground for ZF S636/1.5A which are 2nd gear (Integral) on Layshaft, 1st / 2nd / Reverse gear on Main shaft for improved performance under severe duty cycles.

- Geometrical tolerances of gears are modified.
- All bearings are imported. Input shaft and layshaft bearings are higher rated. Input shaft bearing width increased by 2 mm consequently Input shaft cover, Split ring, Gasket are Modified.
- In selector housing - gear change finger modified, bush introduced in place of Needle roller bearing, twin spring arrangement instead of single spring and selective assembly of detend plunger.
- Casing modified by providing additional ribs and improved casting process. Currently this is imported and applicable only for ZF S636/2.



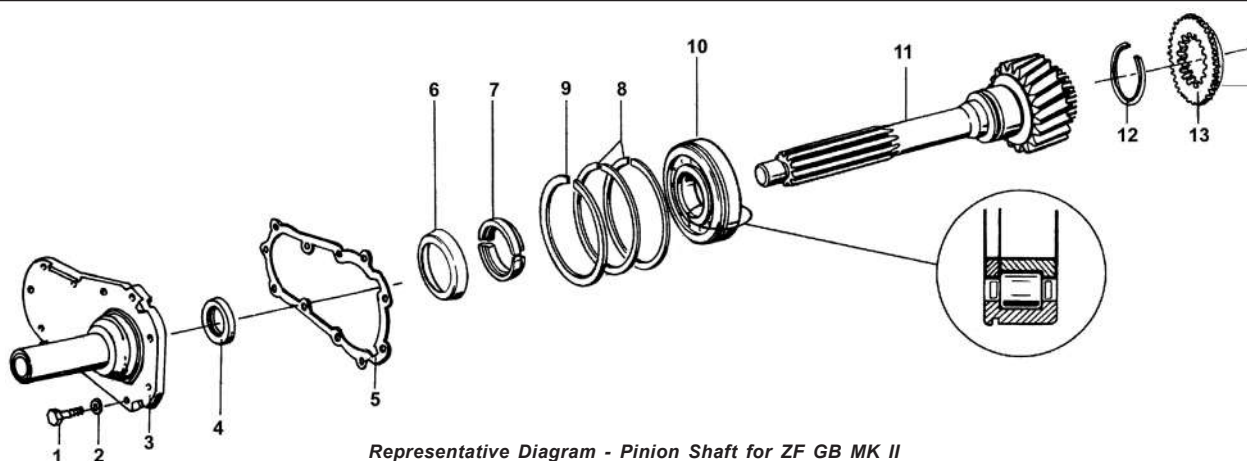
Representative Diagram - ZF Gear Box Casing (S5-36 &amp; S6-36)

ILL. No.	DESCRIPTION	QTY	ILL. No.	DESCRIPTION	QTY
A	Assy of Gear box With Integral Housing	1	27	Washer	1
1	Main Gear Case	1	28	Oil Seal	1
2	Joint For Filler Elbow	1	29	Screw Bush	1
3	Filler Elbow	1	30	Reverse Light Switch	1
4	Filler Plug	1	31	Washer	1
5	Wavy Washer	2	32	Oil Seal	1
6	Screw M8 For Fixing Filler Elbow	2	33	Gasket	1
7	Gasket	1	34	Endcover	1
8	Cover-reverse Idler	1	35	Wavy Washer	4
9	Wavy Washer	8	36	Screw M12 X 25	4
10	Screw M8x30	8	37	Gasket	1
11	Drain Plug-magnetic	1	38	Gearcase Front	1
12	Washer	1	39	Dowel	2
13	Helicoil Insert M18x1.5	1	40	Breather	1
14	Plug M18x1.5	2	41	Wavy Washer 10 Dia	20
15	Joint	1	42	Bolt M10x1.5x70	20
16	PTO Cover	1	43	Clutch Housing	1
17	Wavy Washer	6	44	Special Stud For Fixing Cl Hsg To Gear Case	10
18	Screw M10x22 8.8	6	45	Spring Washer 12mm Dia For Above	10
19	Hammer Driven Screw	4	46	Nut M12x1.5	10
20	Identification Plate	1	47	Cover Plate on Clutch Housing (Top & Bottom)	2
21	S/A of Detent Plunger	1	48	Set Screw M8x1.25 -10mm Long	4
22	Joint For Detent Plunger	1	49	Washer Plain	4
23	Tab Washer 17 ST	1	50	Set Screw 3/8" Bsf 11/8" Long For Cl Hsg To F/W Hsg	12
24	Gear	1	51	Washer	12
25	Shaft	1			
26	Sealing Ring	1			



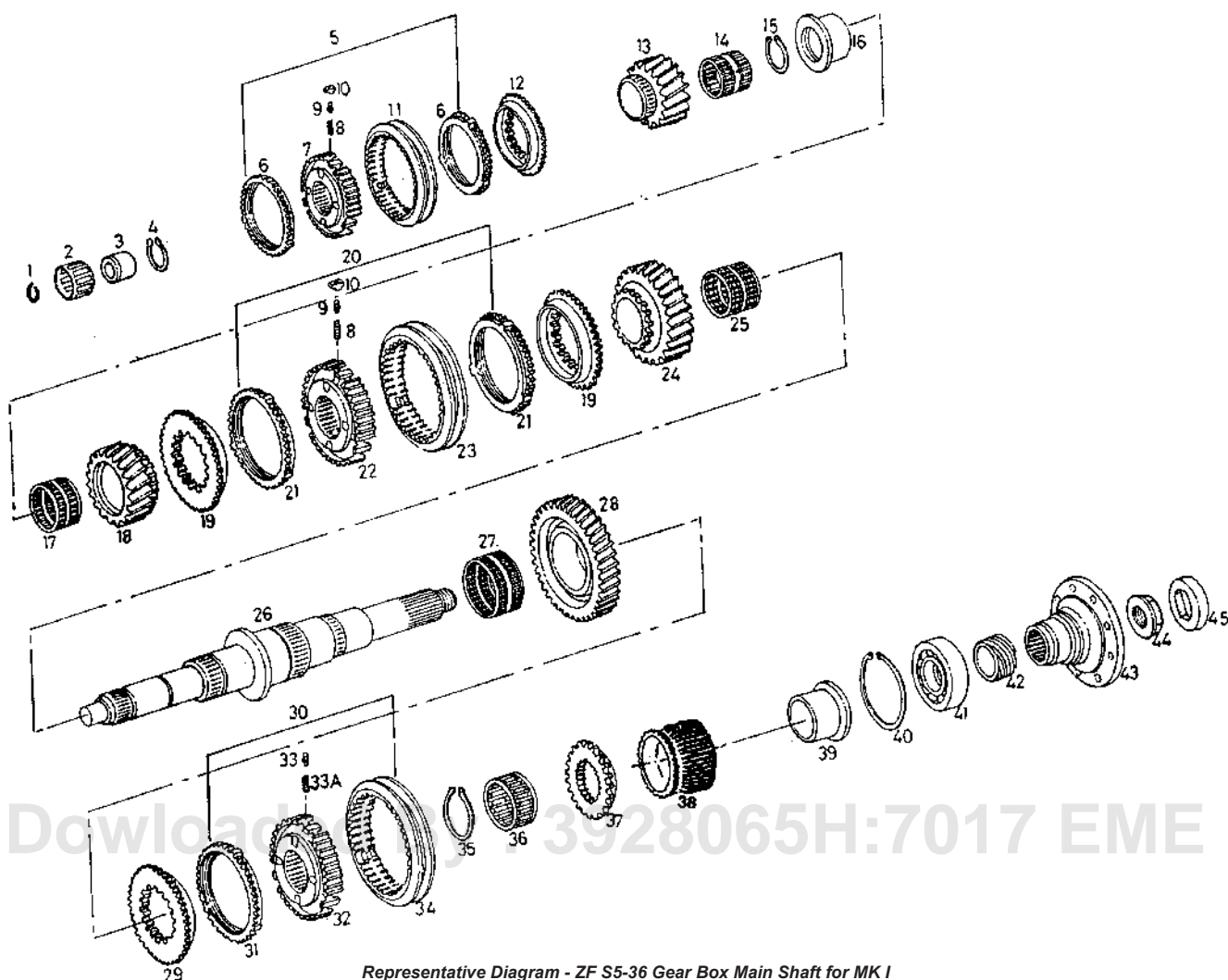
*Representative Diagram - Pinion Shaft for ZF GB MK I*

ILL. No.	Description	Qty
1	Screw M8x28	11
2	Wavy Washer B Din 137	11
3	Input Shaft Cover	1
4	Oil Seal	1
5	Joint	1
6	Locking Ring	1
7	Split Ring	2
8	Washer	1
9	Snap Ring	1
10	Roller Bearing	1
11	Input Shaft	1
12	Spacer	1
13	Synchro Cone	1



*Representative Diagram - Pinion Shaft for ZF GB MK II*

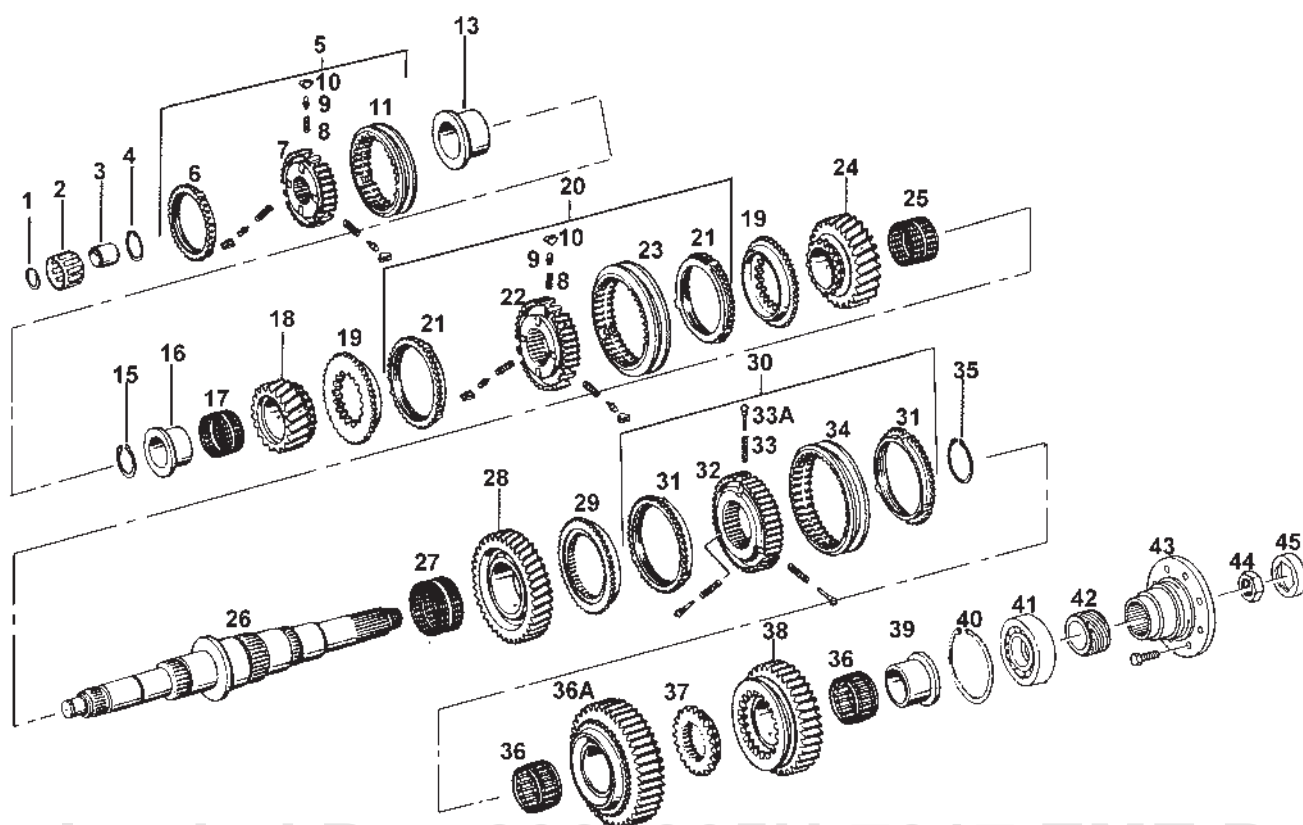
ILL. No.	Description	Qty
1	Screw M8x28	11
2	Wavy Washer B Din 137	11
3	Input Shaft Cover	1
4	Oil Seal	1
5	Joint	1
6	Locking Ring	1
7	Split Ring	2
8	Washer	2
9	Snap Ring	1
10	Roller Bearing	1
11	Input Shaft	1
12	Spacer	1
13	Synchro Cone	1



Representative Diagram - ZF S5-36 Gear Box Main Shaft for MK I

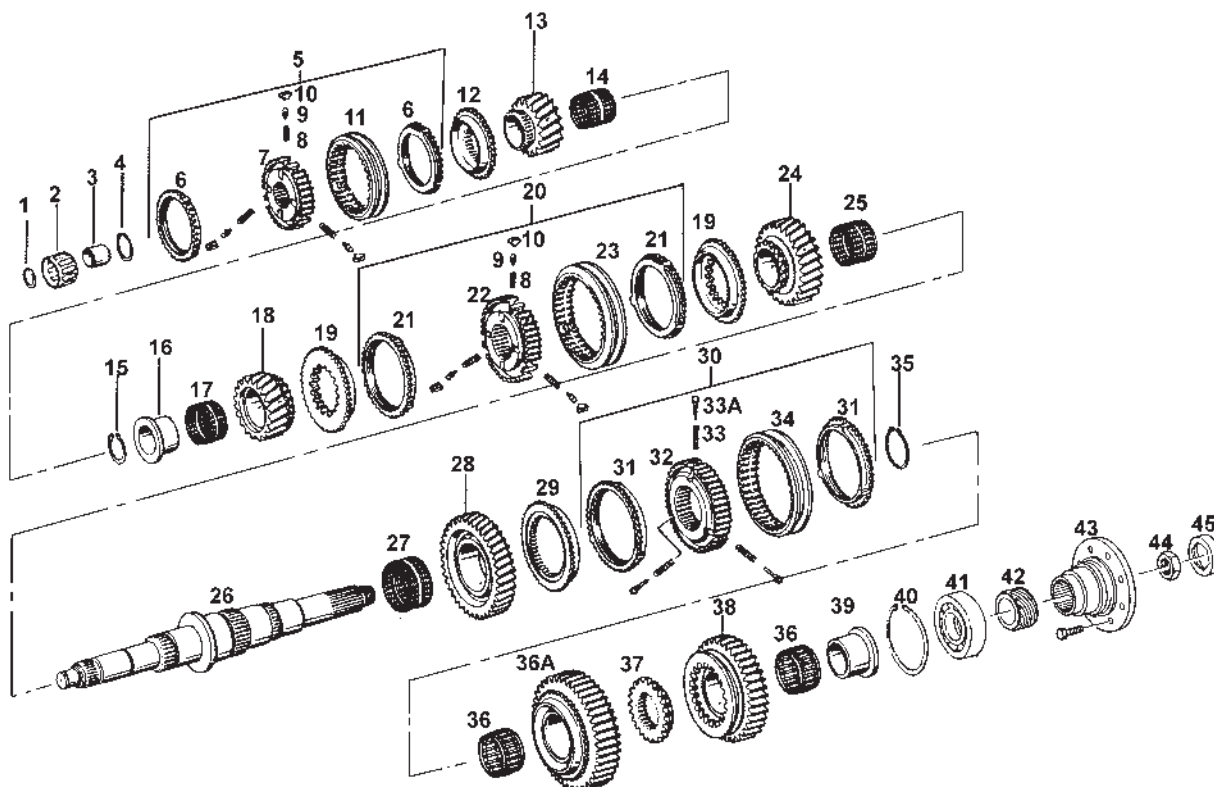
ILL. No.	DESCRIPTION	QTY	ILL. No.	DESCRIPTION	QTY
1	Circlip SW 25	1	24	2nd Gear on Main Shaft	1
2	Spigot Bearing	1	25	Needle Roller Bearing for 2nd Gear	1
3	Sleeve for Spigot Bearing	1	26	Main Shaft	1
4	Circlip	1	27	Needle Roller Bearing for 1st Gear	1
5	S/A of Synchro Pack 4th & 5th	1	28	1st Gear on Mainshaft	1
6	Synchroniser Ring	2	29	Synchro Cone	1
7	Synchroniser Hub	1	30	S/A of Synchro Pack 1st & Rev	1
8	Spring	6	31	Synchro Ring	2
9	Ballpin	6	32	Synchroniser Hub	1
10	Plunger	6	33	Ball Pin	3
11	Sliding Dog Clutch	1	33a	Spring	3
12	Synchro Cone	1	34	Sliding Dog Clutch	1
13	4th Gear on Mainshaft	1	35	Circlip	1
14	Needle Roller Bearing 4th Gear	1	36	Needle Roller Bearing for First Gear & Rev. Gear	2
15	Circlip	1	37	Fixed Dog Clutch Reverse	1
16	Sleeve	1	38	Reverse Gear	1
17	Needle Roller Bearing for 3rd Gear	1	39	Sleeve For N B R	1
18	3rd Gear on Main Shaft	1	40	Circlip	1
19	Synchro Cone	2	41	Roller Bearing Rear	1
20	S/A of Synchro Pack 2nd & 3rd	1	42	Speedometer Worm	1
21	Synchro Ring	2	43	Output Flange	1
22	Synchroniser Hub	1	44	Nut For OP Flange	1
23	Sliding Dog Clutch	1	45	Locking Ring	1





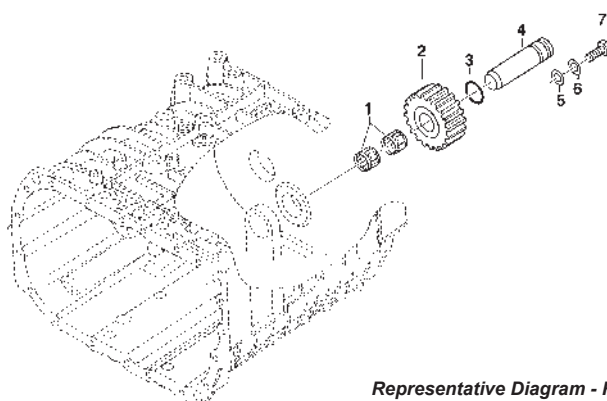
*Representative Diagram - ZF S5-36 Gear Box Main Shaft for MK II*

ILL. No.	DESCRIPTION	QTY	ILL. No.	DESCRIPTION	QTY
1	Circlip SW 25	1	26	Main Shaft	1
2	Spigot Bearing	1	27	Needle Roller Bearing for 2nd Gear	1
3	Sleeve for Spigot Bearing	1	28	2nd Gear on Mainshaft	1
4	Circlip	1	29	Synchro Cone	1
5	S/A of Synchro Pack	1	30	S/A of Synchro Pack 1st & 2nd	1
6	Synchro ring	1	31	Synchro Ring	2
7	Synchroniser Hub	1	32	Synchroniser Hub	1
8	Spring	6	33	Ball Pin	3
9	Ballpin	6	33a	Spring	3
10	Plunger	6	34	Sliding Dog Clutch	1
11	Sliding Dog Clutch	1	35	Circlip 68x2.5	1
13	Bush on Main Shaft	1	36	Needle Roller Brg. for First Gear & Rev. Gear	2
15	Circlip	1	36a	1st Gear	1
16	Sleeve	1	37	Fixed Dog Clutch Reverse	1
17	Needle Roller Bearing for 4th Gear	1	38	Reverse Gear	1
18	4th Gear On Main Shaft	1	39	Sleeve for N B R	1
19	Synchro Cone	2	40	Circlip	1
20	S/A of Synchro Pack 3rd & 4th	1	41	Roller Bearing Rear	1
21	Synchro Ring	2	42	Speedometer Worm	1
22	Synchroniser Hub	1	43	Output Flange 1500 Series	1
23	Sliding Dog Clutch	1	44	Nut For Op Flange	1
24	3rd Gear On Main Shaft	1	45	Locking Ring	1
25	Needle Roller Bearing For 3rd Gear	1			



Representative Diagram - ZF S6-36 and Overdrive Gear Box Main Shaft (MK I &amp; MK II)

ILL. No.	DESCRIPTION	QTY	ILL. No.	DESCRIPTION	QTY
1	Circlip SW 25	1	25	Needle Roller Bearing For 3rd Gear	1
2	Spigot Bearing	1	26	Main Shaft	1
3	Sleeve for Spigot Bearing	1	27	Needle Roller Bearing for 2nd Gear	1
4	Circlip	1	28	2nd Gear on Mainshaft	1
5	S/A of Synchro Pack	1	29	Synchro Cone	1
6	Synchroniser Ring	2	30	S/A of Synchro Pack 1st & 2nd	1
7	Synchroniser Hub	1	31	Synchro Ring	2
8	Spring	6	32	Synchroniser Hub	1
9	Ballpin	6	33	Ball Pin	3
10	Plunger	6	33a	Spring	3
11	Sliding Dog Clutch	1	34	Sliding Dog Clutch	1
12	Synchro Cone	1	35	Circlip 68x2.5	1
13	5th (Over Drive) Gear On Mainshaft	1	36	Needle Roller Brg. for First Gear & Rev. Gear	2
14	Needle Roller Bearing 5th Gear	1	36a	1st Gear	1
15	Circlip	1	37	Fixed Dog Clutch Reverse	1
16	Sleeve	1	38	Reverse Gear	1
17	Needle Roller Bearing for 4th Gear	1	39	Sleeve for N B R	1
18	4th Gear On Main Shaft	1	40	Circlip	1
19	Synchro Cone	2	41	Roller Bearing Rear	1
20	S/A of Synchro Pack 3rd & 4th	1	42	Speedometer Worm	1
21	Synchro Ring	2	43	Output Flange 1500 Series	1
22	Synchroniser Hub	1	44	Nut For Op Flange	1
23	Sliding Dog Clutch	1	45	Locking Ring	1
24	3rd Gear On Main Shaft	1			



Representative Diagram - Reverse Idler Gear

ILL. No.	Description	Qty
1	Needle Roller Bearing for Rev Idler	2
2	Reverse Idler Gear	1
3	'O' Ring	1
4	Reverse Idler Pin	1
5	Washer	1
6	Wavy Washer 8 mm for Rev Idler	1
7	Screw 8 mm for Rev Idler Pin	1

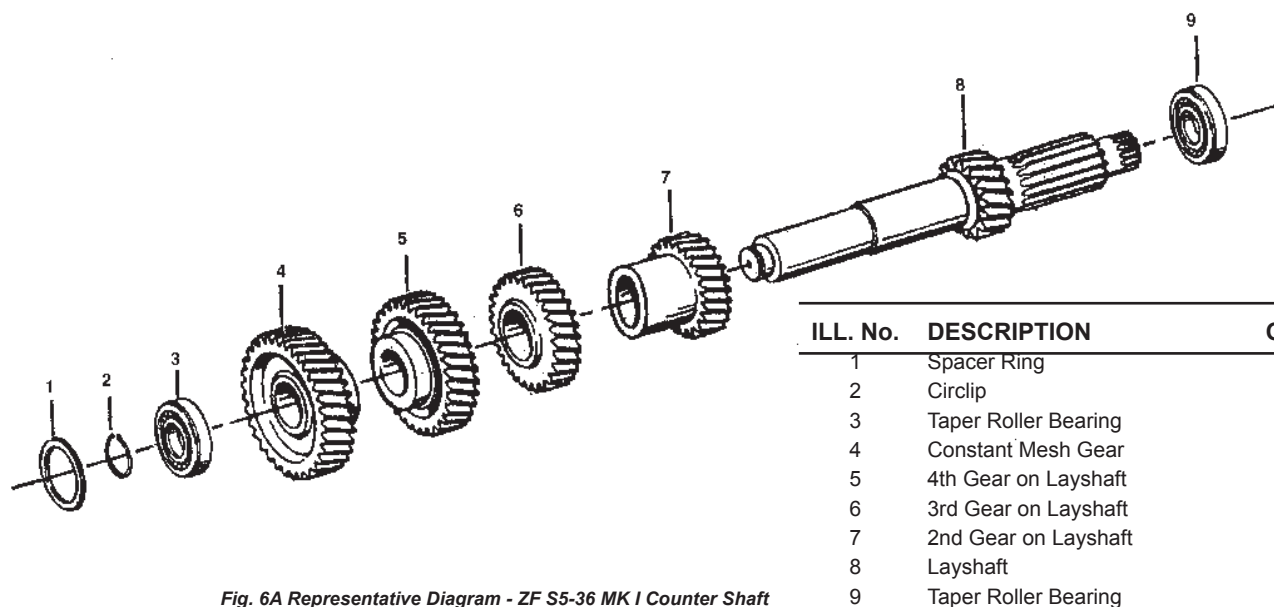
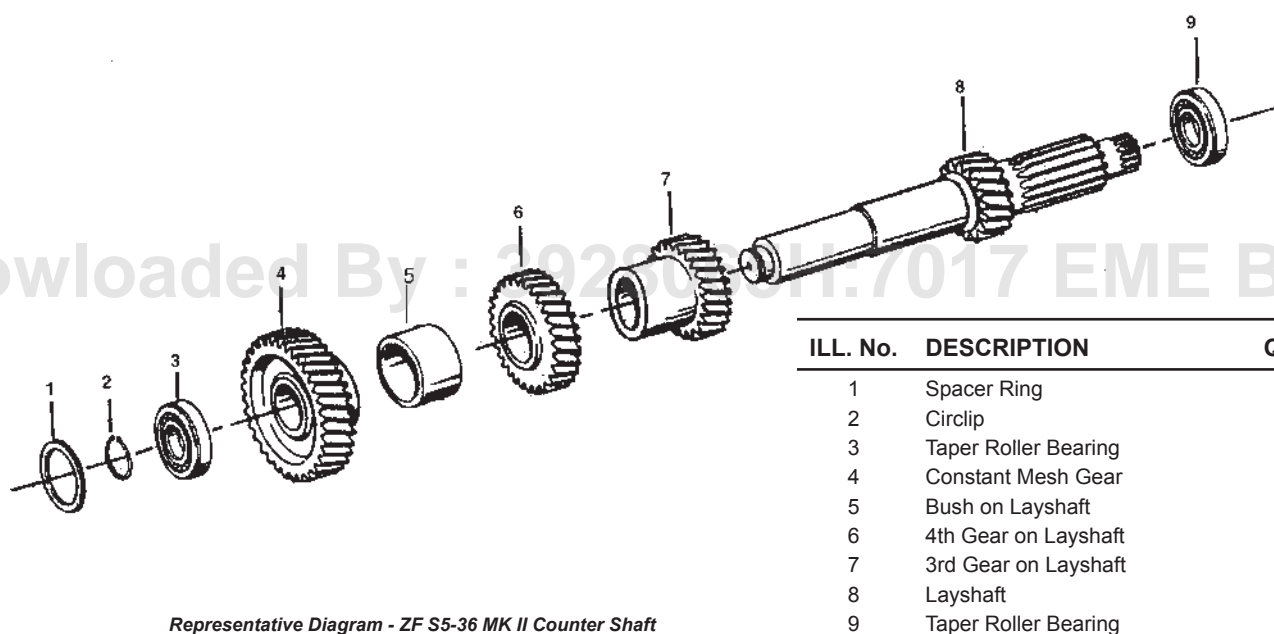
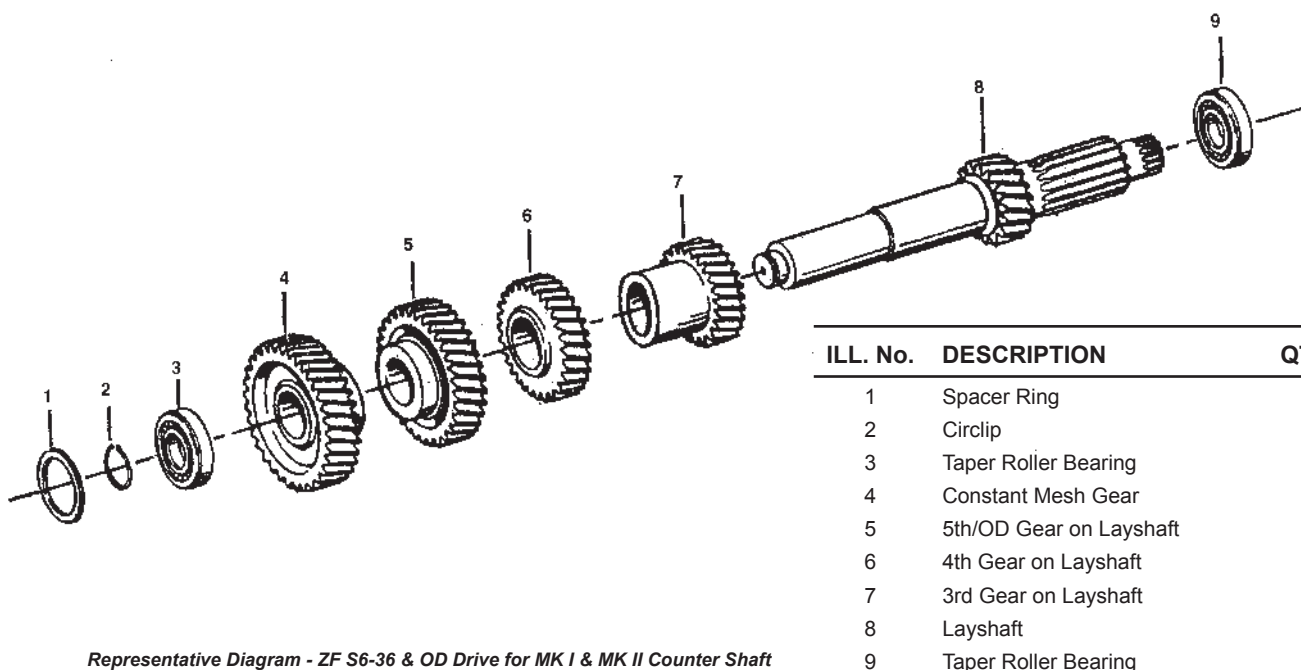


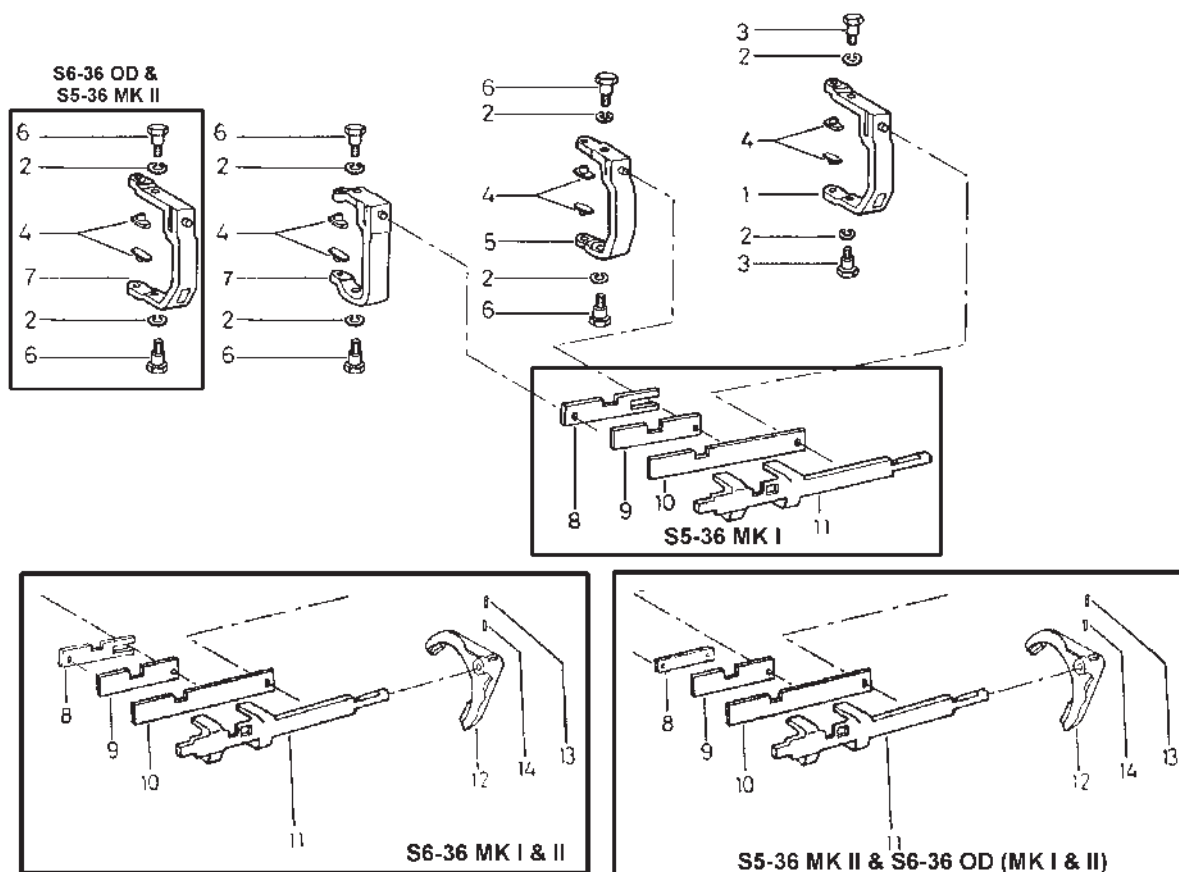
Fig. 6A Representative Diagram - ZF S5-36 MK I Counter Shaft



Representative Diagram - ZF S5-36 MK II Counter Shaft



Representative Diagram - ZF S6-36 & OD Drive for MK I & MK II Counter Shaft

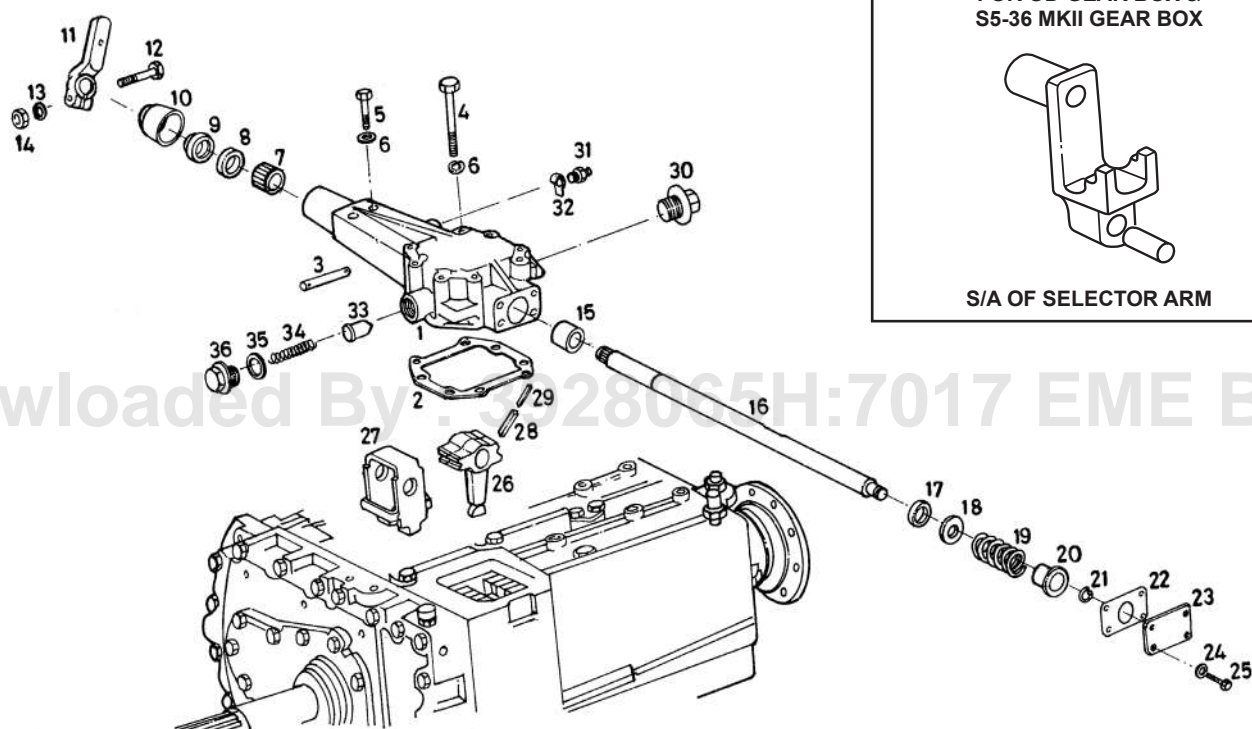


Representative Diagram - Gear Selector

ILL. No.	DESCRIPTION		QTY
	S5-36 MK I	S5-36 MK II	
1	S/A of Selector Fork 1st & Rev.	S/A of Selector Fork 1st & 2nd	1
2	Wavy Washer	Wavy Washer	6
3	Pivot Screw 1st & Rev.	Pivot Screw 1st & 2nd	2
4	Selector Pad	Selector Pad	6
5	S/A of Selector Fork 2nd & 3rd	S/A of Selector Fork 3rd & 4th	1
6	Pivot Screw 2nd & 3rd, 4th & 5th	Pivot Screw 3rd, 4th, 5th & 6th	4
7	S/A of Selector Fork 4th & 5th	S/A of Selector Fork 5th	1
8	Selector Plate 4th & 5th	Selector Plate 5th	1
9	Selector Plate 2nd & 3rd	Selector Plate 3rd & 4th	1
10	Selector Plate 1st & Rev.	Selector Plate 1st & 2nd	1
11	Reverse Selector Shaft	Reverse Selector Shaft	1
12	-	Reverse Selector Fork	1
13	-	Roll pin 6 x 28	1
14	-	Roll pin 3.5 x 28	1

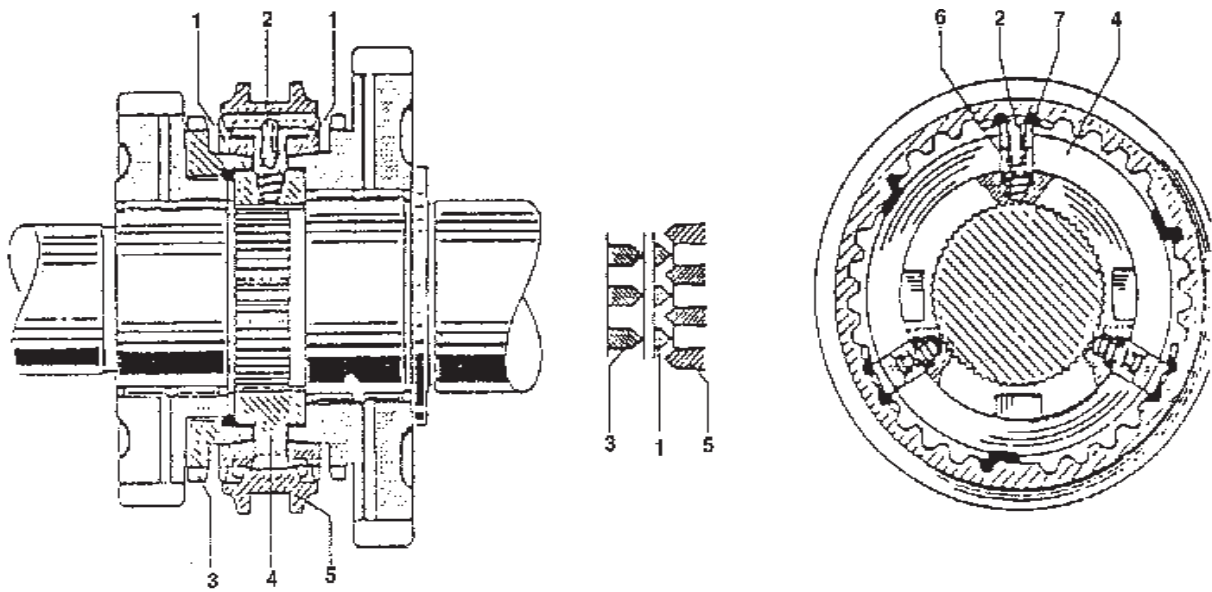
  

ILL. No.	DESCRIPTION		QTY
	S6-36 MK I & II	S6-36 OD (MK I & II)	
1	S/A of Selector Fork 1st & 2nd	S/A of Selector Fork 1st & 2nd	1
2	Wavy Washer	Wavy Washer	6
3	Pivot Screw 1st & 2nd	Pivot Screw 1st & 2nd	2
4	Selector Pad	Selector Pad	6
5	S/A of Selector Fork 3rd & 4th	S/A of Selector Fork 3rd & 4th	1
6	Pivot Screw 3rd, 4th, 5th & 6th	Pivot Screw 3rd, 4th, 5th & OD	4
7	S/A of Selector Fork 5th & 6th	S/A of Selector Fork 5th & OD	1
8	Selector Plate 5th & 6th	Selector Plate 5th & OD	1
9	Selector Plate 3rd & 4th	Selector Plate 3rd & 4th	1
10	Selector Plate 1st & 2nd	Selector Plate 1st & 2nd	1
11	Reverse Selector Shaft	Reverse Selector Shaft	1
12	Reverse Selector Fork	Reverse Selector Fork	1
13	Roll pin 6 x 28	Roll pin 6 x 28	1
14	Roll pin 3.5 x 28	Roll pin 3.5 x 28	1

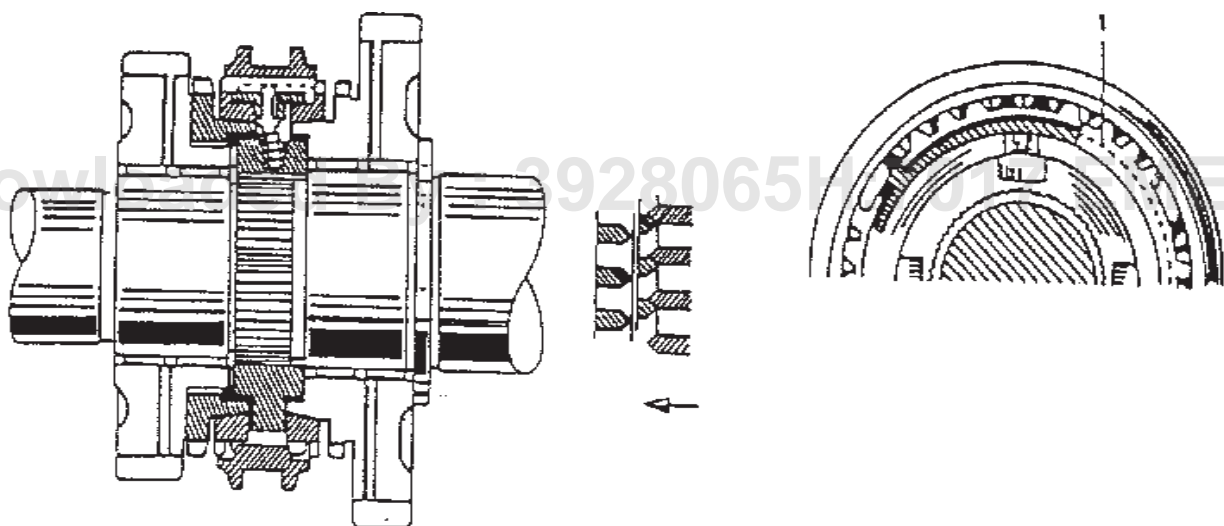


Representative Diagram - Selector Housing

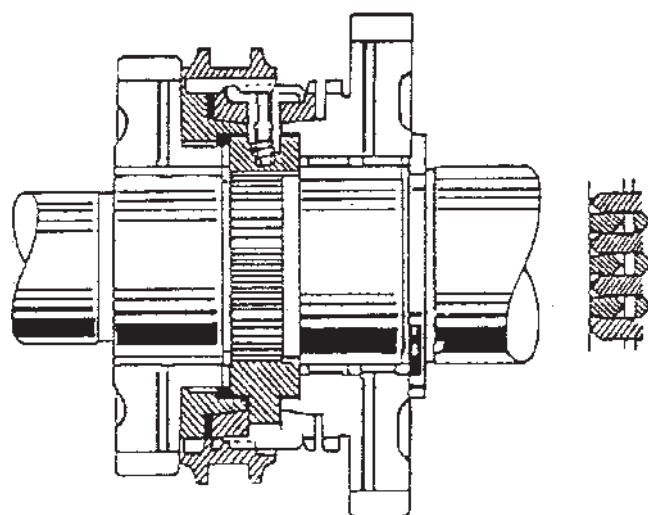
ILL. No.	DESCRIPTION	QTY	ILL. No.	DESCRIPTION	QTY
1	Selector Housing	1	18	Washer	1
2	Gasket Selector Housing to Gear Case	1	19	Spring	1
3	Gasket Selector Housing to Gear Case	1	20	Bush	1
4	Bolt M8 x 70	8	22	Gasket	1
5	Bolt M8 x 50	2	23	End Cover	1
6	Wavy Washer	10	24	Wavy Washer 8mm	4
7	Needle Roller Brg. HK2520 Selector Hsg. 25 x 32 x 20		25	Screw M8 x 20	4
8	Oil Seal 25x35x7 B ZFN 132 NB	1	26	Selector Lever	1
9	Scraper as 25 x 35 x 7	1	27	Locking Piece	1
10	Dust Cap	1	28	Roll Pin	2
11	Gear Shift Lever	1	29	Roll Pin	2
12	Bolt M10x40	1	30	Screw Plug M18x1.5	1
13	Wavy washer M10	1	31	Reverse Light Switch	1
14	Nut M10	1	32	Washer	1
15	Bush	1	33	Detent Plunger	1
16	Selector Shaft	1	34	Spring	1
17	Stop Tube	1	35	Washer A24 x 29	1
			36	Plug M24 x 1.5	1



ZF Synchroniser



Locked Position



Engaged Position



#### 26.0.4 Synchronising Mechanism

##### ZF-B-Lock Synchroniser

The use of a lock synchronising device as a speed equaliser will enable the driver to carry out quick, safe and noiseless gear changes without double declutching during up changes and also without actuating the accelerator pedal during down changes, even on downhill gradients and in difficult situations.

The function of the ZF-B Synchroniser is based on the principle that a satisfactory gear change can only be achieved after the parts to be coupled attain equal rotational speed. During each gear change procedure the engagement of the sliding sleeve with the teeth of the counter part (clutch body) must therefore be delayed until the existing difference in speeds has been eliminated. The ZF-B-Synchroniser is designed so that the externally toothed synchroniser ring, when pressed against the friction cone of the clutch body, executes a rotary motion, which is limited by stops on the synchroniser body. Due to this rotary synchroniser ring will be pressed against the chamfered teeth of the sliding sleeve only after the conical friction surfaces have caused the parts to be coupled to run at equal speeds. The persistent pressure on the sliding sleeve affect the return of the synchroniser ring to its original position. The bulking effect is released and the sliding sleeve can be pushed into the teeth of the clutch body.

##### Locked position

Due to the axial movement to the sliding sleeve the synchroniser ring (1) is pressed over the ball plungers (2) and the pressure pieces (7) against the friction cone of the clutch body (3) the existing difference in speeds of

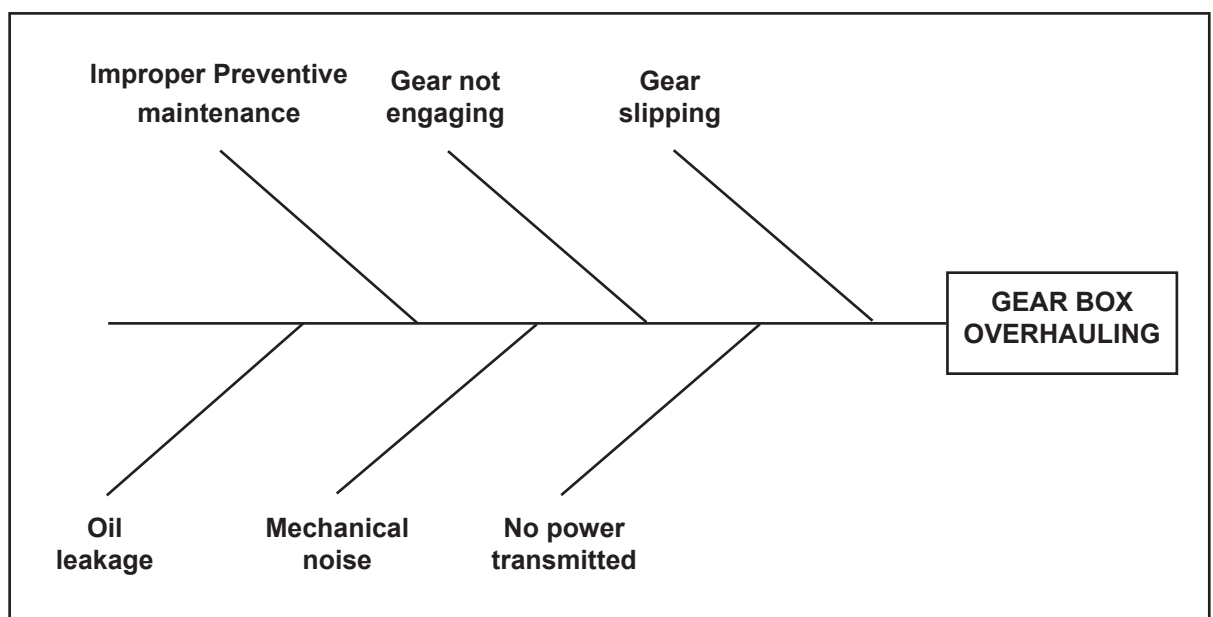
the parts to be engaged causes the synchroniser ring to move in radial direction. Due to this movement, which is limited by stops, the chamfered teeth of the synchronizer ring are pressed against those of the sliding sleeve and thereby prevent any further movement of the sliding sleeve. Due to the persistent pressure on sliding sleeve, radial movement of synchronizer ring and to the chamfered teeth of both, an axial contact pressure is produced between the friction cones of synchroniser ring and clutch body, which reduces difference in speeds of the parts to be engaged and effect synchronisation.

##### Engaged position

The parts to be engaged have obtained equal rotational speeds. Due to the persistent pressure of the sliding sleeve against the synchroniser ring, the synchroniser ring has been turned back sufficient until the teeth of the sliding sleeve are in front of the tooth gaps of the synchroniser ring. At this instant the resistance, which prevented any further movement of the sliding sleeve during the gear change procedure has been overcome and the sliding sleeve can be pushed noiselessly into the teeth of the clutch body of the gear to be engaged. Should by any chance tooth encounter tooth during the engagement the chamfering will help to turn the gears sufficiently until tooth encounters gap.

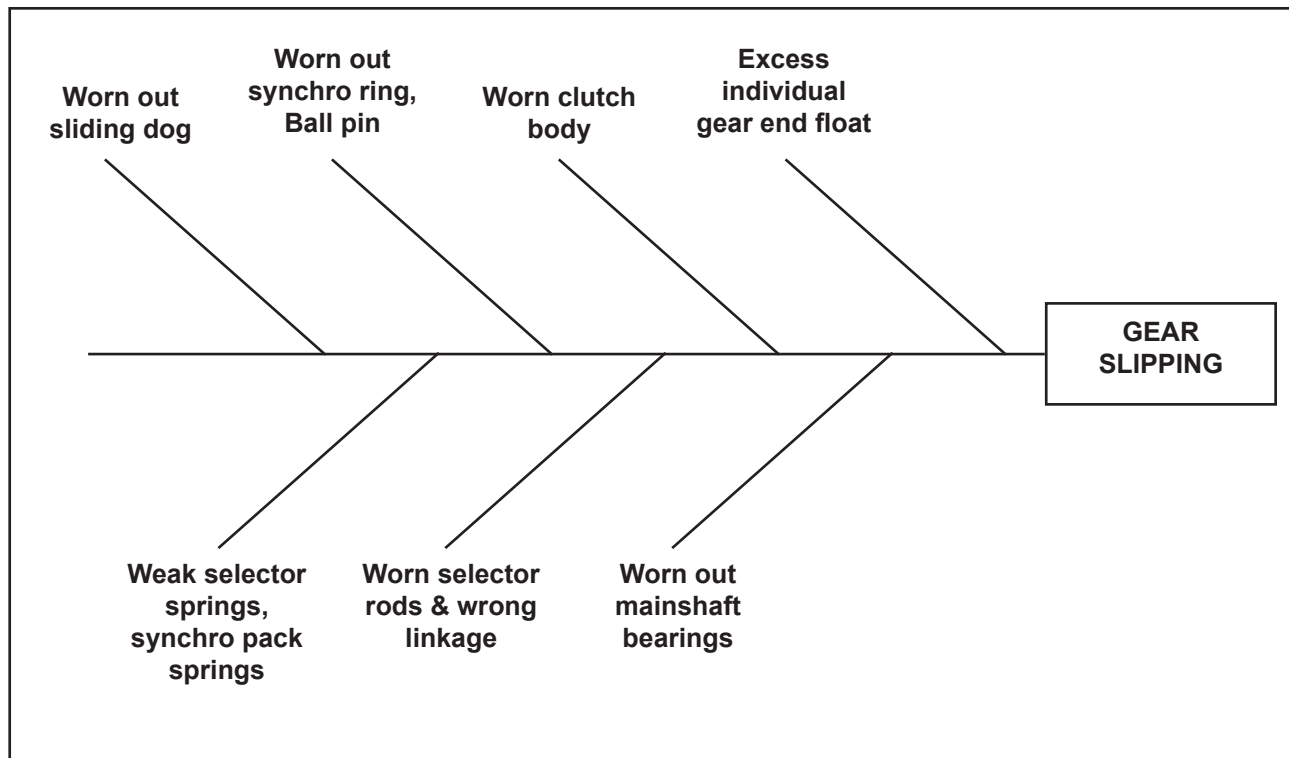
#### 26.0.5 Gear Box Preliminary Checks

It is mandatory to carry out few preliminary check on gearbox before dismounting from the vehicle. The following cause and effects can lead to overhauling decision

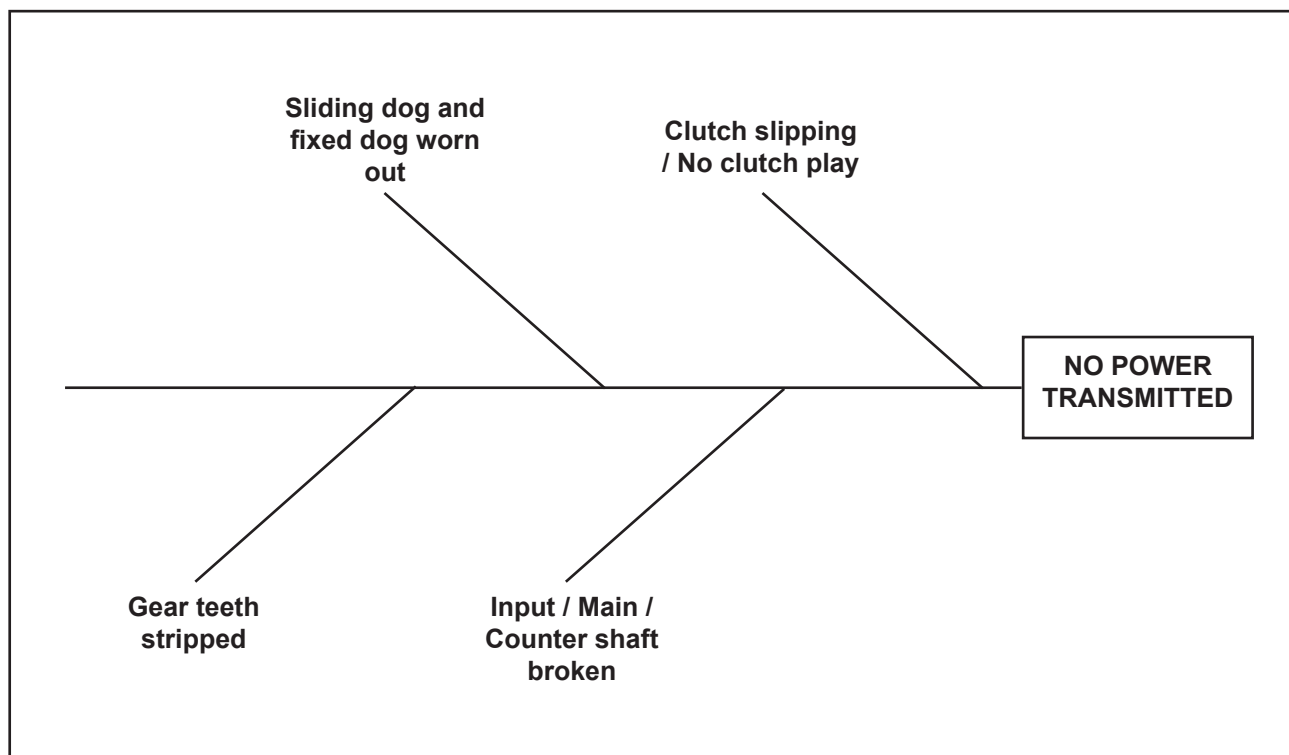


Cause and Effect Diagram - Gear box overhauling

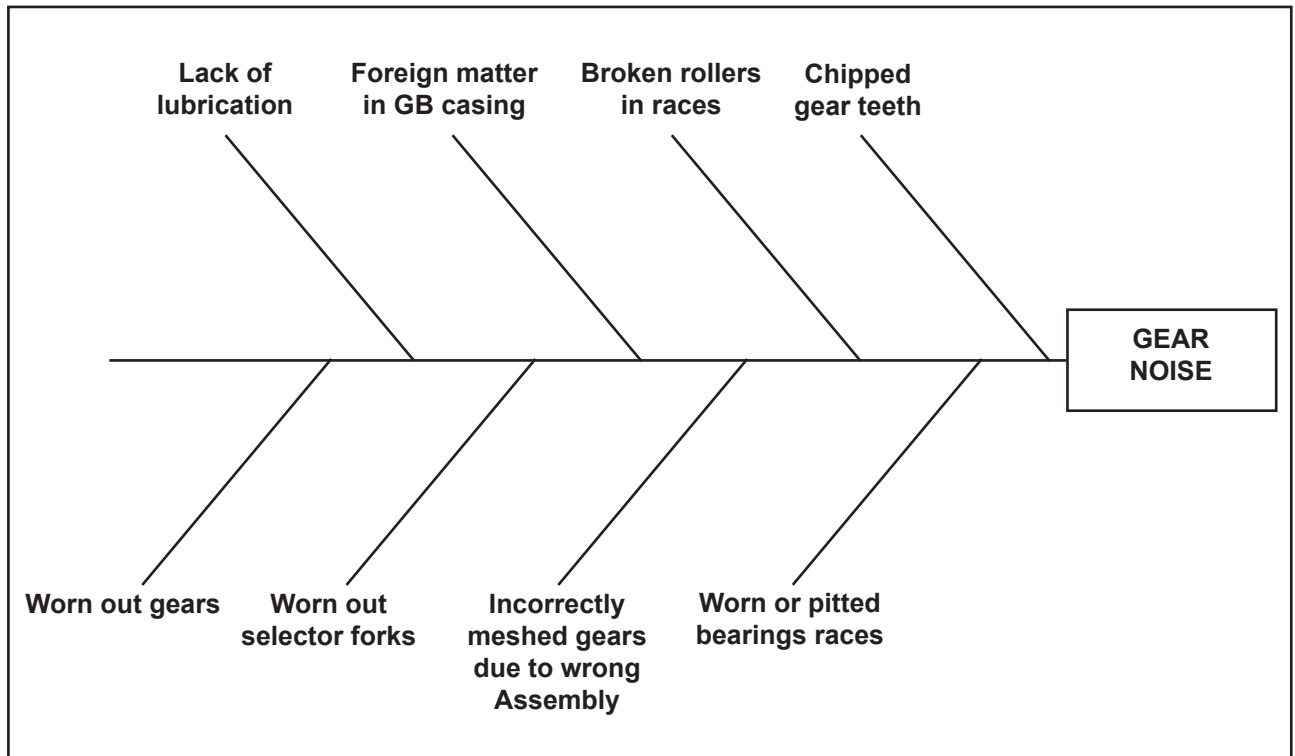




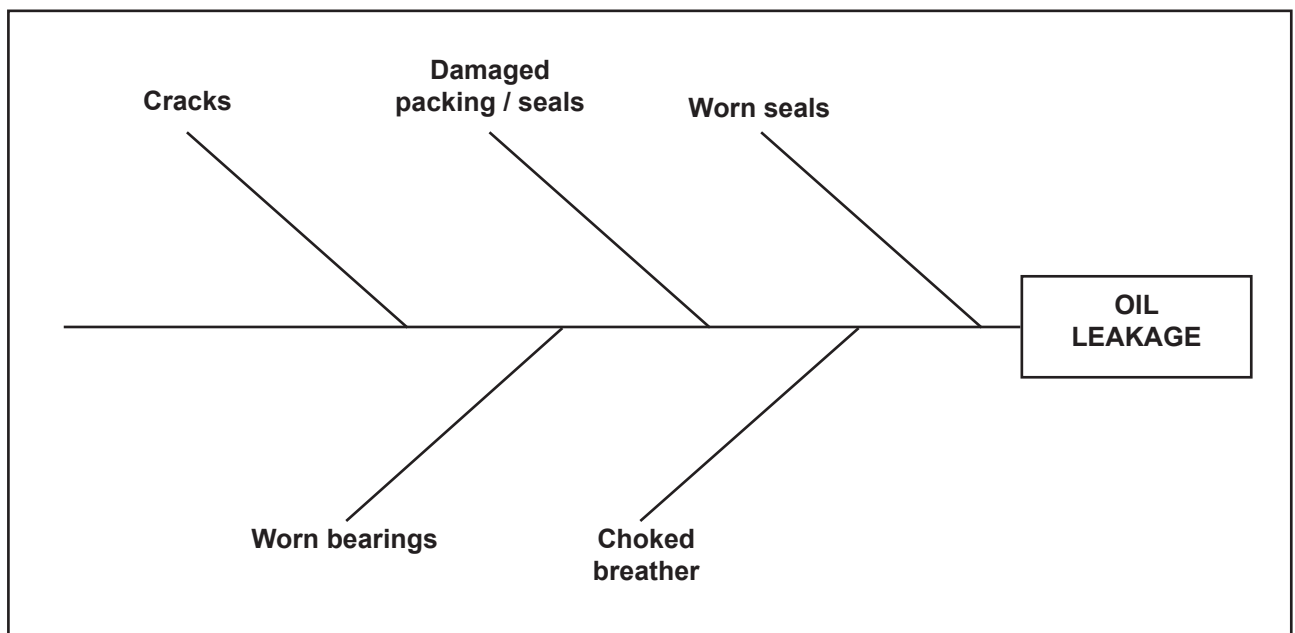
Cause and Effect Diagram - Gear Slipping



Cause and Effect Diagram - No Power Transmitted

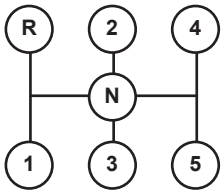
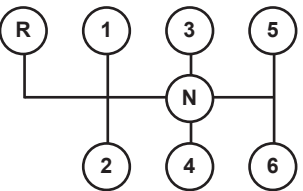
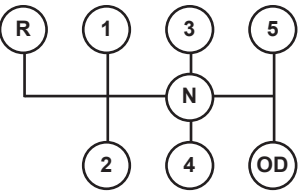
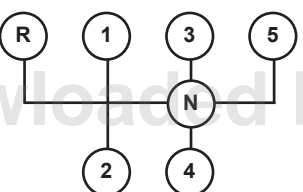

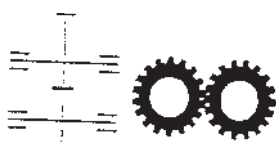


*Cause and Effect Diagram - Gear Noise*



*Cause and Effect Diagram - Oil leakage*

## 26.0.6 General Data

SL.NO	FIGURE	DESCRIPTION	VALUE
1		Gear Shifting pattern for ZF S5-36 (MK I)	5 + Reverse
2		Gear Shifting pattern for ZF S6-36	6 + Reverse
3		Gear Shifting pattern for ZF S6-36 OD	6 + Reverse
4		Gear Shifting pattern for ZF S5-36 MK II	5 + Reverse
5		Type of mesh	Reverse - Constant mesh Forward - Synchro mesh
6		Gear Ratio	Refer Gear Ratio Table



## Gear Ratio

Gear	ZF S6-36 MK I			ZF S5-36 MK I		ZF S6-36 MK II				ZF S5-36 MK II
	S6-36	S6-36	S6-36 OD			S6-36	S6-36	S6-36	S6-36 OD	
I	8.97	7.43	6.93	6.50	7.20	8.97	7.43	9.20:1	6.93	8.08
II	5.22	4.32	4.43	4.22	4.22	5.22	4.32	5.22:1	4.43	4.70
III	3.10	2.57	2.63	2.44	2.44	3.10	2.57	3.10:1	2.63	2.75
IV	1.96	1.75	1.51	1.52	1.52	1.96	1.62	1.96:1	1.51	1.64
V	1.33	1.26	1.00	1.00	1.00	1.33	1.21	1.33:1	1.00	1.00
VI	1.00	1.00	0.84	---	---	1.00	1.00	1.00:1	0.84	---
Reverse	8.05	6.67	6.22	8.05	8.05	8.05	6.67	8.05:1	6.22	7.25

## Circlips Thickness

Location	Diameter (mm)	Thickness (mm)
<b>Mainshaft</b>		
Before 5th/6th synchro pack (S6-36 gear box)	40	2.5, 2.45, 2.4, 2.35, 2.3, 2.2
Before 4th/5th synchro pack (S5-36 gear box)		
Before 4th gear sleeve (S6-36 gear box)	-	2.1, 2.0, 1.9
Before 3rd gear sleeve (S5-36 gear box)		
After 1st/2nd synchro pack (S6-36 gear box)	68	2.5, 2.45, 2.4, 2.35, 2.3
After 1st/Reverse synchro pack (S5-36 gear box)		
After reverse gear sleeve (S6-36 gear box)	100	3, 2.9, 2.8, 2.7
After reverse gear sleeve (S5-36 gear box)		
<b>Layshaft</b>		
Before layshaft input end bearing (S6-36 gear box)	40	1.75, 1.7, 1.65, 1.6,
Before layshaft input end bearing (S5-36 gear box)		1.55, 1.45, 1.4, 1.35

## Spacer Thickness

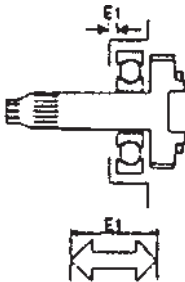
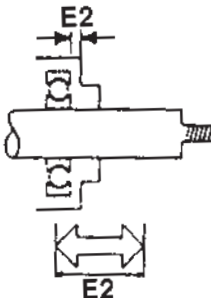
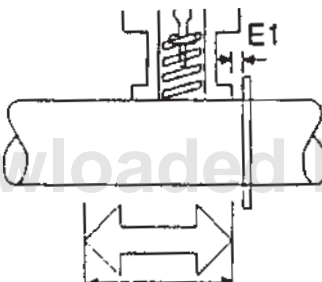

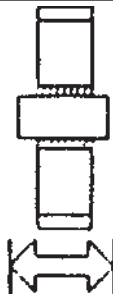
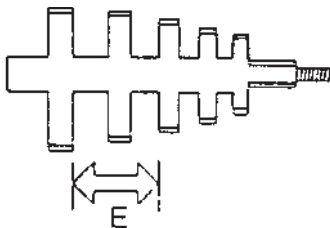
Location	Thickness (mm)
Input shaft split ring	3.4, 3.5, 3.6, 3.7
Input shaft end play setting	2.0 - 1.0 (In steps of 0.05)
Lay shaft end play setting	2.2, 2.0, 1.75, 1.7, 1.65
Spacer ring between input shaft and clutch body	3.0, 3.3, 3.5, 3.7, 4.0, 4.3, 4.6, 4.9, 5.2

## Power Take Off

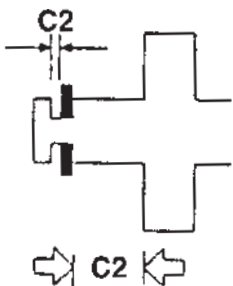
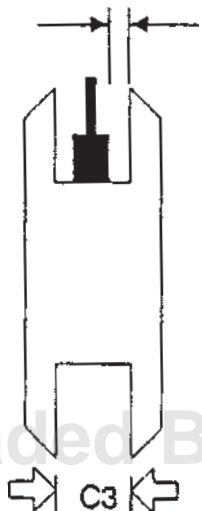
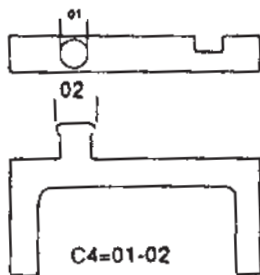
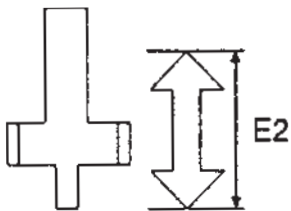
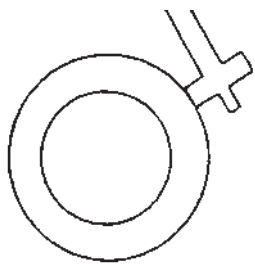
Gear Box Spec and Description	Power Take off specification	Mounting Position on Gear Box	Output Flange Series/Details	Max output Torque Kgm	Max. output HP Output RPM at Engine 2400 RPM	Ratio-PTO Output to Engine Speed Direction Rotation CW/CCW*	Actuation type mechanical/ Pneumatic Air pressure kg/cm <sup>2</sup>
ZF S6-36 (8.97) MK I & II	ALPTO11	Side	1300	28.23	77/1948	0.812/CCW	Pneumatic 7.25
	ALPTO12	Rear	1300	30.5	53.6/1248	0.52/CCW	
ZF S6-36 (7.43) MK I	ALPTO11	Side	1300	28.23	90/2275	0.948/CCW	Pneumatic 7.25
	ALPTO12	Rear	1300	30.5	60.3/1512	0.63/CCW	
ZF S5-36 (6.5 & 7.2) MK I	ALPTO11	Side	1300	28.23	70/1760	0.733/CCW	Pneumatic 7.25
	ALPTO12	Rear	1300	30.5	53.6/1248	0.52/CCW	
ZF S6-36 (6.93 OD) MK I & II	ALPTO12	Rear	1300	30.5	69/1618	0.674/CCW	Pneumatic 7.25


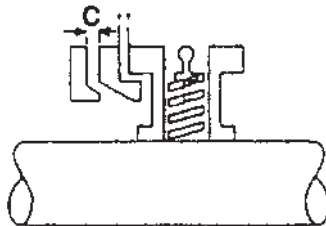
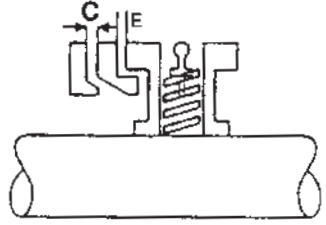
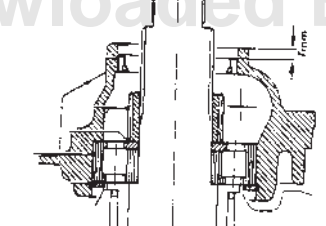
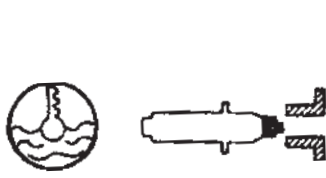
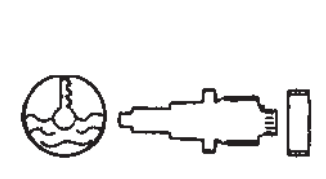
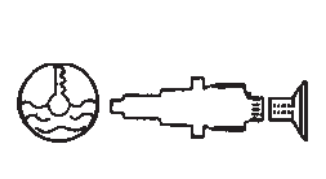
\* CW - Clockwise CCW - Counter Clockwise

## 26.0.7 Repair Data

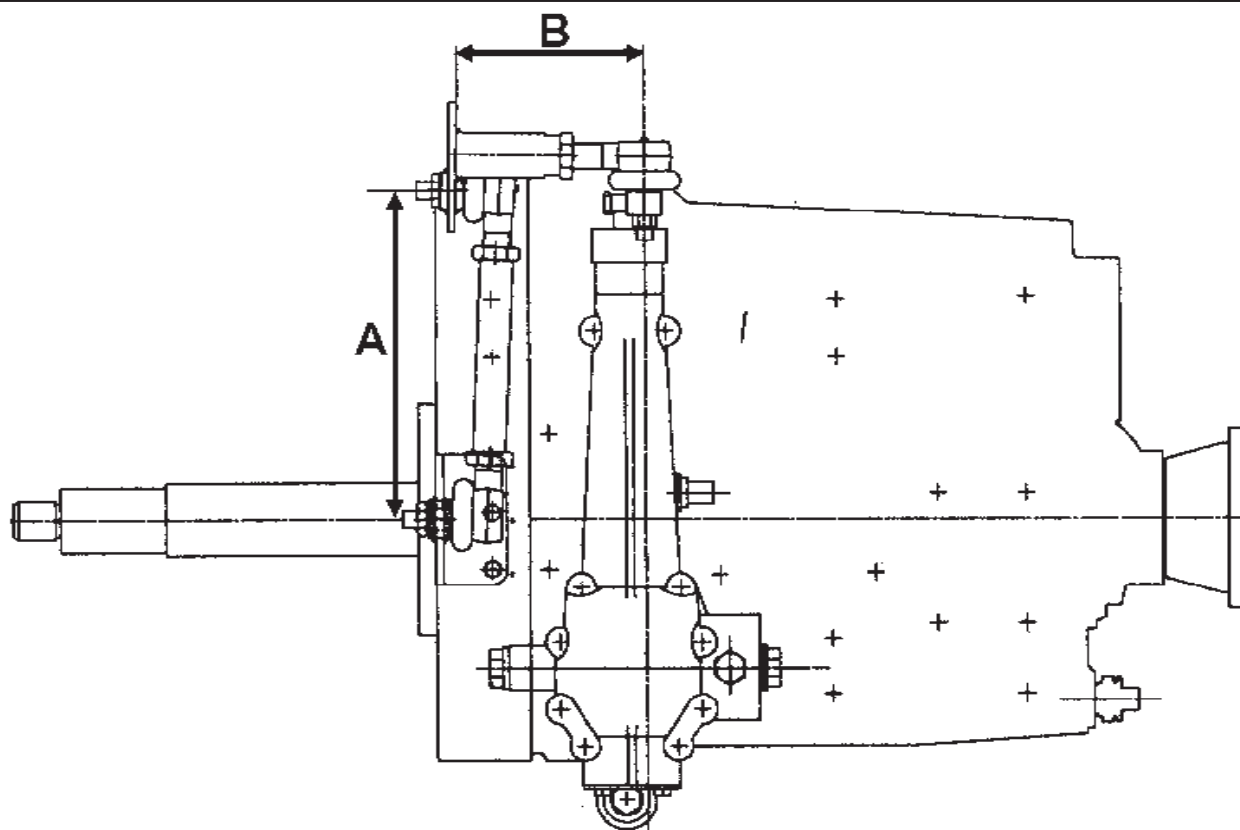
SL. NO	FIGURE	DESCRIPTION	VALUE																					
1		Axial clearance of bearing on Input side (bearing outer ring)	0 - 0.1 mm																					
2		Axial clearance of bearing on output side (bearing outer ring)	0 - 0.1 mm																					
3		Axial clearance of circlip	0 - 0.1 mm use circlips of different thickness for adjustment Refer to circlip thickness table for various sizes available.																					
4		Axial preload of split ring on input shaft	0 - 0.5 mm (Split rings are available in 4 different thickness)																					
5		<div>Axial clearance of gears on main shaft</div> <table><tr><td>S6-36</td><td>S5-36</td><td></td></tr><tr><td>5th</td><td>4th</td><td>0.15 - 0.60 mm</td></tr><tr><td>4th</td><td>3rd</td><td>0.25 - 0.65 mm</td></tr><tr><td>3rd</td><td>2nd</td><td>0.20 - 0.45 mm</td></tr><tr><td>2nd</td><td>1st</td><td>0.20 - 0.45 mm</td></tr><tr><td>1st</td><td>-</td><td>0.15 - 0.50 mm</td></tr><tr><td>Reverse Idler</td><td>Reverse Idler</td><td>0.30 - 1.30 mm</td></tr></table>	S6-36	S5-36		5th	4th	0.15 - 0.60 mm	4th	3rd	0.25 - 0.65 mm	3rd	2nd	0.20 - 0.45 mm	2nd	1st	0.20 - 0.45 mm	1st	-	0.15 - 0.50 mm	Reverse Idler	Reverse Idler	0.30 - 1.30 mm	
S6-36	S5-36																							
5th	4th	0.15 - 0.60 mm																						
4th	3rd	0.25 - 0.65 mm																						
3rd	2nd	0.20 - 0.45 mm																						
2nd	1st	0.20 - 0.45 mm																						
1st	-	0.15 - 0.50 mm																						
Reverse Idler	Reverse Idler	0.30 - 1.30 mm																						
6		Axial clearance of layshaft	0 - 0.1 mm Bring bearing to abutment and measure. Adjust with shims. Refer to Table for various spacer thickness available																					



SL. NO	FIGURE	DESCRIPTION	VALUE
7		Axial clearance of circlip on layshaft input end	0 - 0.05 mm Adjustment with circlips of different thickness. Refer to Table for various circlip thickness.
8		Clearance of fulcrum pads in guide grooves or sliding sleeves (When new)  Maximum permissible clearance of fulcrum pads in sliding sleeve or guide grooves	0.4 - 0.7 mm (Higher value indicates wear on fulcrum pads)  1.2 mm (Approx.) (Worn out parts to be renewed to get correct values)
9		Clearance of selector fork guide grooves maximum permissible clearance	0.2 - 0.5 mm (when new) 1 mm (Approx) (Renew parts if worn out to obtain correct values)
10		Axial clearance of speedometer shaft	0 - 0.1 mm
11		Backlash of speedo pinion	0.1 - 0.2 mm

26.20	ZF SYNCHROMESH GEAR BOX Service Manual		 ASHOK LEYLAND
SL. NO	FIGURE	DESCRIPTION	VALUE
12		Wear limit of synchro rings and/or clutch body, measured between plain faces of ring and body; friction cones of both must be centrally in contact without play.	0.8 mm (Renew synchro ring and /or clutch body if worn out to obtain correct values)
13		Synchroniser clearance (All forward gears)	0.6 mm (Higher values indicate wear on synchroniser)
14		Axial clearance of the spacer ring being installed between input shaft and clutch body	0.9 - 1.2 mm Refer to Table for various available thickness.
15		Distance from housing edge to face of shaft seal on output end	7 mm
16		Temperature for shrink fit of thrust bushing for 3rd gear on main shaft and reverse spur gear	120°
17		Temperature for shrink fit of layshaft gears	160° - 180°
18		Temperature for shrink fit of output flange	100° - 120°





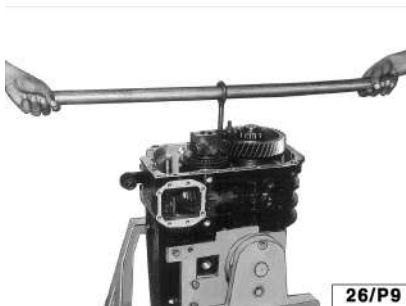
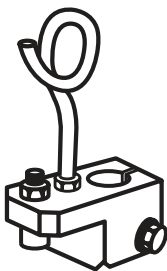
*ZF Gear Box - Representative Diagram - Gear Shift Linkage*

**LINKAGE DIMENSION**

SL	DRG	SETTING DIMENSION		GEAR BOX SPECIFICATIONS
		REACTION ROD 'A'	CONN FLANGE 'B'	
1	F9608600	270 + 5	120 + 5	66/17, 66/2
2	F9612000	265 + 5	110 + 5	42/16, 66/36
3	F9615700	245 + 5	105 + 5	41/36, 66/10
4	F9624500	250 - 5	130 + 5	84, 41/31, 66/27, 89/3, 89/4, 90/1
5	F9651100	270 + 5	105 + 5	32/28, 32/30, 66/30
6	F9657900	280 + 5	130 + 5	66/32
7	F9660000	250 + 5	110 + 5	53/9
8	F9662800	250 + 5	140 + 5	94, 92/3, 92/8
9	F9671300	260 + 5	120 - 5	87/1
10	F9678300	250 + 5	110 + 5	89/5, 89/6
11	F9684600	265 - 5	130 + 5	84/1
12	F9687900	200 + 5	100 + 5	66/37
13	F9795800	265 + 5	100 + 5	41/12, 53/7
14	F9796600	255 + 5	105 + 5	90, 41/28, 83/2
15	F9796700	280 + 5	100 + 5	66/18
16	F9796800	260 + 5	90 + 5	41/23, 66/12, 66/13, 66/14, 66/21, 66/25, 66/26, 66/29, 66/38
17	X9842600	270	130	83, 92, 41/26, 41/29, 92/1, 92/7
18	X9856200	243 - 5	130 + 5	83/3, 84/4, 92/4

**26.0.8 Special Tool**

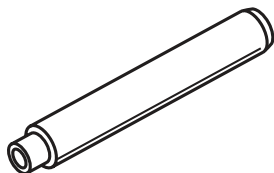
0302001 (3901) - LIFTING DEVICE



TO LIFT / LOWER  
THE COUNTER  
SHAFT AND  
MAINSHAFT ASSYS  
OUT OF MAIN GB  
CASING

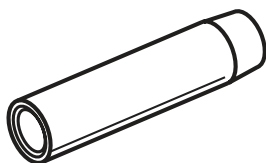
26/P9

0302002 (3902) - DRIFT SELECTOR SHAFT BUSH



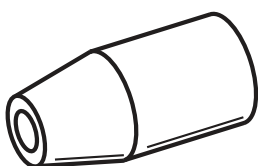
TO INSTALL  
SELECTOR SHAFT  
BUSH

0302003 (3903) - ADAPTOR

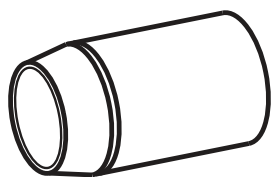


TO INSTALL  
SELECTOR  
HOUSING OIL SEAL

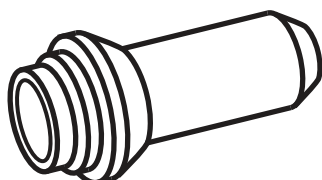
0302004 (3904) - PROTECTIVE SLEEVE



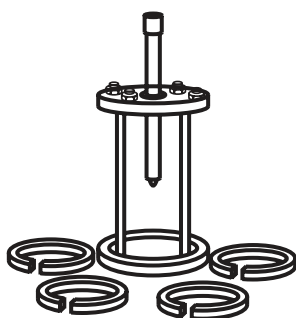
TO PROTECT  
THE SELECTOR  
HOUSING OIL SEAL  
WHILE INSERTING  
THE SHAFT

**0302005 (3905) - CENTRALISER MAINSHAFT ASSEMBLY**

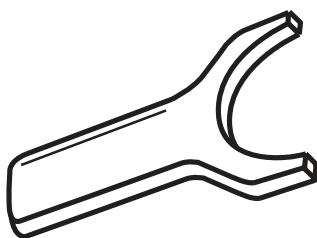
TO CENTRALISE  
MAINSHAFT ASSY.  
WHILE LOWERING  
INTO MAIN GB  
CASING

**0302006 (3906) - DRIFT REAR OIL SEAL**

TO FIT REAR END  
OIL SEAL IN GB  
CASING

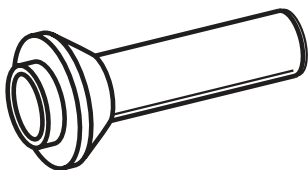
**0302007 (3907) - PULLER MAIN SHAFT GEARS**

EXTRACTOR TO BE  
USED ALONG WITH  
VARIOUS SPLIT  
PLATES AND FULL  
ROUND PLATES  
TO EXTRACT  
MAINSHAFT GEARS

**0302008 (3908) - DRIFT SPLIT RING**

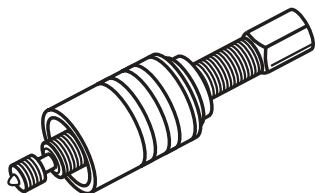
TO INSTALL INPUT  
SHAFT SPLIT RINGS

## 0302009 (3909) - DRIFT FRONT OIL SEAL



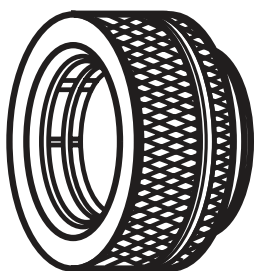
TO INSTALL FRONT  
OIL SEAL IN INPUT  
SHAFT COVER

## 0302010 (3910) - BASIC TOOL



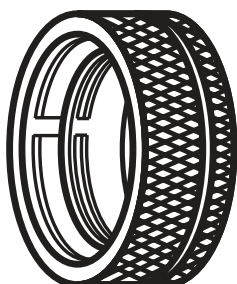
TO BE USED WITH  
APPROPRIATE  
GRIPPING TOOL TO  
REMOVE COUNTER  
SHAFT TAPER  
ROLLER BEARINGS

## 0302011 (3911) - GRIPPING TOOL INPUT END

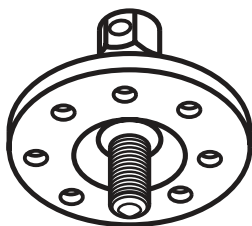
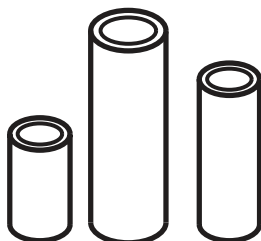
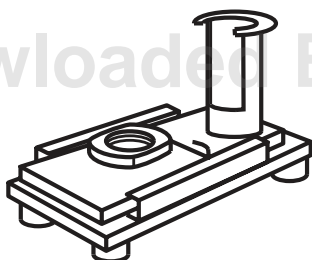
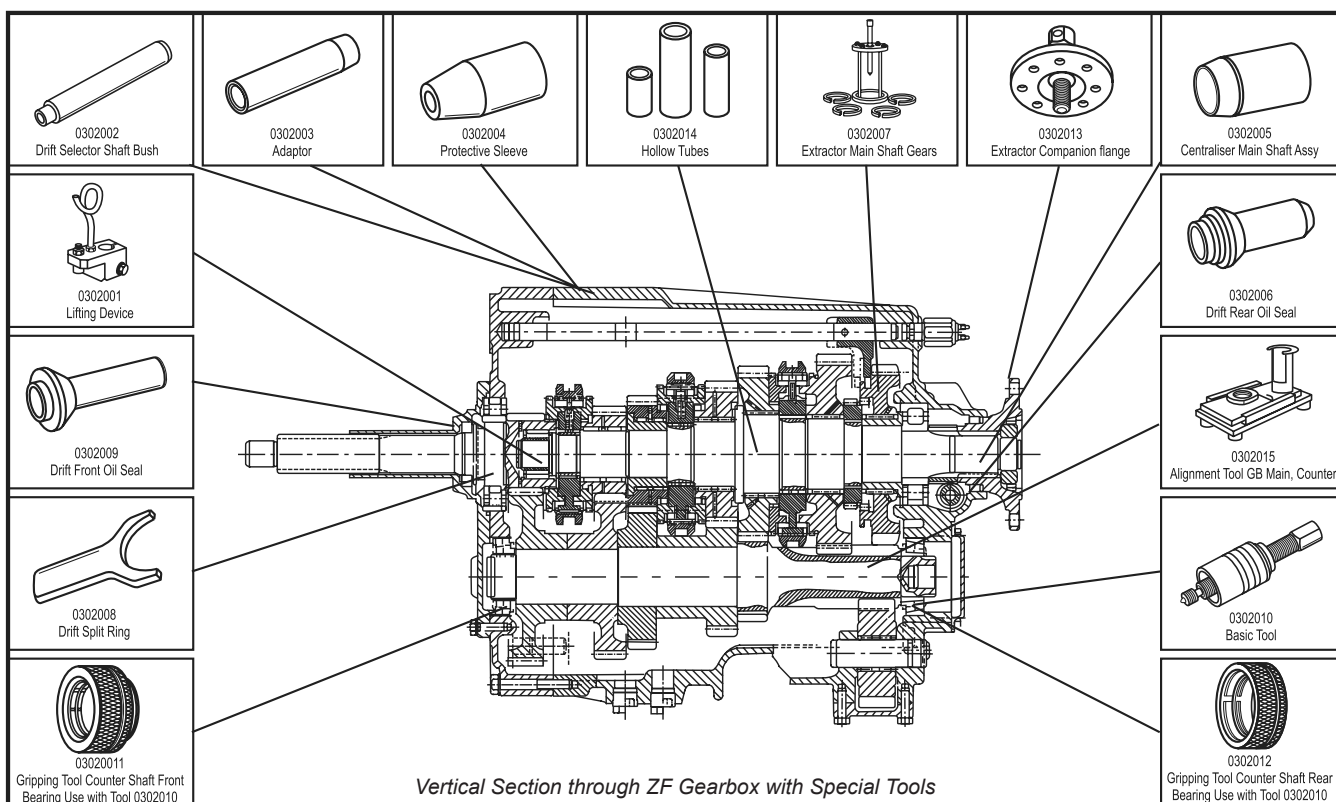


TO BE USED WITH  
0302010 - BASIC  
TOOL, TO REMOVE  
COUNTER SHAFT  
FRONT BEARING

## 0302012 (3912) - GRIPPER TOOL OUTPUT END



TO BE USED WITH  
0302010 - BASIC  
TOOL, TO REMOVE  
COUNTER SHAFT  
REAR BEARING

**0302013 (3913) - PULLER COMPANION FLANGE (4 AND 8 HOLES FLANGE)**TO REMOVE  
COMPANION  
FLANGE**0302014 (3914) - HOLLOW TUBES ZF GB**USED FOR  
PRESSING  
MAINSHAFT GEARS  
ON TO MAINSHAFT**0302015 (3915) - ALIGNMENT TOOL GB MAIN -COUNTER .**TO ALIGN  
MAINSHAFT AND  
COUNTER SHAFT  
ASSY TOGETHER



## 26.1 TO REMOVE AND REFIT GEAR BOX ASSEMBLY FROM VEHICLE



**Disconnect battery terminals and choke the road wheels using wedges. Make sure the vehicle is parked on a level ground.**

Remove front propeller shaft bolts.

Hang removed propeller shaft to the chassis frame.

Unscrew speed change lever pinch bolt and remove the lever.

Disconnect clutch lever ball joint sockets split pin and remove the locating screw from the clutch operating lever, press out the fulcrum pin and remove the operating lever.



**In case of hydraulic clutch actuation disconnect slave cylinder push rod from clutch operating lever and also hose connection.**

Disconnect Speedo cable, Exhaust pipe clamp, reverse indicator switch, wiring connections, fuel supply and return connections.

Drain gear box oil in a clean container.

Locate the gearbox trolley jack under the gear box. Unscrew clutch housing fasteners.



**In case of tipper models ensure removal of PTO assembly from gearbox after draining lubricant oil.**

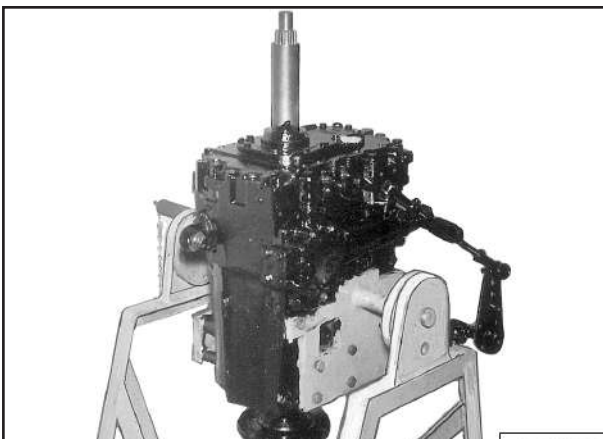
Clean the gearbox assembly free from dirt, mud, etc., before dismantling.

Perform the above in reverse order to refit the gearbox assembly to the vehicle.

## 26.2 TO OVERHAUL ZF S5-36 SYNCHROMESH GEARBOX

/ Gear box assembly removed from vehicle. Refer section 26.1 /

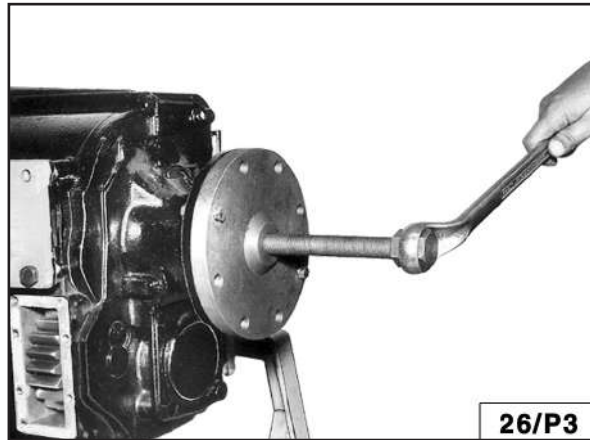
### 26.2.0 Dismantling



Remove clutch withdrawal assembly and clutch housing. Mount gear box on assembly stand **SME 03002**.

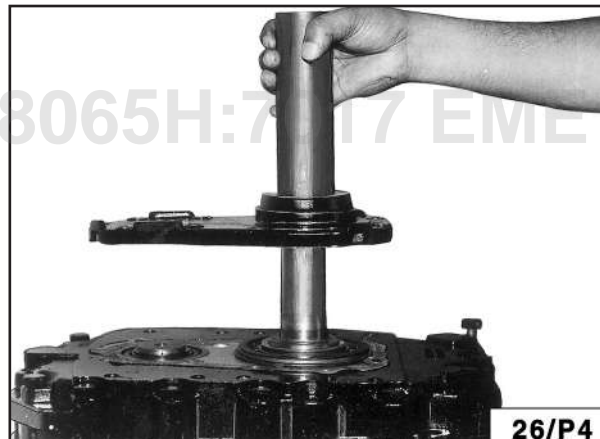
Remove Selector reaction linkage, Selector assembly, Speedo assembly, External plug for selector guide rod, Reverse Idler cover and Lock for reverse spindle.

Shift two thrust rod to engage any two gears



26/P3

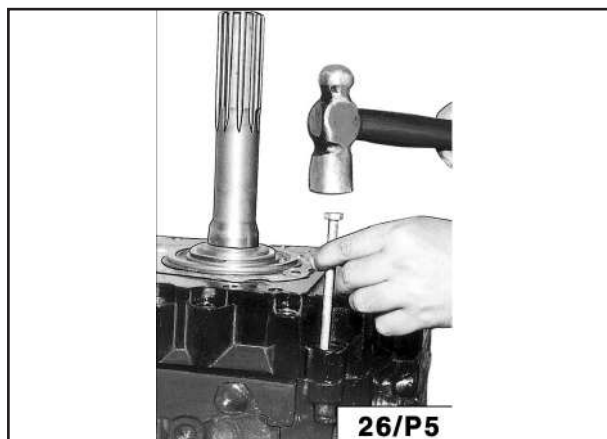
- Remove lock on output flange nut and Remove output flange nut
- Pull off flange using **Special Tool 0302013 - Puller Companion Flange**.



26/P4

Position box with input shaft upwards

Remove connection plate and preserve shims for input shaft bearing and counter shaft bearing.



26/P5

Drift out two dowels from connection housing to main assembly.

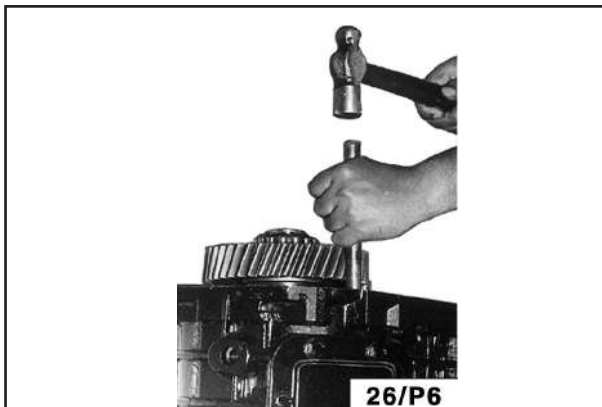




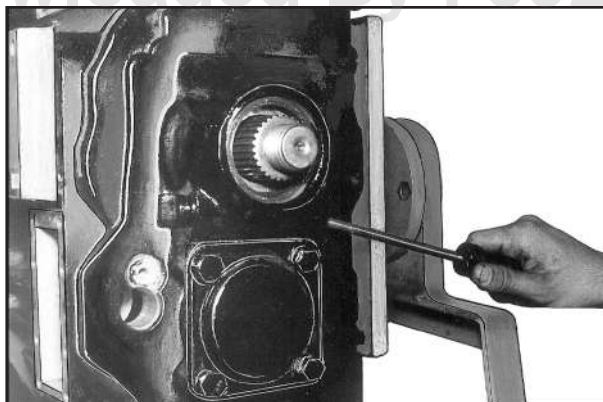
- Remove connection housing along with input shaft bearing and counter shaft bearing.
- Press out cup for bearing on countershaft.
- Remove retainer on the input shaft and lever out split locks remove circlip on outer race. Press out input shaft sub-assembly from connection housing.



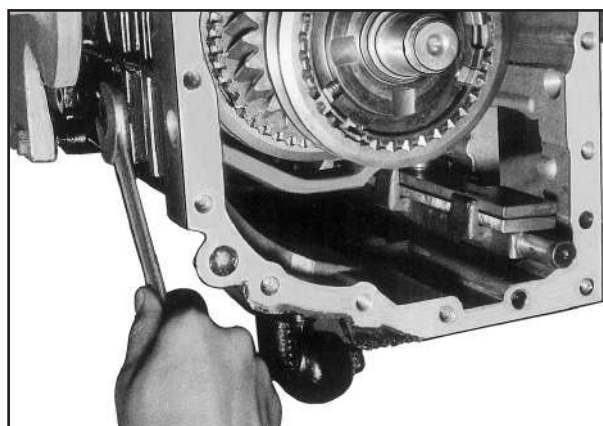
**The connection housing cannot be removed from the clutch body if the input shaft is twisted. If so remove connection plate and snap ring heat up area around bearing lift off connection housing driving back input shaft.**



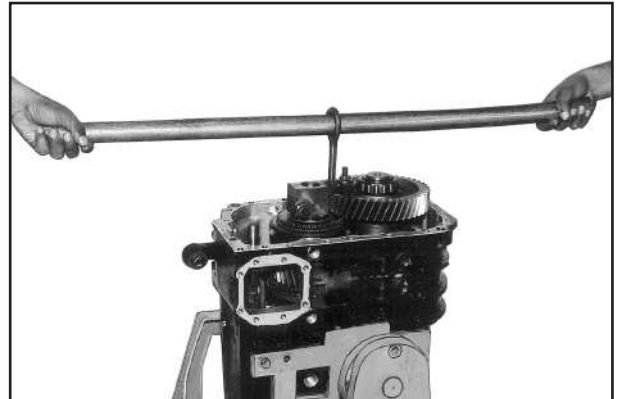
Tap the reverse idler spindle from inside and remove idler gear through the window along with needle rollers.



Remove spigot bearing on mainshaft  
Pry out the speedo gear on mainshaft rear end without damaging threads.  
Remove forks and selector plates after unscrewing pivot bolts.

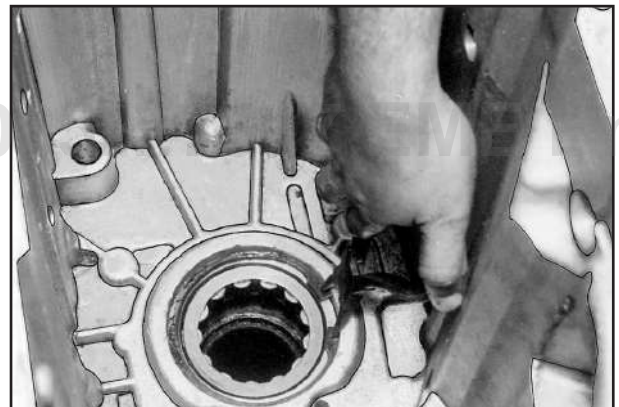


Remove the reverse gear detent from main housing.  
Remove fulcrum pins on 4th and 5th forks and remove fork along with thrust rod.  
Remove the above for 2nd and 3rd fork and thrust rod.  
Remove fulcrum pin for 1st and reverse and remove thrust rod only.



Fit using **Special Tool 0302001 - Lifting Device** to main and countershaft assemblies.

Lift out main shaft and counter shaft assemblies together.

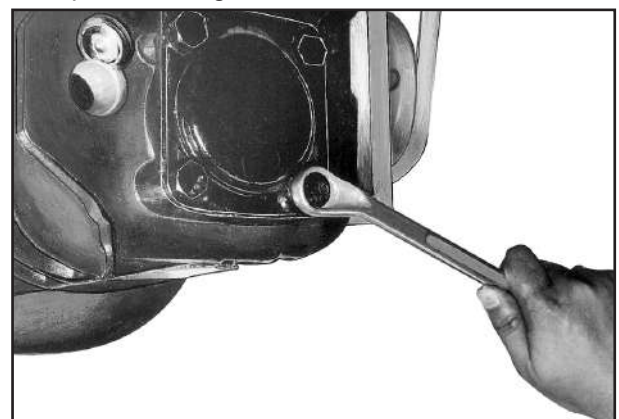


Remove guide rod.

Remove Lifting device to separate mainshaft and counter-shaft assembly.

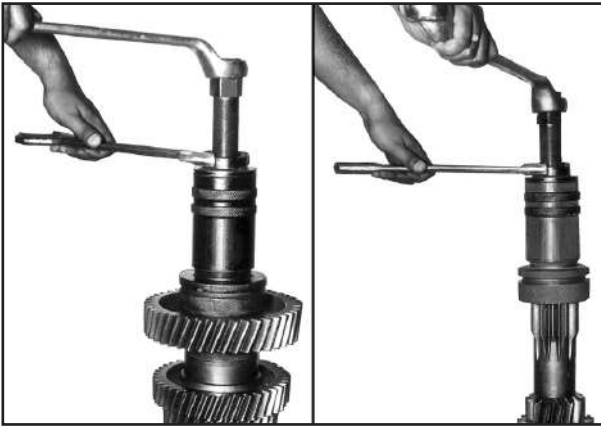
The third piece of mainshaft rear bearing is to be taken out and preserved.

Remove circlip above mainshaft rear bearing in casing and tap out bearing.



Remove counter shaft rear cover and tap out bearing cup.





Remove circlip on countershaft.

Remove countershaft front and rear bearing cones using **Special Tool 0302010 - Basic Tool**, **Special Tool 0302011 - Gripping Tool Input End** and **Special Tool 0302012 - Gripping Tool Output End**.

Press out constant mesh wheel

Press out 4th and 3rd gears on counter shaft

Press out 2nd gear on counter shaft.



From mainshaft assembly remove 5th clutch body, 5th synchro ring, 4th and 5th sliding sleeve and preserve thrust piece ball pins & springs

Remove circlip on 4th and 5th synchro body

Using **Special Tool 0302007 - Puller Main Shaft Gears** and suitable split ring supplied with above tool remove 4th and 5th synchro body.

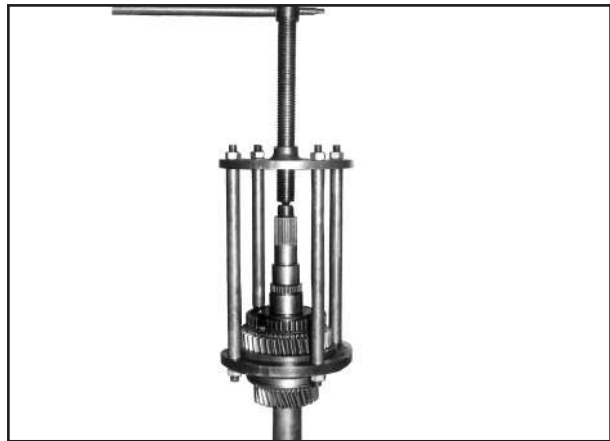
Remove 4th, 5th synchro body, 4th synchro ring, 4th gear and 4th gear needle roller bearing.



Invert the main shaft assembly and reposition **Special Tool 0302007 - Puller Main Shaft Gears** with 1st/Reverse gear marked split rings to remove the reverse gear.



**Before placing the special tool engage 1st gear for placing the split rings of special tool properly.**



Remove the reverse fixed dog clutch from main shaft using **Special Tool 0302007 - Puller Main Shaft Gears** and smallest split ring.

Remove circlip on 1st and reverse synchro body

Using **Special Tool 0302007 - Puller Main Shaft Gears** with split rings marked as 1st/Reverse below first gear to extract the 1st/reverse synchro pack along with first gear.



Remove 1st gear needle roller bearing.

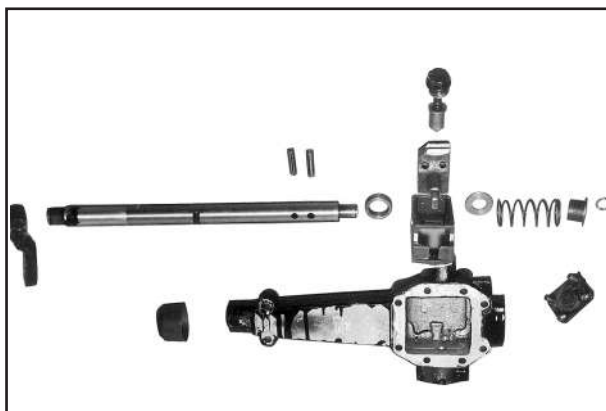
Invert shaft and remove circlip on steel bush for 3rd gear.



With 2nd gear seated on **Special Tool 0302007 - Puller Main Shaft Gears** with suitable split rings extract 2nd



gear, 2nd, 3rd synchro pack, 3rd gear, Needle bearing for 3rd gear, Steel bush for needle bearing and remove needle bearing for 2nd gear.



Remove lever and shield on selector casing.

Remove end cover, plugs and detents and from external bore remove Spacer, Spring and Washer.



**Position the striking finger such that one of the cylindrical roll pins align with the path hole in the selector casing.**

Tap out the roll pins 2 pairs into hole and remove it.

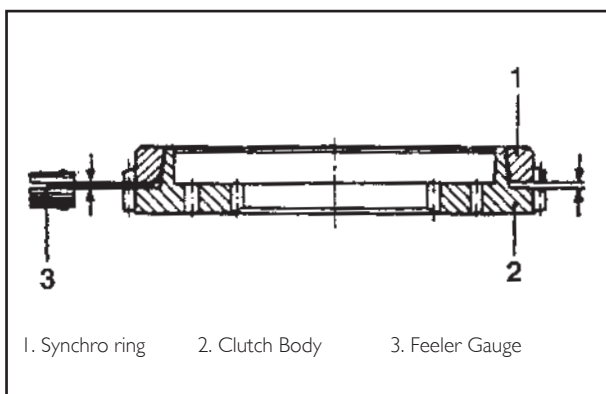
Shift the 2nd pin to the hole and remove it likewise.

Draw out the selector shaft.

Remove blocking plate and selector finger and spacer.

Remove needle bearing, bush bearing and seal.

### 26.2.1 Inspection



Clean all parts and inspect them. Replace where necessary



**Synchro ring clutch body and synchro body are related dimensionally. After checking clearance, they must be assembled as such on mainshaft.**

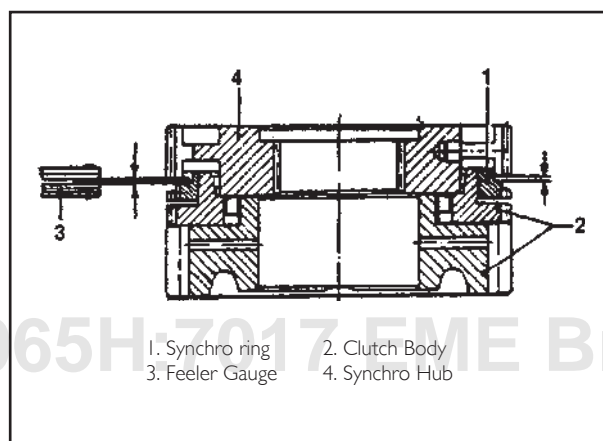
### Synchro ring to clutch body clearance

Position synchro ring respective clutch body so that its seating is uniform and parallel

Using a feeler gauge to check clearance between face of synchro ring and clutch body. Replace synchro ring if clearance is less than 0.8 mm.

Inspect clutch body for wavy wear

### Synchro ring to synchro body clearance.



1. Synchro ring  
2. Clutch Body  
3. Feeler Gauge  
4. Synchro Hub

Place clutch body on respective gear and ensure perfect seating.

Place respective synchro ring on clutch body. Ensure uniform and parallel seating.

Set respective synchro body on the synchro ring.

Use a feeler gauge to check clearance between rear of synchro ring and tooth face of adjacent gear.

The clearance should be more than 0.6 mm.



**Minimum clearance 0.6 mm**

### 26.2.2 Assembly

Replace all spring, O ring, seals and gaskets.

Use special tools wherever Indicated. The special tools prescribed are basically service tools. To improve productivity special fixture can be developed.

To avoid distortion or fracture, heat selected components as specified.

Mount gear box on assy stand **SME 03002**.

Heat (Hot air blower) bore and fit taper bearing cap in counter shaft bore from inside of casing

Heat (Hot air blower) bore and fit mainshaft bearing outer race from Inside of casing. Fit circlip.

#### 26.2.2.0 Sub Assembly of Counter Shaft

Mount counter shaft suitably on press with front end upwards

Heat (180°C) all counter shaft gears. All the bore and end faces must be free of oil.

Press 2nd and 3rd gear with gear end downwards.

Press 4th gear with longer hub end facing up and 5th gear with longer hub end downwards.

Press taper bearing with collared end downwards.

Select and fit circlip such that it fits snugly between bearing face and groove. Clearance allowed 0 - 0.5 mm

Press taper bearing cone on rear end of shaft.

#### 26.2.2.1 Sub Assembly of Mainshaft



**All circlips to be free of bend and burrs.**

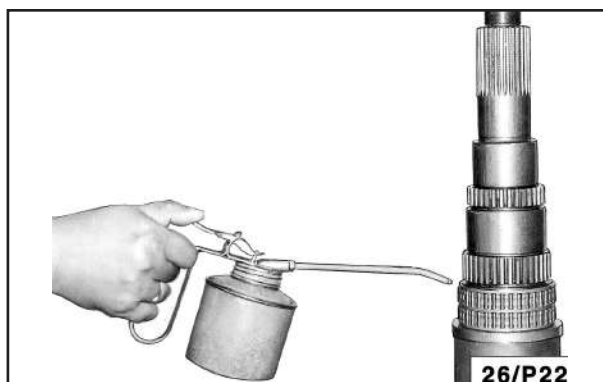
Observe related positions of synchro body synchro rings and sliding sleeves

Check end float at each stage of gear assy.

Position mainshaft with output end upwards in suitable stand.



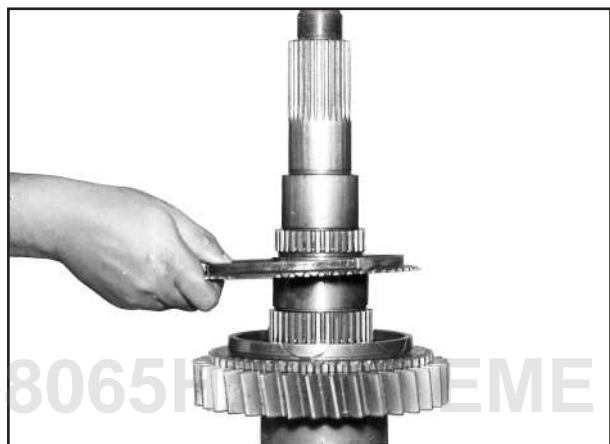
**Use Special Tool 0302014 - Hollow Tubes ZF GB for positioning main shaft and applying fitting force during assy stages.**



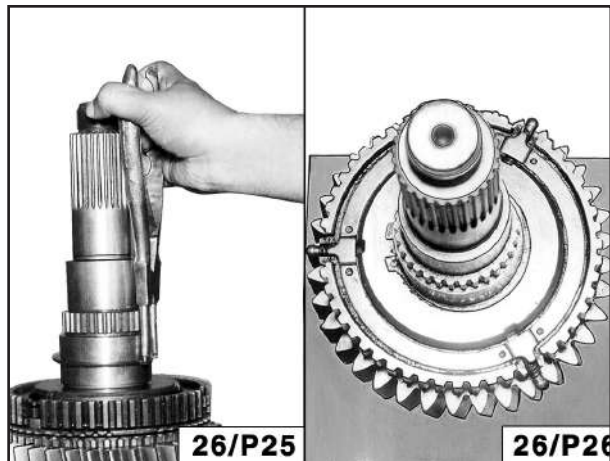
Lubricate and fit 1st gear needle bearing



Fit 1st gear with clutch body upwards.



Fit 1st gear synchro ring.



Heat (120°C) and locate synchro body for 1st/Reverse gears. Select and fit circlip. Ensure snugness. Clearance 0 - 0.01 mm.



**Ensure Stopper ring of synchro body faces towards output end.**

Glue in spring and ball pins into synchro body with grease.



Fit sliding sleeve.



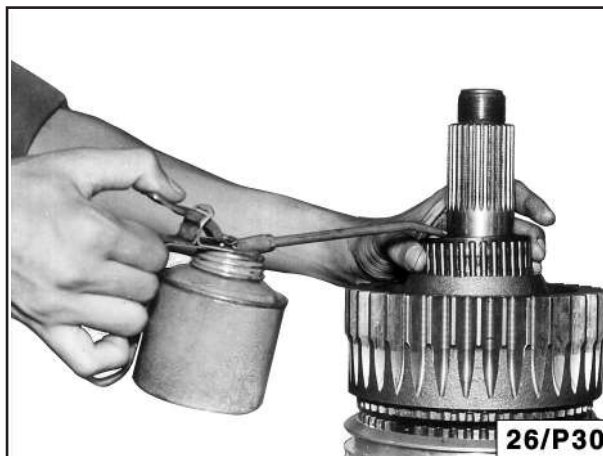
**Check free rotation, end float and engagement of all gears after installation.**



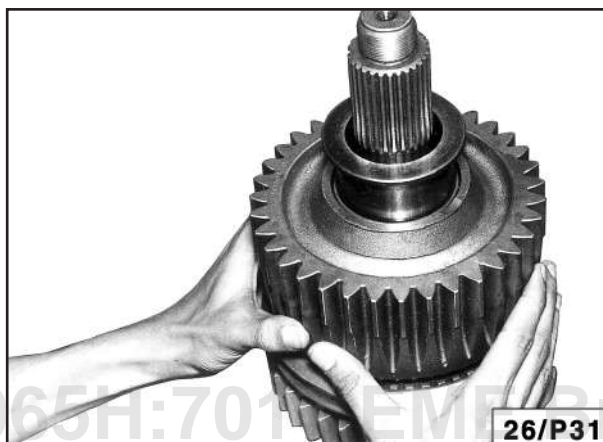
Heat (120°C) and fit spacer with rounded end of teeth upward.



Locate reverse gear on spacer.



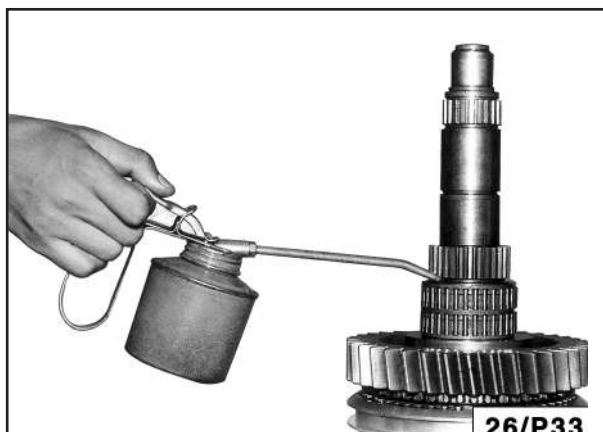
Lubricate and fit needle bearing.



Heat (120°C) and fit collared sleeve with collar upwards.

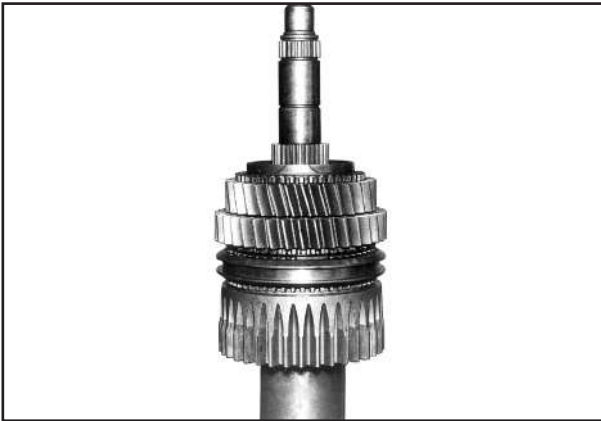


Invert shaft on stand.

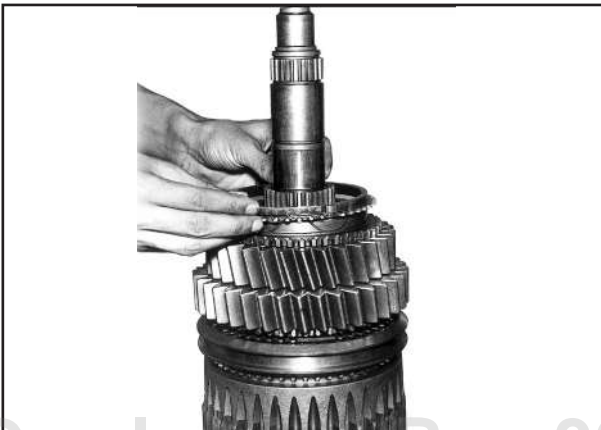


Lubricate and fit needle bearing for 2nd gear.





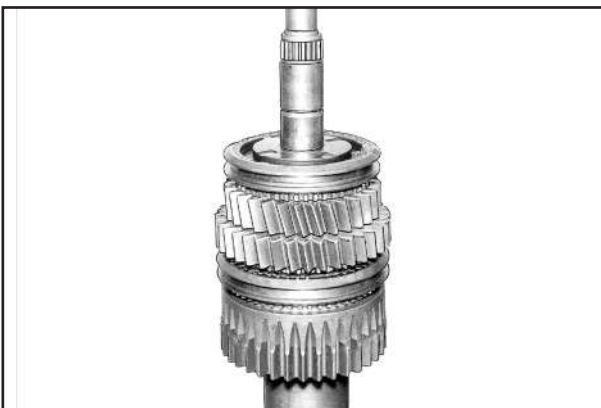
Fit 2nd gear with clutch body upwards.



Place 2nd synchro ring on gear.



Heat synchro body and locate its slots on lugs of synchro ring.

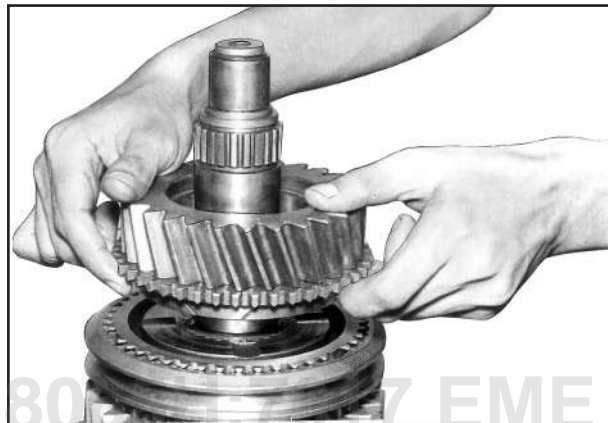


Glue in the three sets of thrust pieces, ball pins and springs into respective holes in synchro body.

Fit sliding sleeve correctly.



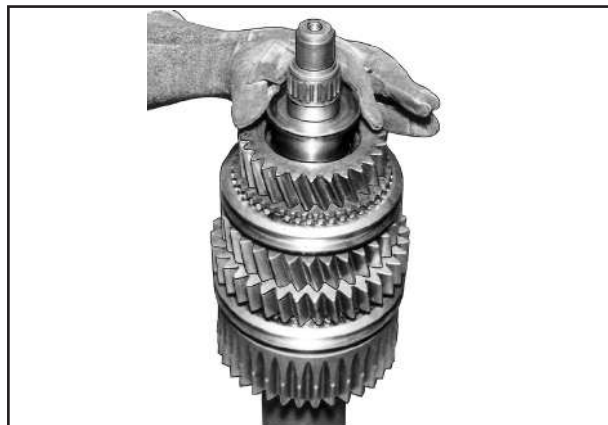
Fit 3rd synchro ring into slot of synchro body.



Locate 3rd gear in synchro ring.



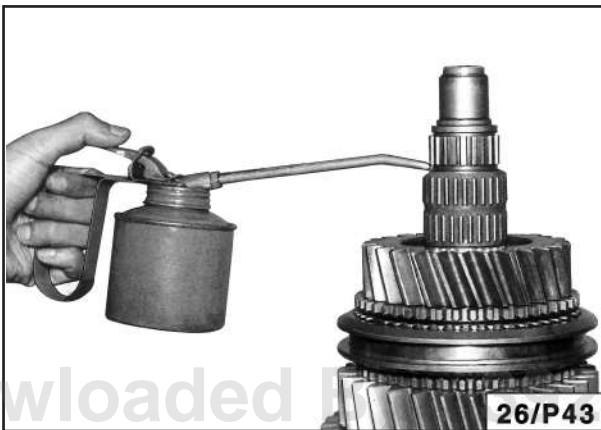
Lubricate needle bearing and fit.



Heat (120°C) collared sleeve and fit with collared face upwards.



Select and fit circlip to ensure snugness. Clearance maximum 0 - 0.1 mm.



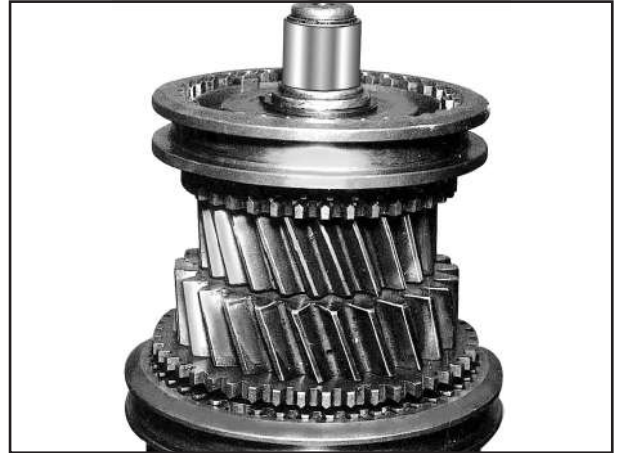
Lubricate and fit needle bearing for 4th gear.



Fit 4th gear with dog teeth end upwards.



Place synchro ring on gear



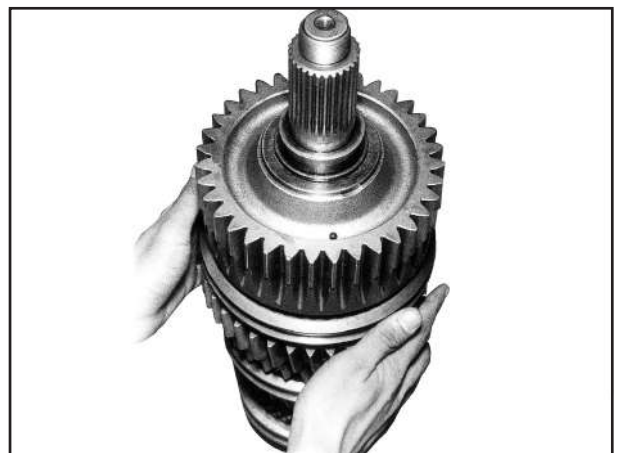
Heat and fit 4/5 synchro body. Locate slots on synchro ring lugs (Recess should face in top).



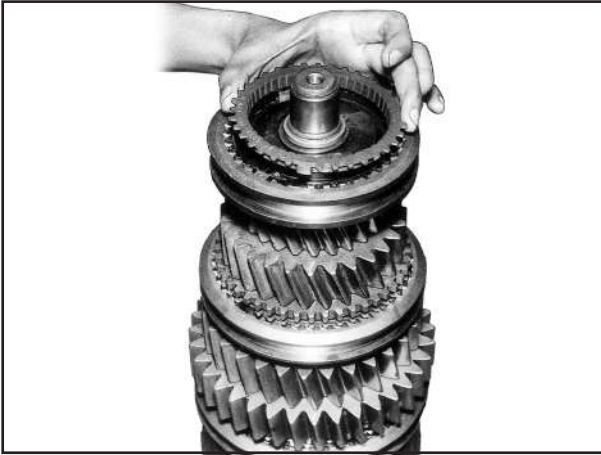
Glue thrust pieces to ball pins and springs with grease into holes of synchro body.

Fit sliding sleeve correctly.

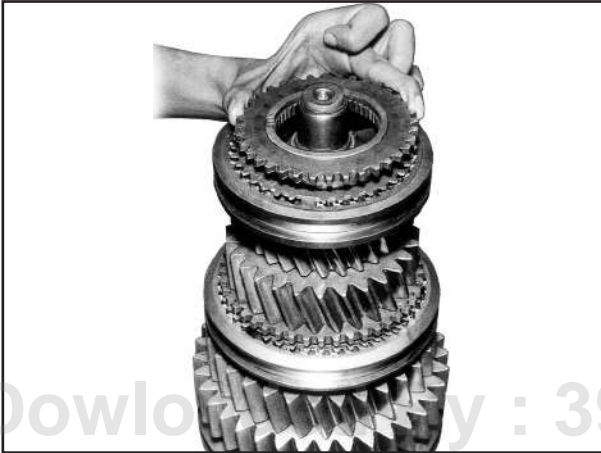
Fit circlip on shaft. Ensure snugness. Clearance maximum 0 - 0.1 mm.



Fit inner race of output end bearing with collar against sleeve for reverse gear.

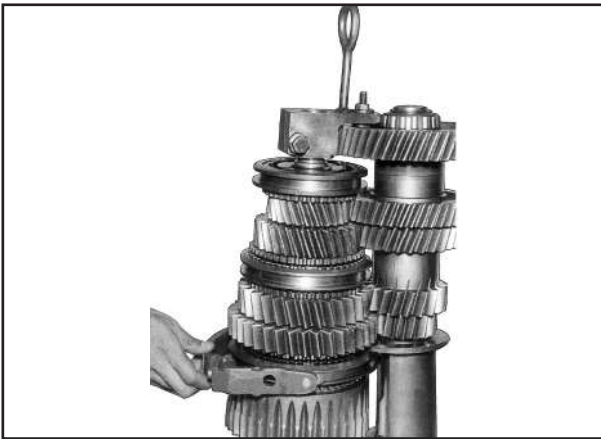


Locate 5th synchro ring in synchro body



Place graded snap ring into clutch body of input shaft and place it on synchro ring.

### 26.2.3 Main Assembly



Position the main shaft and counter shaft assembly together, meshing their respective gears and fit the **Special Tool 0302001 - Lifting Device**.



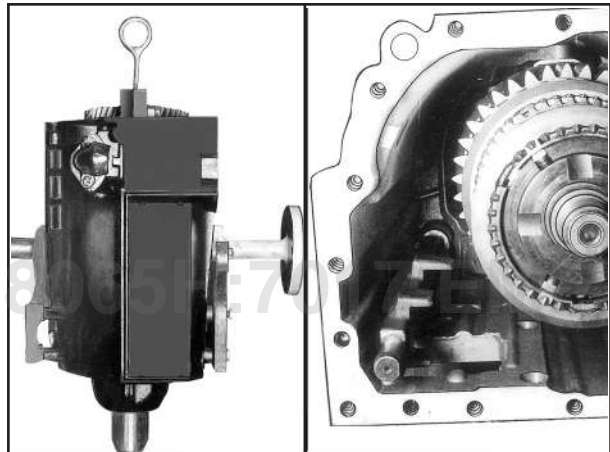
**Use Special Tool 0302015 - Alignment Tool GB Main Counter** to position the counter shaft and main shaft before fixing the lifting device and 1st reverse fork.

Place two wear pads in 1st/Reverse fork (largest) and fit fork on 1st/Reverse sleeve.



Wind a long cord around fork and around the shaft assembly and form a slip knot at the lifting tool.

Fit **Special Tool 0302005 - Centraliser Mainshaft Assembly** on main shaft output end.

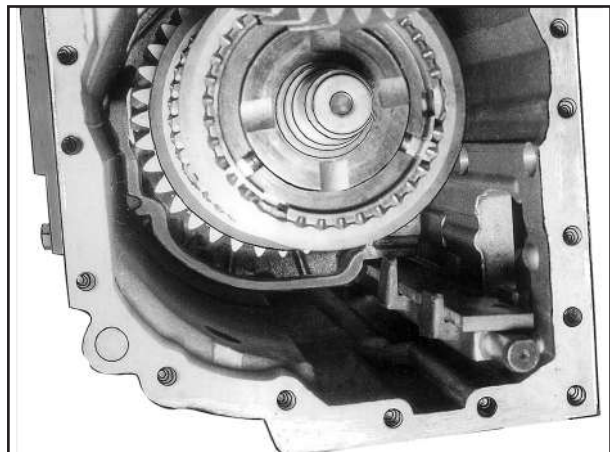


Lift the shaft assembly and lower it into casing. Ensure shafts enter their bore and the assemblies take a perfect seating in their respective bearings. The centraliser on the mainshaft assembly is to be unscrewed.

Remove slip knot on cord and remove cord.

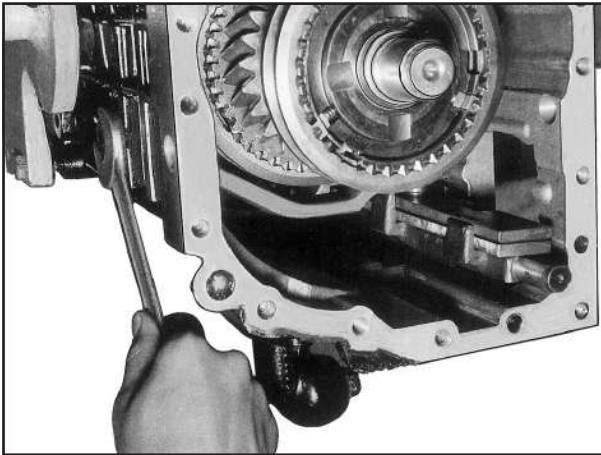
Remove lifting tool

Fit guide rod into its hole in casing.



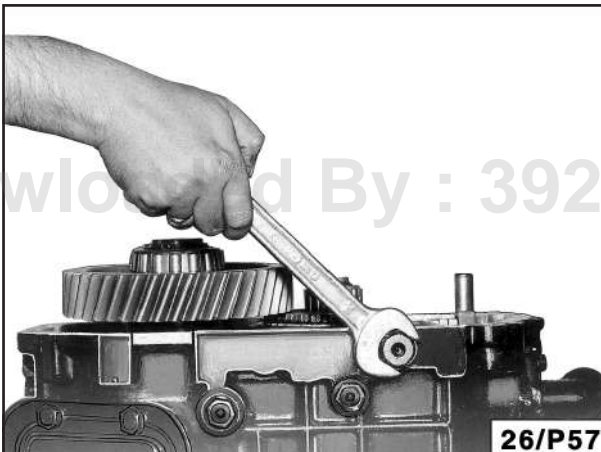
Fit 1st/Reverse thrust plate into guide rod and pull fork towards it, till pin locates in hole of thrust plate.



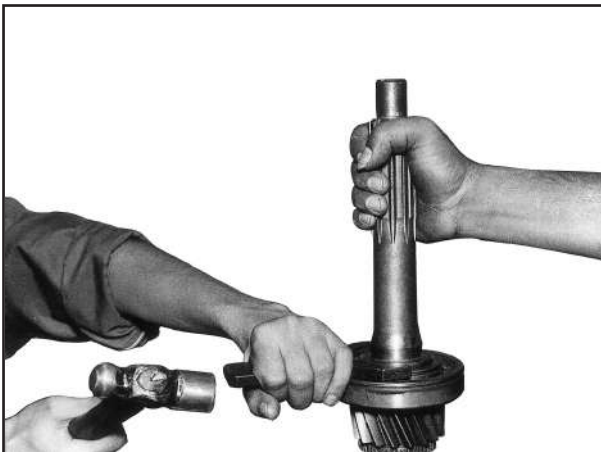


Screw in short hinge bolt through casing into 1st/ Reverse fork. Use spanner only for final tightening. This is to prevent bending of forks.

Fit wear pads in fork ( With longer ball pin) and slide it into 3/2 sliding sleeve. Slip 3/2 shift rod without 'U' slot into guide rod and locate fork ball end in its hole. Fit pivot bolts through casing into fork.



Fit wear pads into 5/4 fork and slide it into sliding sleeve. Slip the thrust rod with 'U' cut out into the selector guide and locate ball pin for fork into the hole of thrust. Screw in hinge bolts.



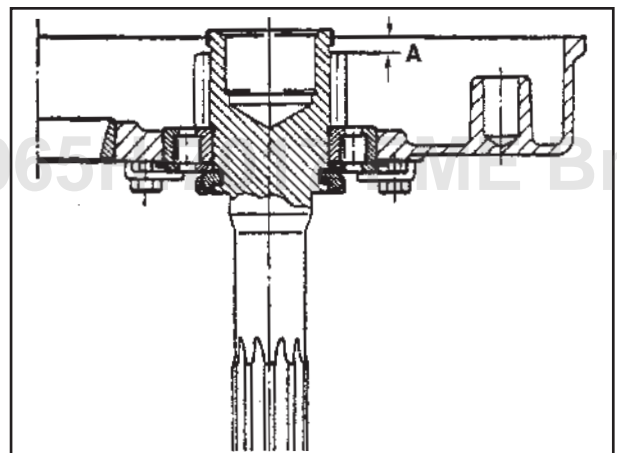
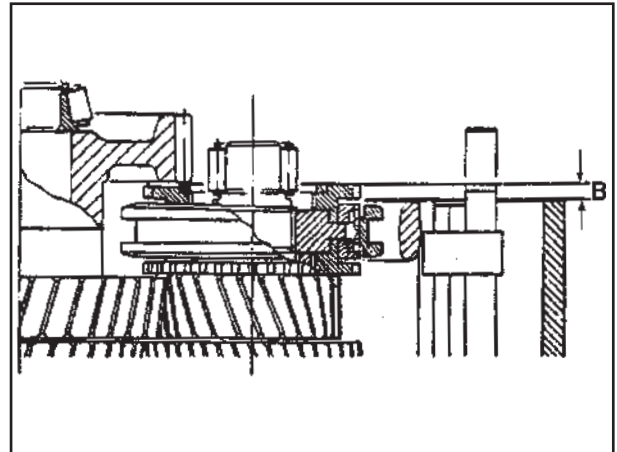
Strike the mainshaft and counter shaft with a plastic hammer downward. Place a gasket on casing.

Press roller bearing on pinion shaft

Select split lock to have firm fit in groove of input shaft and fit. (Preload - 0.05 mm).

Use **Special Tool 0302008 - Drift Split Ring** to ensure proper seating and fit retainer cup. Crimp edge.

**Adjustment of axial clearance between 5th gear clutch body and its synchro ring.**



Fit snap ring on bearing outer race.

Heat connection housing and press in input shaft bearing and outer race for counter shaft.

Fit temporary clips on input shaft bearing outer race to hold snap ring against connection housing.

Measure "A" from seating face of connection housing to the end of the input shaft gear tooth.

Measure 'B' from gear casing to existing graded circlip top surface.

#### Example

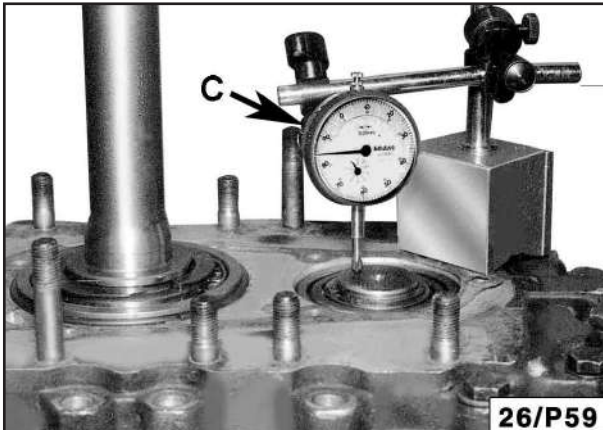
Distance from connection housing to gear tooth	A = 7.5 mm
Distance from gear casing to seating graded circlip	B = 6.0 mm
Difference (A - B)	1.5 mm
Minus Required clearance	0.9 - 1.2 mm
Graded washer to be thicker by	0.3 - 0.6 mm

Remove existing graded washer and replace accordingly.  
 Fit roller bearing cage on main shaft  
 Fit connection housing  
 Drive in dowel pins, screw in bolts and torque tighten.  
 Fit gasket for connection plate.

#### Adjustment for Axial Float of Counter Shaft

Tap in outer race of bearing

Measure distance 'C' from gasket to top of bearing outer race



#### Example

Distance C = 2.55 mm

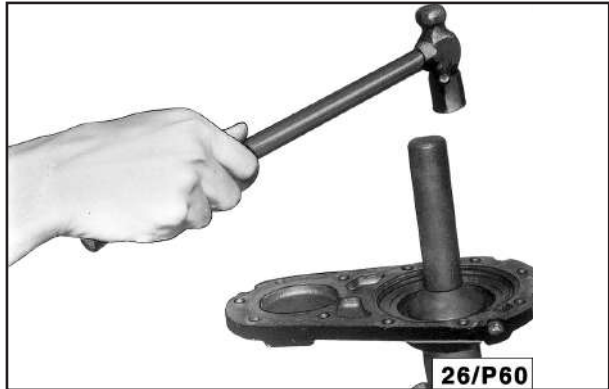
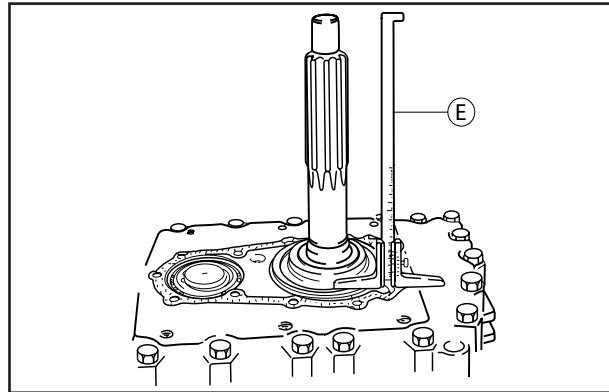
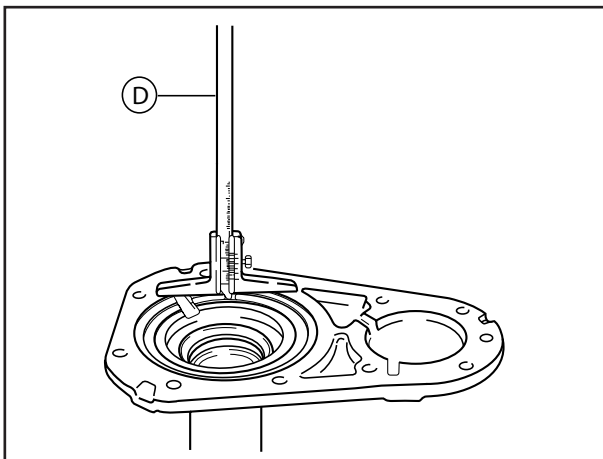
Minus gasket setting distance = 1.03 mm

Minus average of required clearance of 0 - 0.1 mm = 0.05 mm

Place a shim of this thickness on bearing outer race. =  $1.47 \pm 0.05$  mm

#### Adjustment of axial clearance for input shaft bearing.

Measure at connection plate distance 'D' from joint face to contact surface for bearing outer race. Drive back outer race of input bearing until snap ring abuts free of play. Fit gasket to connection housing. Measure distance 'E' from bearing outer race to gasket. The size of correct shim is calculated as follows:



#### Example

Distance of connection housing seating face to contact face for bearing "D" = 6.5 mm

Distance from bearing to gasket "E" = 4.8 mm

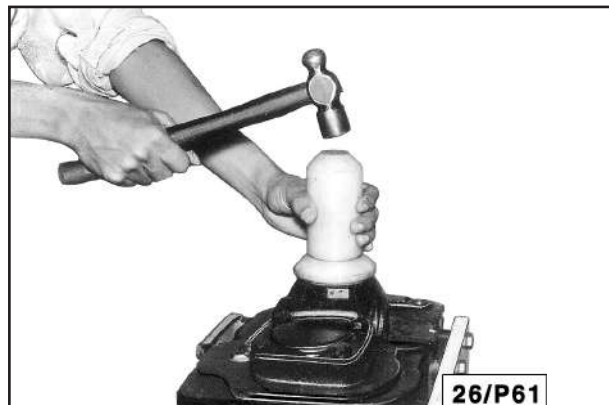
Minus distance from gasket to bearing "(D-E)" = 1.7 mm

Minus gasket setting distance = 0.03 mm

Minus average of required clearance of 0 to 0.1 mm = 0.05 mm

Place a shim of this thickness on outer race of bearing =  $1.62 \pm 0.05$  mm

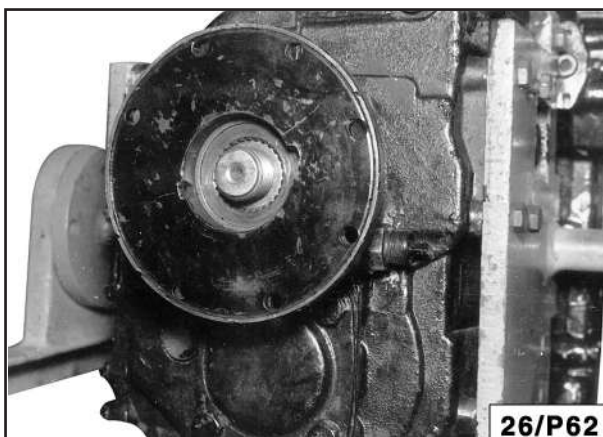
Apply a thin coat of sealing compound on outer wall of oil seal and press into bore of connecting plate. Lubricate the tip of the seal. Use **Special Tool 0302009 - Drift Front Oil Seal.**



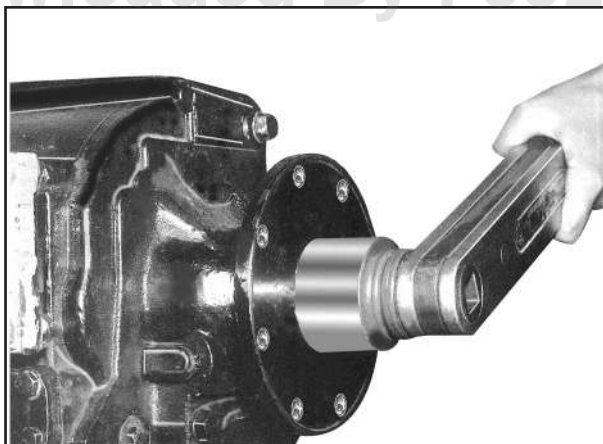
Fit connecting plate to connection housing with mainshaft & counter shaft bearing shims.



Fit new 'O' ring on reverse idler shaft.  
 Fit needle bearing cage into reverse idler gear.  
 Insert gear through opening in casing and position it.  
 Insert idler spindle through rear of casing into gear.  
 Lock spindle with plate washer and screw  
 Fit cover with gasket  
 Invert casing on stand  
 Fit third piece of rear end roller bearing on shaft  
 Fit speedo meter gear on output shaft  
 Fit oil seal using **Special Tool 0302006 - Drift Rear Oil Seal** at specified depth (7 mm).



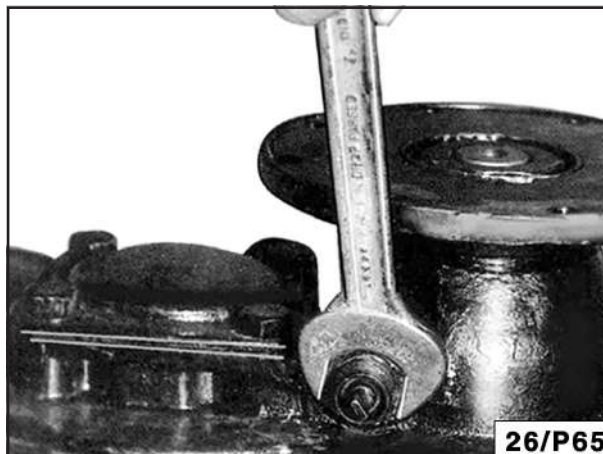
Lubricate seal lip. Heat (120°C) and fit output flange.



Screw on flange nut. Engage any two gears and torque nut.

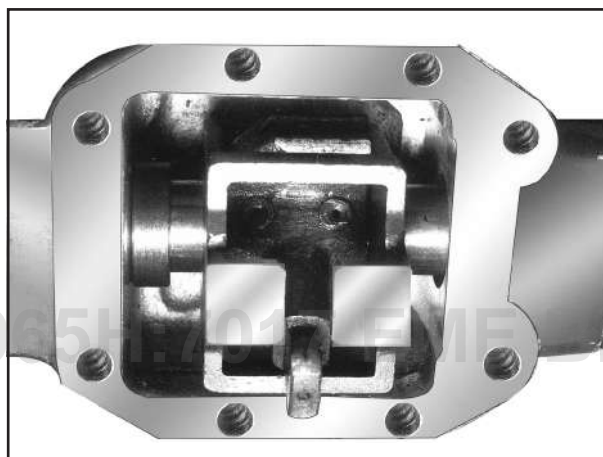


Fit and lock retaining cup



Fit speedo output gear

### 26.2.3.0 Sub Assembly of Selector Casing



Chill and press bushes for selector rod into casing.  
 Lubricate them, Fit oil seal.



**Use Special Tool 0302002 - Drift Selector Shaft Bush, Special Tool 0302003 - Adaptor and Special Tool 0302004 - Protective Sleeve for fixing the Bushes and Oil seal.**

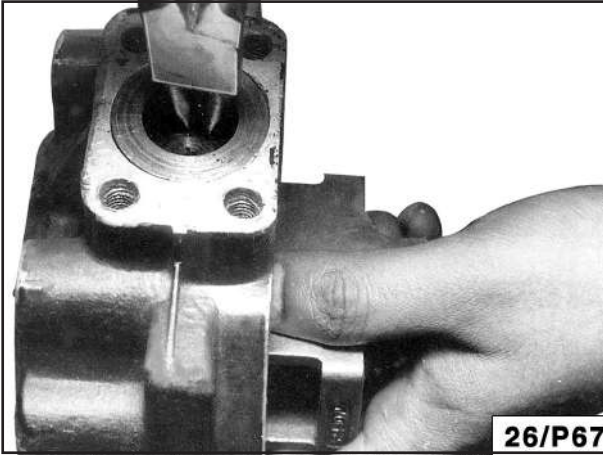
Insert stepped end of selector shaft into casing.

Fit spacer on stepped end of shaft inside casing.

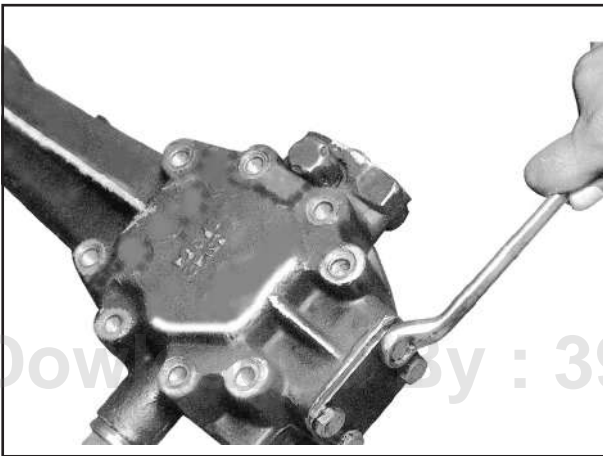
Position striking finger, inside locking plate and lower them into casing and insert shaft through them.

Fit the two sets of cylindrical locking pins through striking finger and shaft.



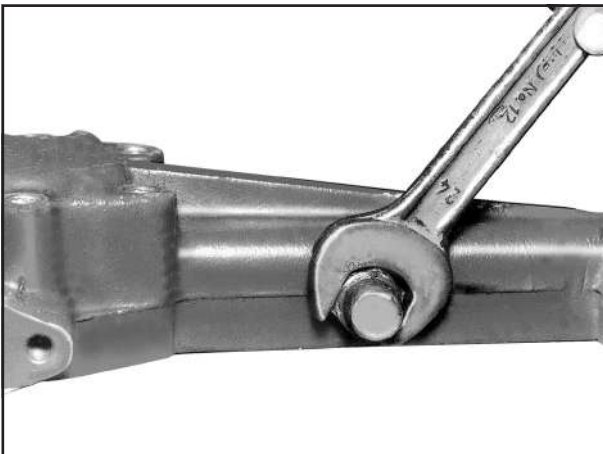


Fit washer on shaft through external bore followed by spacer and spring.

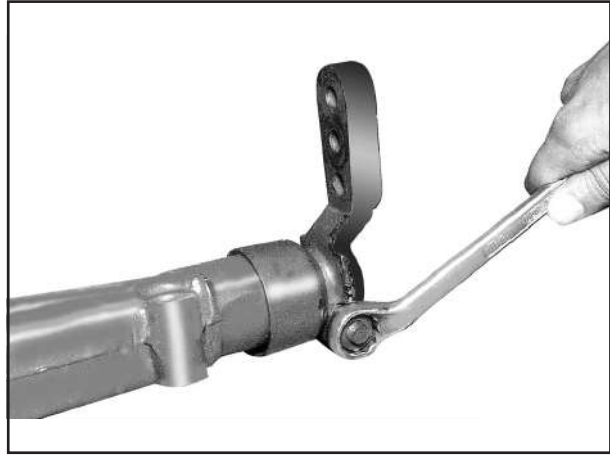


Fit end cover.

Fit detent assembly and plugs.



Fit selector casing with gasket on gearbox.



Position and fit lever on splined end of selector shaft.

Fit filler and drain plug on casing.

Fit reaction linkage. Refer page 26.21 for linkage setting drawings.

### 26.3 TO OVERHAUL S6-36 GEAR BOX

The procedure involved in overhauling the S6-36 gear box is similar to S5-36 except for the following changes.

The 4th & 5th synchro pack becomes 5th & 6th.

The 2nd & 3rd synchro pack becomes 3rd & 4th.

The 1st & Reverse synchro pack becomes 1st & 2nd.

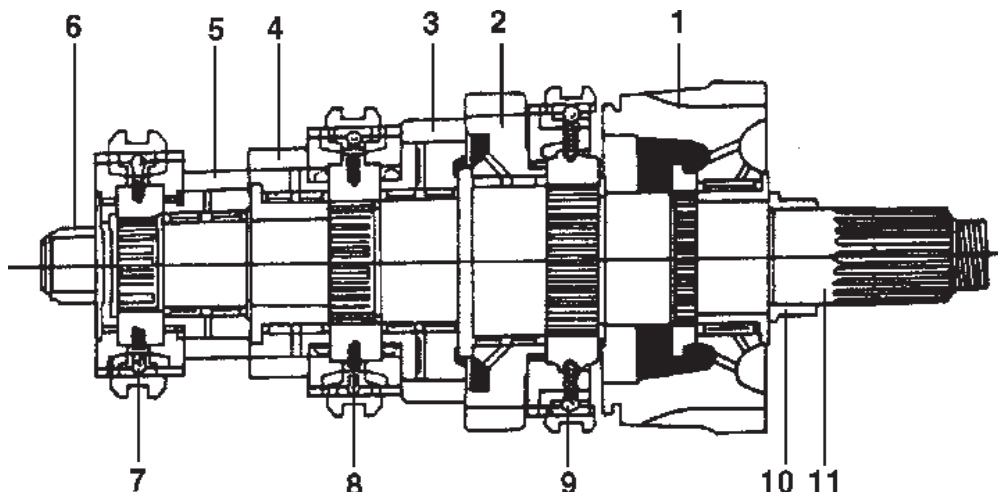
There is one additional shift fork for reverse gear to slide mesh the reverse gear. The set of split rings of **Special Tool 0302007 - Puller Main Shaft Gears** is required to dismantle the main shaft assembly are different from S5-36 gear box.

For easy comparison, mainshaft cut section views of S5 36 as well as S6 36 gear boxes are shown below.

### 26.4 TO OVERHAUL S6-36 OD GEAR BOX

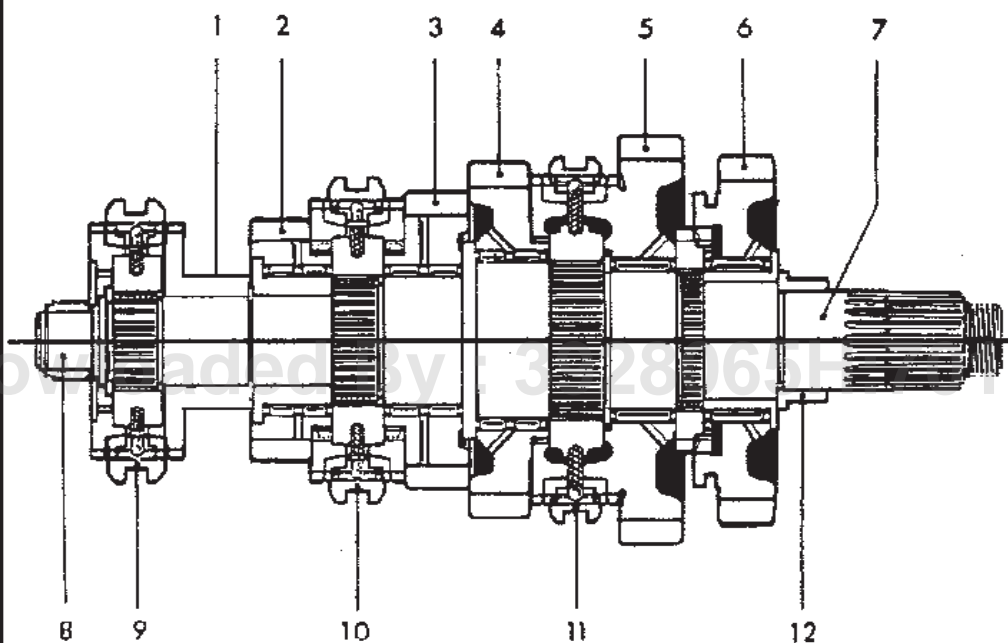
The procedure involved in overhauling the S6-36 OD gear box is similar to S6-36 except for the following changes.

The 4th & 5th synchro pack becomes 5th & OD (6th).



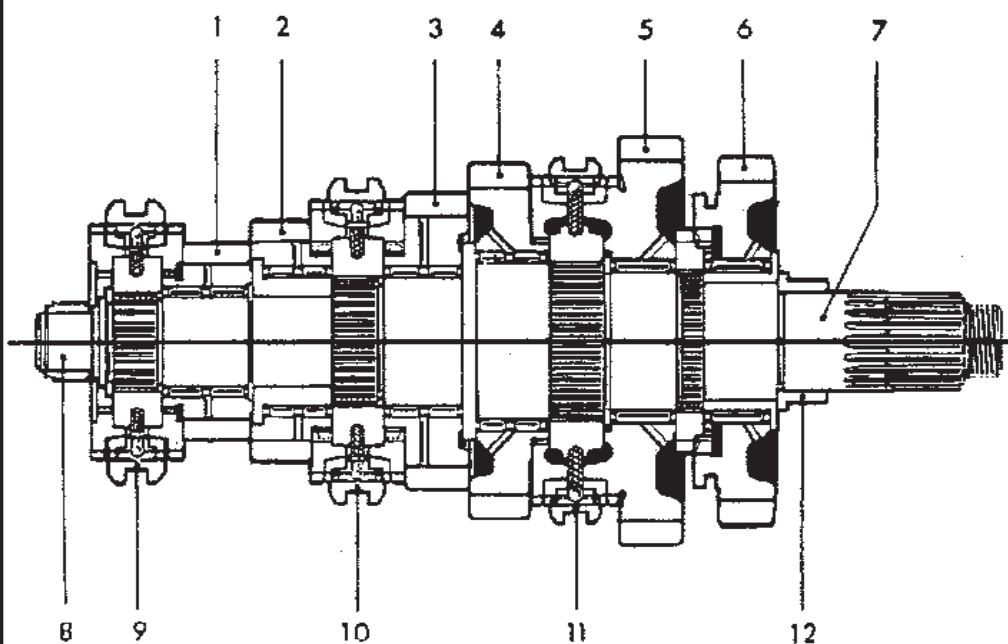
Main Shaft Section View S5-36 MK I

1. Reverse Gear
2. 1st Gear
3. 2nd Gear
4. 3rd Gear
5. 4th Gear
6. Spigot Bearing
7. 4th / 5th Synchro Pack
8. 2nd / 3rd Synchro Pack
9. 1st / Rev. Synchro Pack
10. Main Shaft Rear Bearing
11. Main Shaft



Main Shaft Section View S5-36 MK II

1. Bush on Main Shaft
2. Fourth Gear
3. Third Gear
4. Second Gear
5. First Gear
6. Reverse Gear
7. Main Shaft
8. Spigot Bearing
9. 5th/6th Synchro Pack
10. 3rd/4th Synchro Pack
11. 1st/2nd Synchro Pack
12. Mainshaft Rear bearing Inner Race



Main Shaft Section View S6-36 and S6-36 OD (MK I & II)

1. Fifth Gear/OD Gear
2. Fourth Gear
3. Third Gear
4. Second Gear
5. First Gear
6. Reverse Gear
7. Main Shaft
8. Spigot Bearing
9. 5th/6th Synchro Pack
10. 3rd/4th Synchro Pack
11. 1st/2nd Synchro Pack
12. Mainshaft Rear bearing Inner Race

26.5 TIGHTENING TORQUES	kgm	lb.ft	Nm
Hexagon nut on output flange	37	266	360
Speedo connection	10	74	100
For screw plug M 24 x 1.5 (oil filler and oil control plugs) in housing.	6	44	60
For screw plug M 20 x 1.5 for detent element on selector housing.	5	37	50
For reversing light switch M18 X 1.5	4.5	33	45
For Pawl limit M 16 X 1.5 in selector and gearbox housings.	4	30	40
For breather M 10 X 1	1	7.5	10
Setscrew pinion shaft bracket	2.5	18	25
Hinge bolt for selector fork	16	118	160
Setscrew selector Housing	2.3	17	23
Setscrew countershaft cover	8	58	79
Setscrew reverse idler cover	2.3	17	23
Clutch housing nut	8	58	79
PTO cover set screw	4.6	34	46

## 26.6 RECOMMENDED LUBRICANTS

Aggregate	Ambient Temp. °C	Co-branded Lubricant	Approved Lubricant
		Gulf Oil India	Indian Oil Corporation
Gear box Synchromesh (S536 and S636) for all applications other than those mentioned separately below	-25	Gulf Gear XP Dura Max 80W-90	Servo Gear ALT80W-90(LL)
Gear Box Synchromesh (S636) for 2518 Tipper	-10	Tipper Guard Max 85W - 140	-

NOTE : Do not mix lubricants of different brands/grades.

## 26.7 FILLING CAPACITY

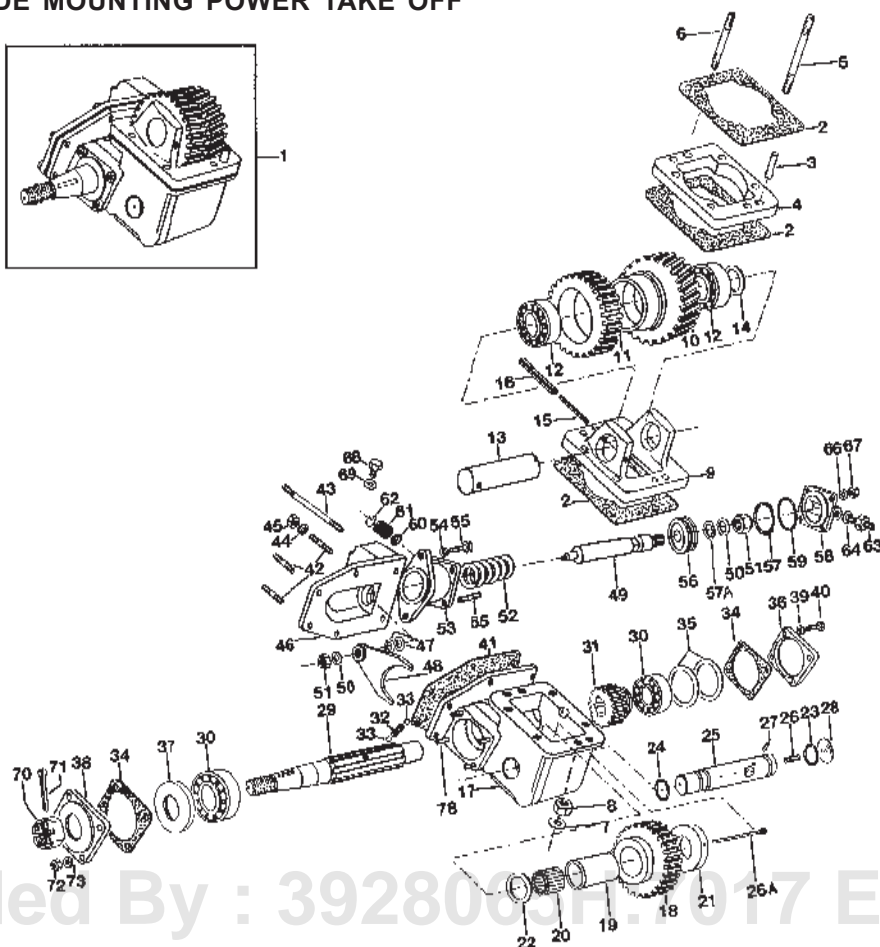
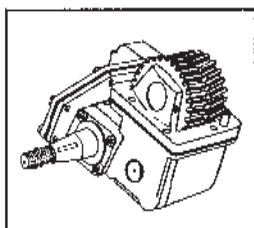
Aggregates	Filling Capacity (ℓ)
ZF S5-36, S6-36 and S6-36 OD	6.5
ZF S5-36, S6-36 with Power Take Off	7.5

## 26.8 MAINTENANCE SCHEDULE

S.NO	MAINTENANCE ACTIVITY	PDI	Daily	Weekly	Every km x 1000	Remarks
<b>A</b>	<b>Lubrication</b>					
1	Lubricate gear shift ball joints					
	For Tippers	✓		✓		
	For all other applications	✓				Monthly
2	Check oil level, top up and clean breather				8	
3	Change oil when hot. Refill upto correct level - <b>For all applications other than Tippers</b>				120	For intra city & intercity applications
4	Change oil when hot. Refill upto correct level - For Tippers				1000 Hrs	
<b>B</b>	<b>Maintenance</b>					
1	Check for correct operation of gear shift linkage and setting				8	
2	Check tightness of clutch housing mounting bolts				16	
3	Check and tighten output flange nut				24	



## 26.9 ZF - SIDE MOUNTING POWER TAKE OFF

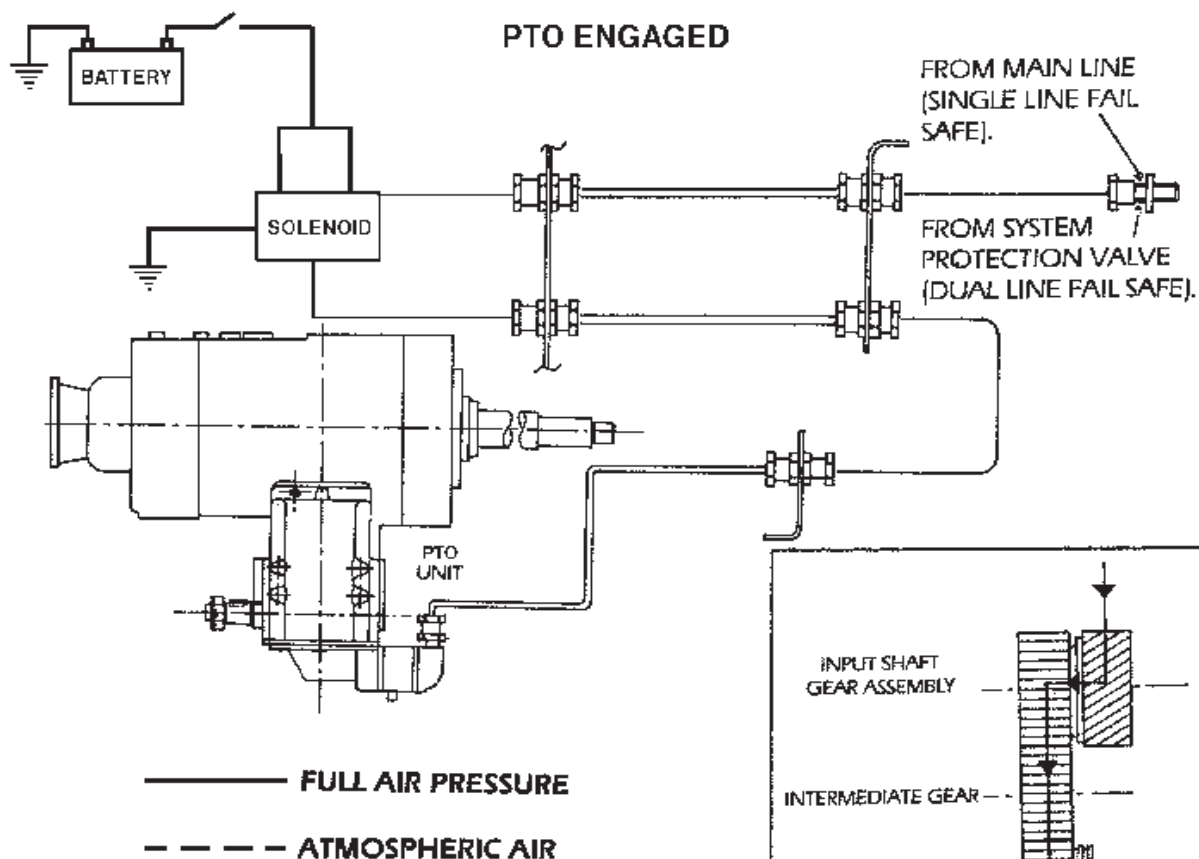
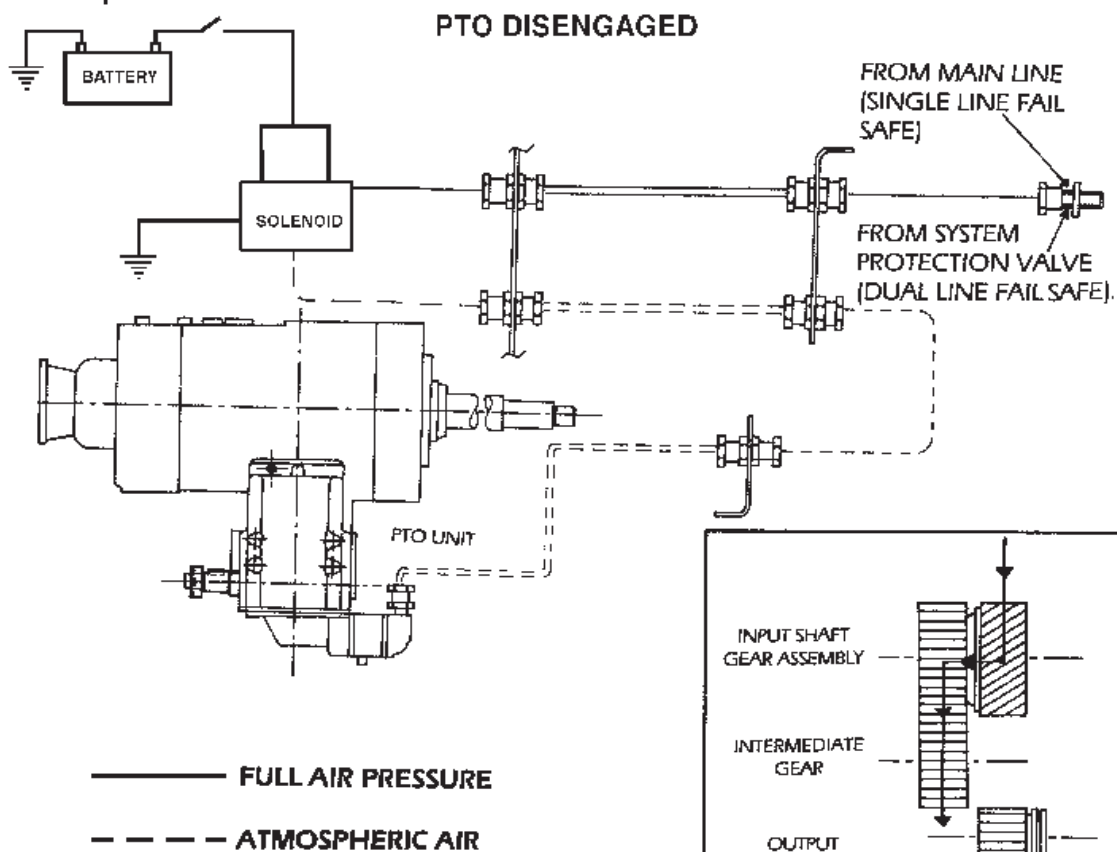


Ill. No.	Description	Qty.	Ill. No.	Description	Qty.
1	Assy of power take off		37	Oil seal - Output shaft	1
	<b>* Input Shaft Group Comprises</b>		38	Oil seal housing	1
2	Joint	3	39	Washer	4
3	Dowel	2	40	Bolt M8 x 1.25 x 20 long	4
4	Distance piece	1		<b>Selector Group Comprises of:</b>	
5	Stud M10 (long)	4	41	Joint-Selector Casing to PTO Casing	1
6	Stud M10 (Short)	2	42	Stud M8 (Short)	4
7	Double coil washer dia 10	6	43	Stud M8 (long)	2
8	Nut M10 x 1.25	6	44	Double coil washer	6
	<b>* S/A of brkt for input shaft comprises of:</b>		45	Nut	6
9	Brkt for input shaft	1	46	Selector casing	1
10	Input helical gear	1	47	O' Ring	2
11	Input spur gear	1	48	Selector fork	1
12	Taper roller bearing	2	49	Selector shaft	1
13	Input shaft	1	50	Washer 3/8" dia	2
14	Select washer (6 sizes available)	1	51	Simmonds nut	2
15	Roll pin	1	52	Spring-selector housing	1
16	Roll pin	1	53	Shift cylinder body	1
	<b>* Driver Casing Group Comprises of:</b>		54	7/16" dia double coil washer	2
17	PTO drive casing	1	55	Setscrew 7/16" BSF x 7/8" long	2
18	Intermediate gear	1	56	Piston-shift cylinder	1
19	Sleeve	1	57	Piston 'O' ring	1
20	Needle roller bearing	2	57A	Push rod grommet	1
21	Distance piece	1	58	Shift cylinder cover	1
22	Thrust washer	1	59	Shift cylinder grommet	1
23	O' ring	1	60	Strainer plate	2
24	O' ring	1	61	Nylon strainer	1
25	Intermediate shaft	1	62	Strainer plate retainer	1
26	Plug in shaft	1	63	Adaptor 1/4" to 1/8" BSP	1
26A	Split pin 3 dia x 70 long	1	64	Washer	1
27	Locking screw	2	65	Stud	4
28	Welch washer	1	66	Washer 1/4" dia	4
29	Output shaft	1	67	Nut plain	4
30	Taper roller bearing	2	68	Plug	1
31	Output gear	1	69	Washer	1
32	Spring-output shaft	1	70	1/2" BSP Nut	1
33	Ball 5/16" dia-Output shaft	2	71	Split pin	1
34	Joint-Cover front	2	72	Nut	4
35	Shim (4 sizes available)	AR	73	Washer	4
36	Cover front	1	78	Stud	4

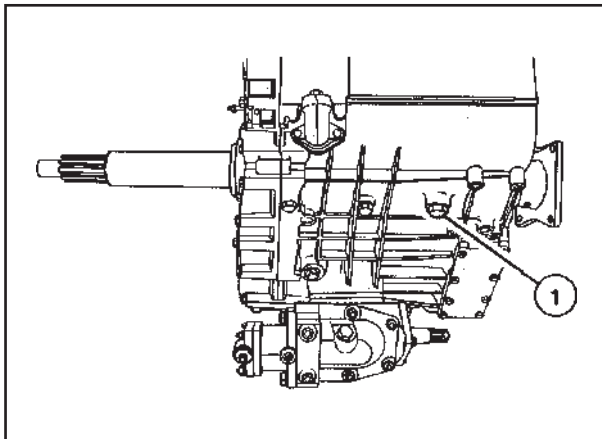
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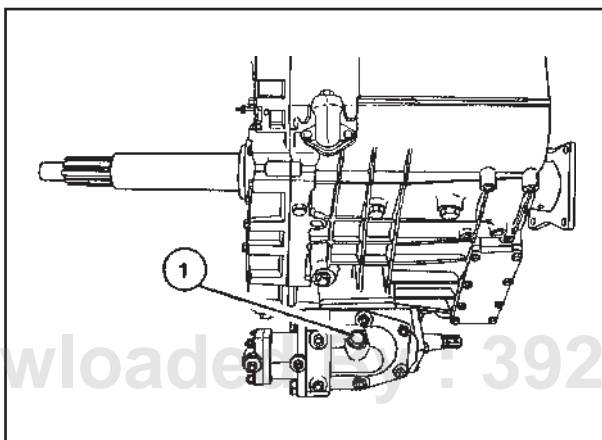
## 26.9.0 PTO Operation



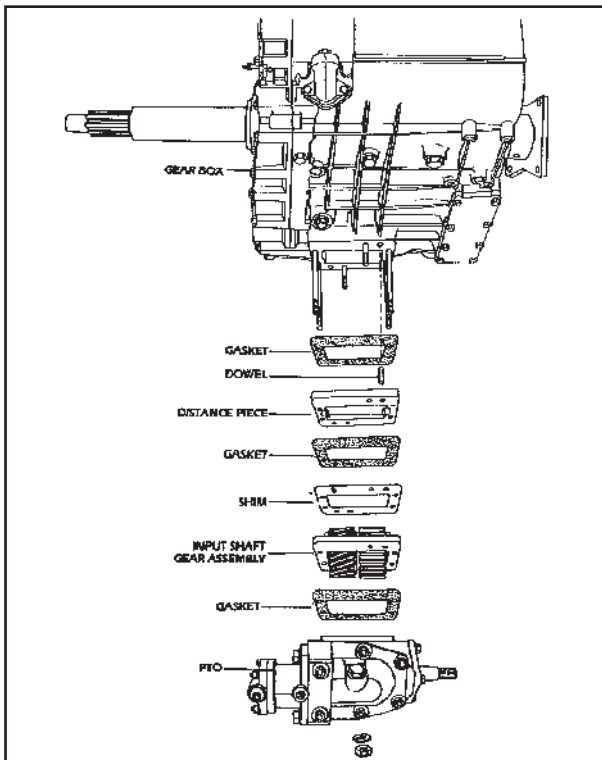
### 26.9.1 Disassembly



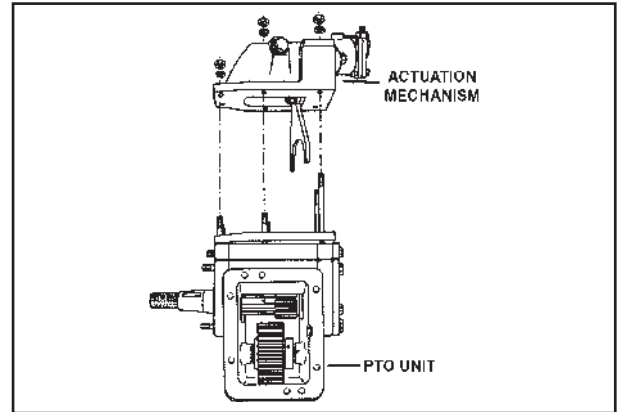
1. Drain oil from gear box by removing plug 1.



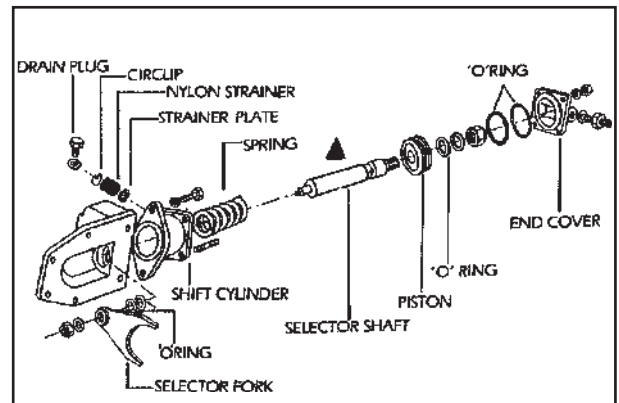
2. Drain oil from PTO unit by removing plug 1.



3. Remove PTO unit from gear box.

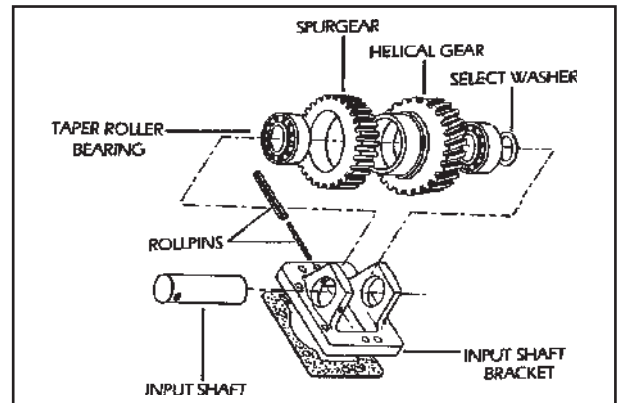


4. Remove actuation mechanism from PTO.

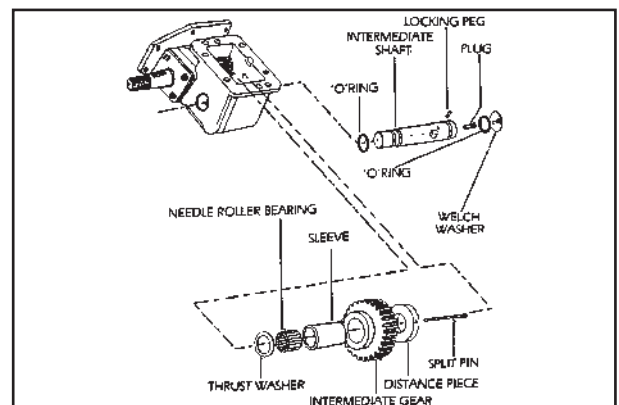


5. Dismantle actuation mechanism.

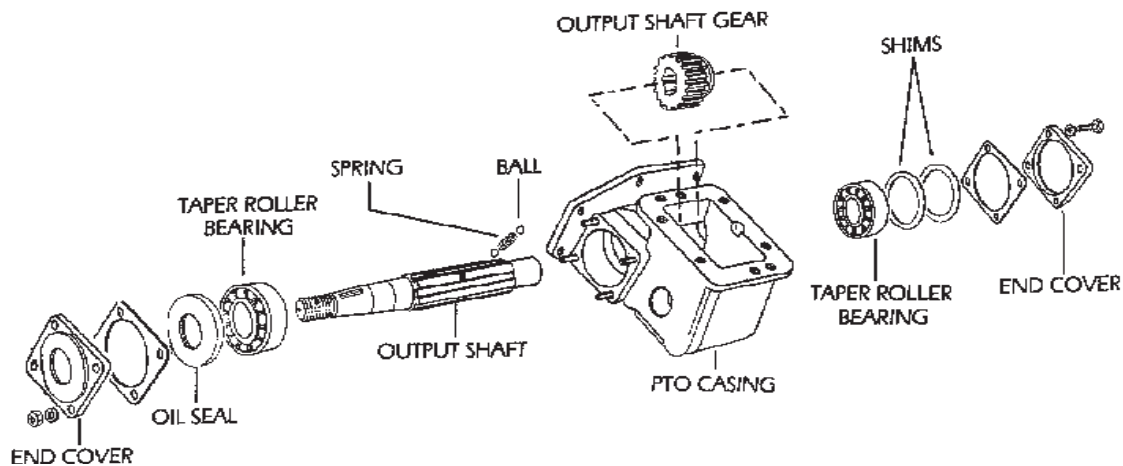
- Square section provided in selector shaft for spanner accessibility to facilitate removal of piston nut.



6. Dismantle input shaft assembly.



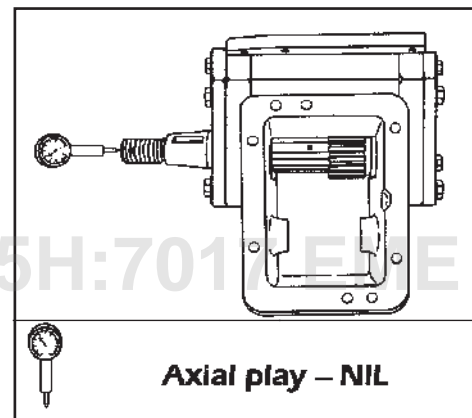
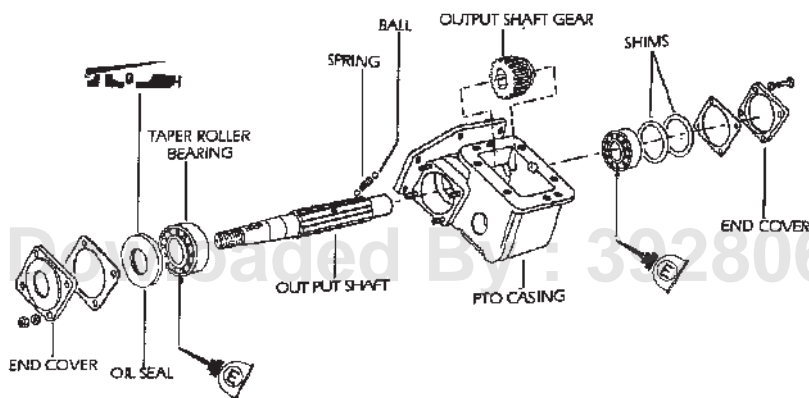
7. Dismantle intermediate shaft assembly



8. Dismantle output shaft assembly.

### 26.9.2 Assembly

#### Output Shaft Assembly

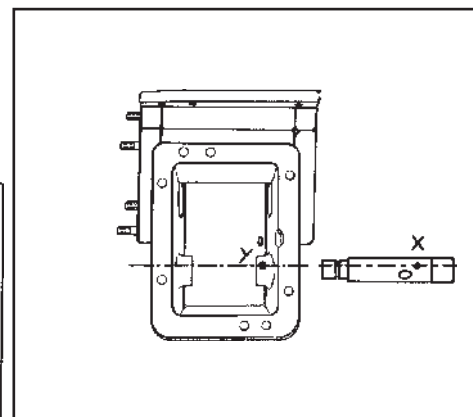
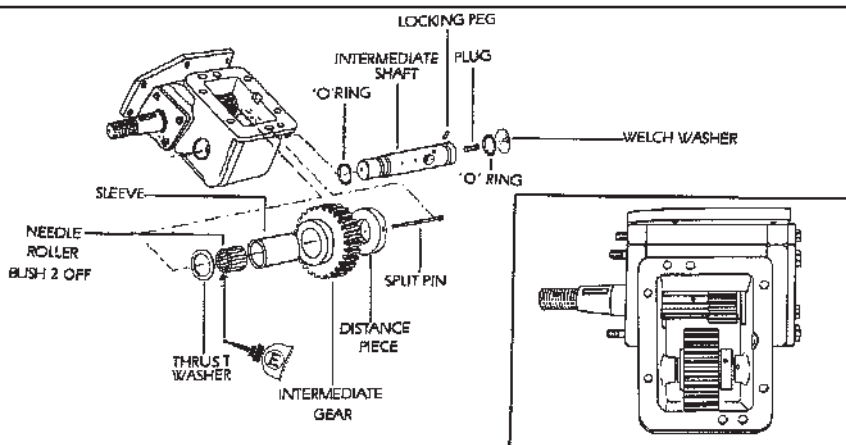


Check Output Shaft end play. Using shims at bearing rear end cover ensure nil axial play.



Check and ensure free rotation of out put shaft.

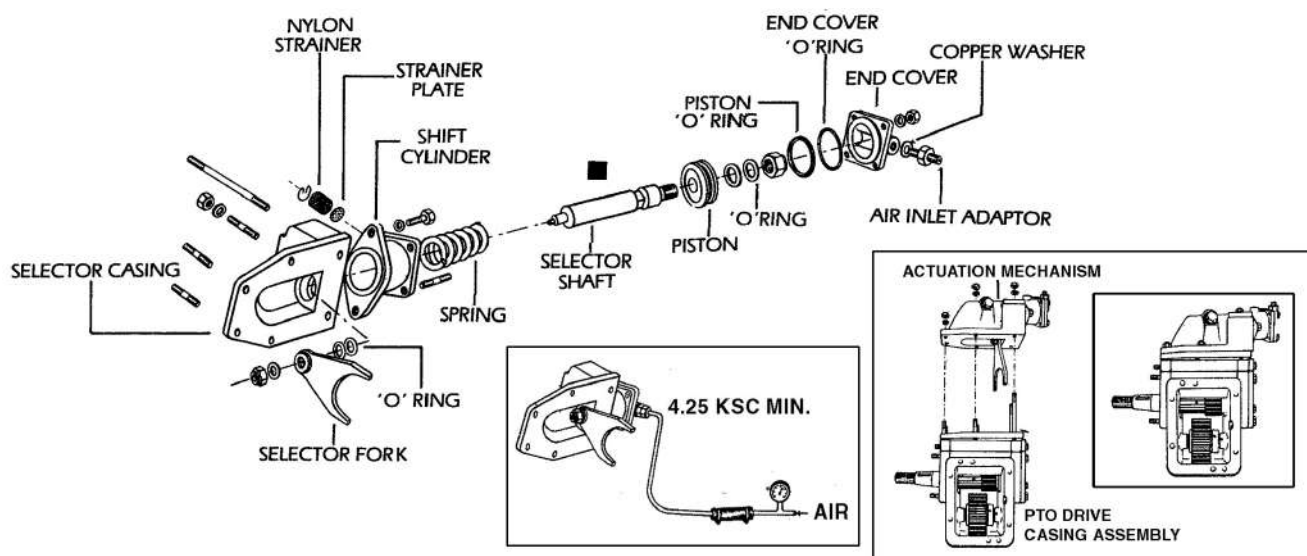
#### Intermediate Shaft Assembly



Check while inserting intermediate shaft ensure that the locking peg hole on the shaft 'X' and on the housing 'Y' are in line as shown.



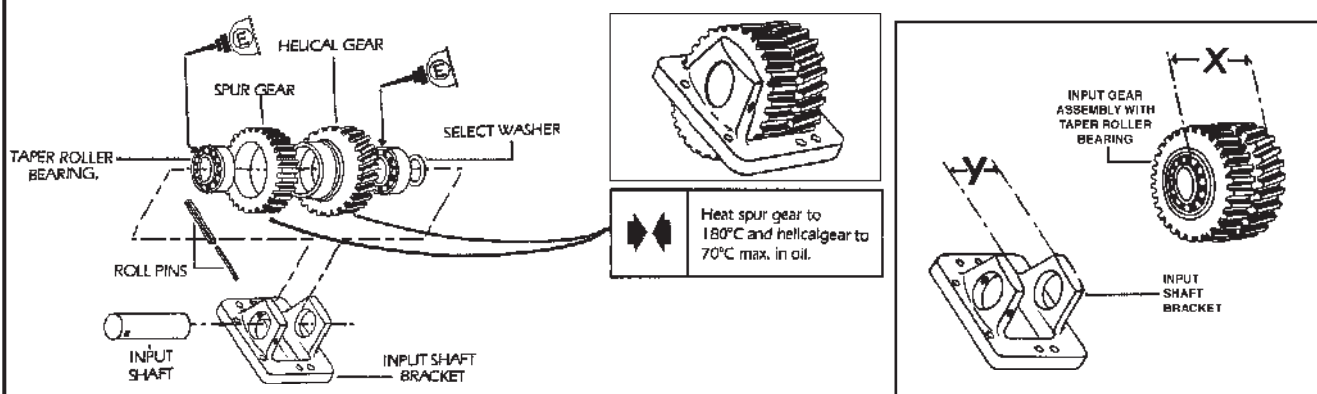
Ensure proper seating of 'O' rings. Welch washer to be punched. Sleeve and bush to be press fitted and not to project beyond gear face.

**Actuation Mechanism**

Check and ensure the 'O' ring grooves are free from foreign particles.

Square section provided in selector shaft for spanner accessibility to facilitate removal of piston nut  
Check Actuation Mechanism for air leaks.

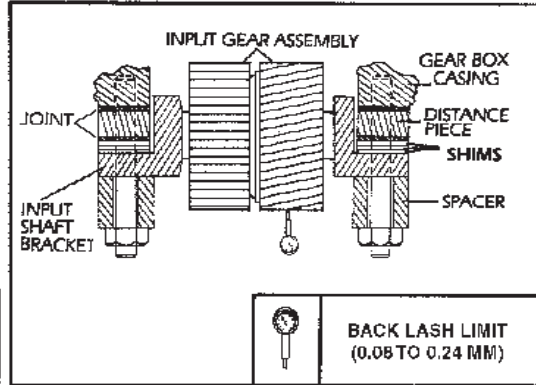
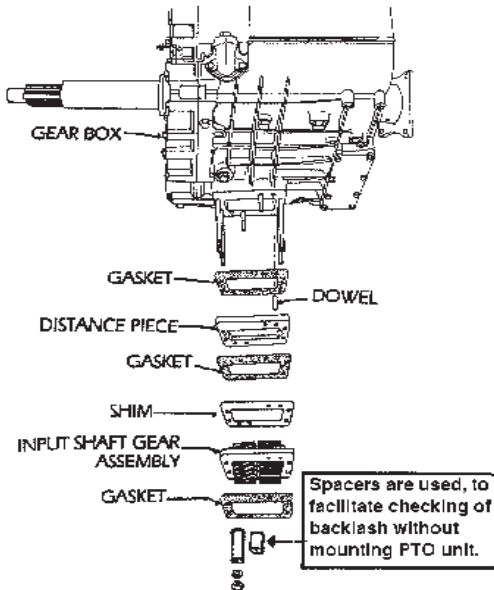
Assemble Actuation Mechanism on to PTO drive casing assembly.

**Input Shaft Assembly****Selection of washer**

- Measure 'X' and 'Y'
- Thickness of Washer =  $Y - X$   
select the nearest large washer

Allowable axial play = 0 - 0.001"

## Shim Selection for Input Shaft Bracket

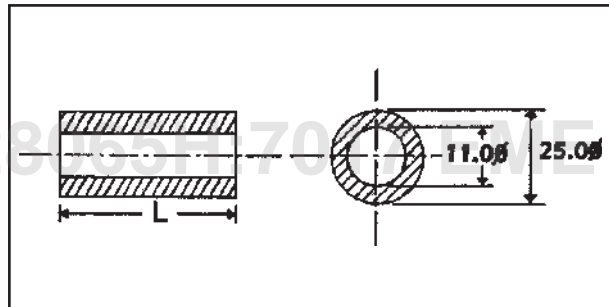


Before checking backlash ensure mounting nuts are torqued to  $5 \pm 0.5$  kgm.

## Spacer specifications

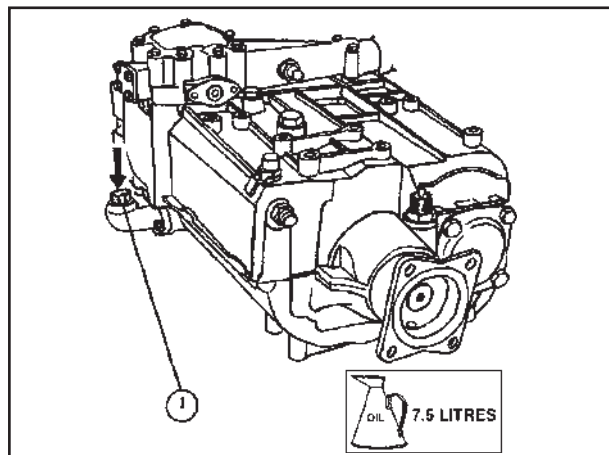
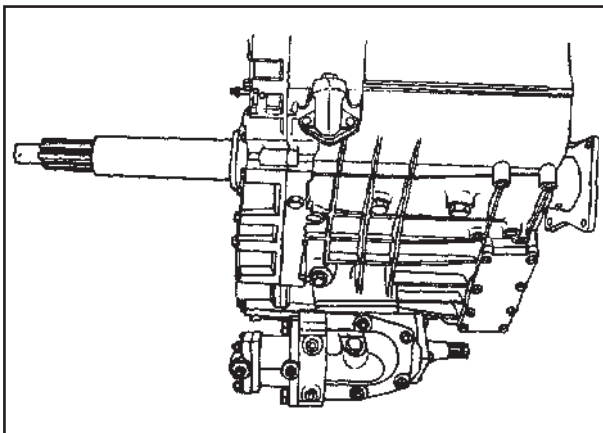
Spacer Type 'L' (mm) Qty.

Spacer Type	"L"(mm)	Qty.
A	105.0	4
B	11.5	2



For optional fitment of PTO, PTO units will be supplied with preselected shims. For distance piece selection, refer mounting parts matrix and stud matrix.

## Assemble PTO unit on to Gear box



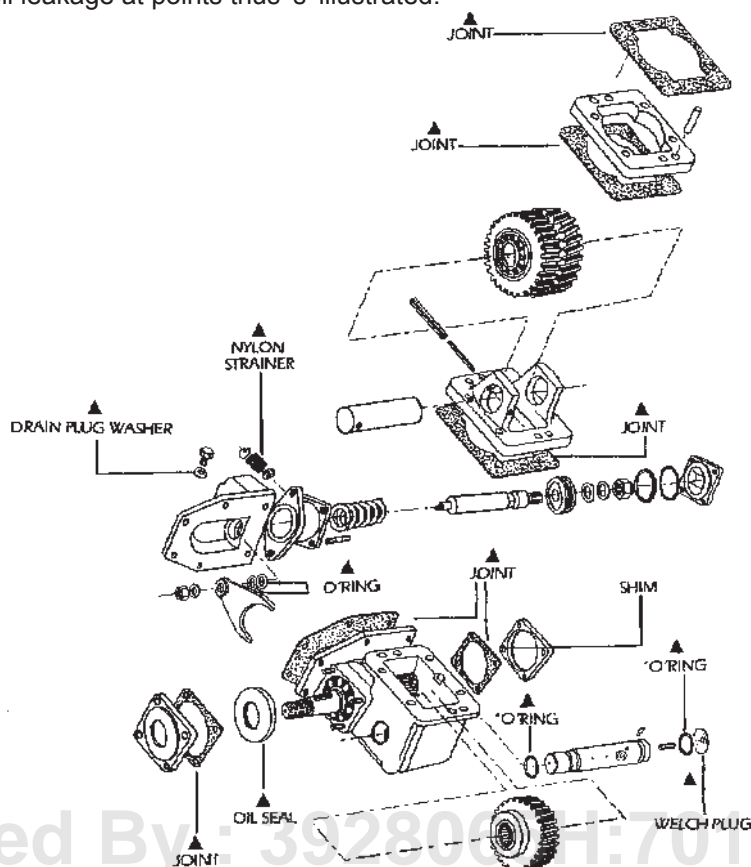
Fill Gear box oil through plug (1)

Gear box (without PTO)  
oil capacity : 6.5 litres

PTO oil capacity : 1 litre.

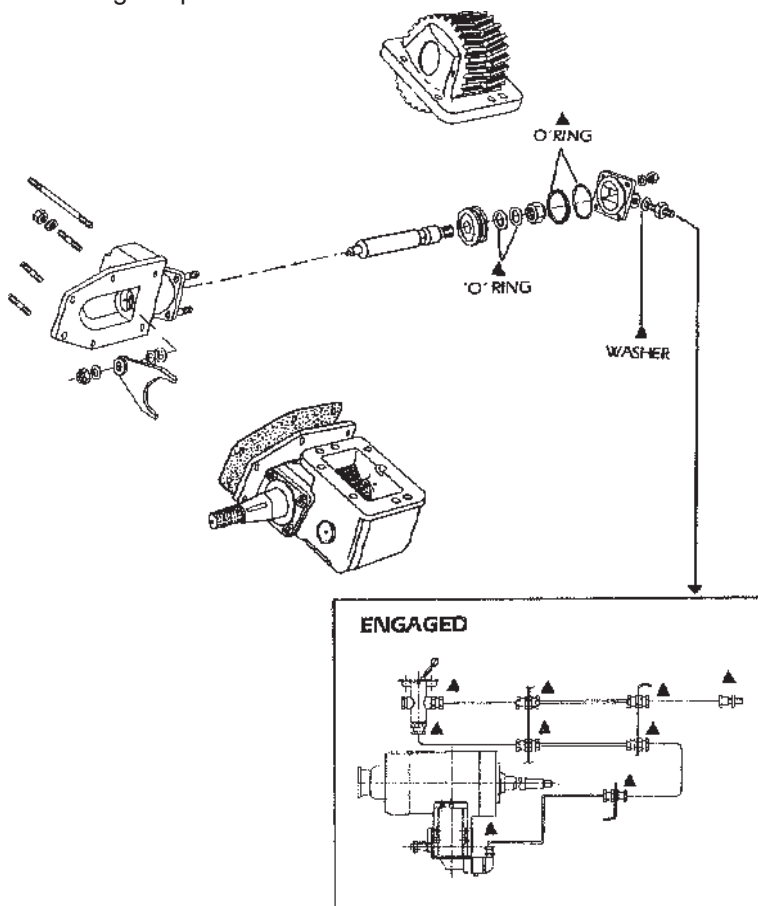
**26.9.3 Maintenance**

1. Check for oil leakage at points thus 's' illustrated.



Replace Seal, 'O' ring, joints to arrest leakage.

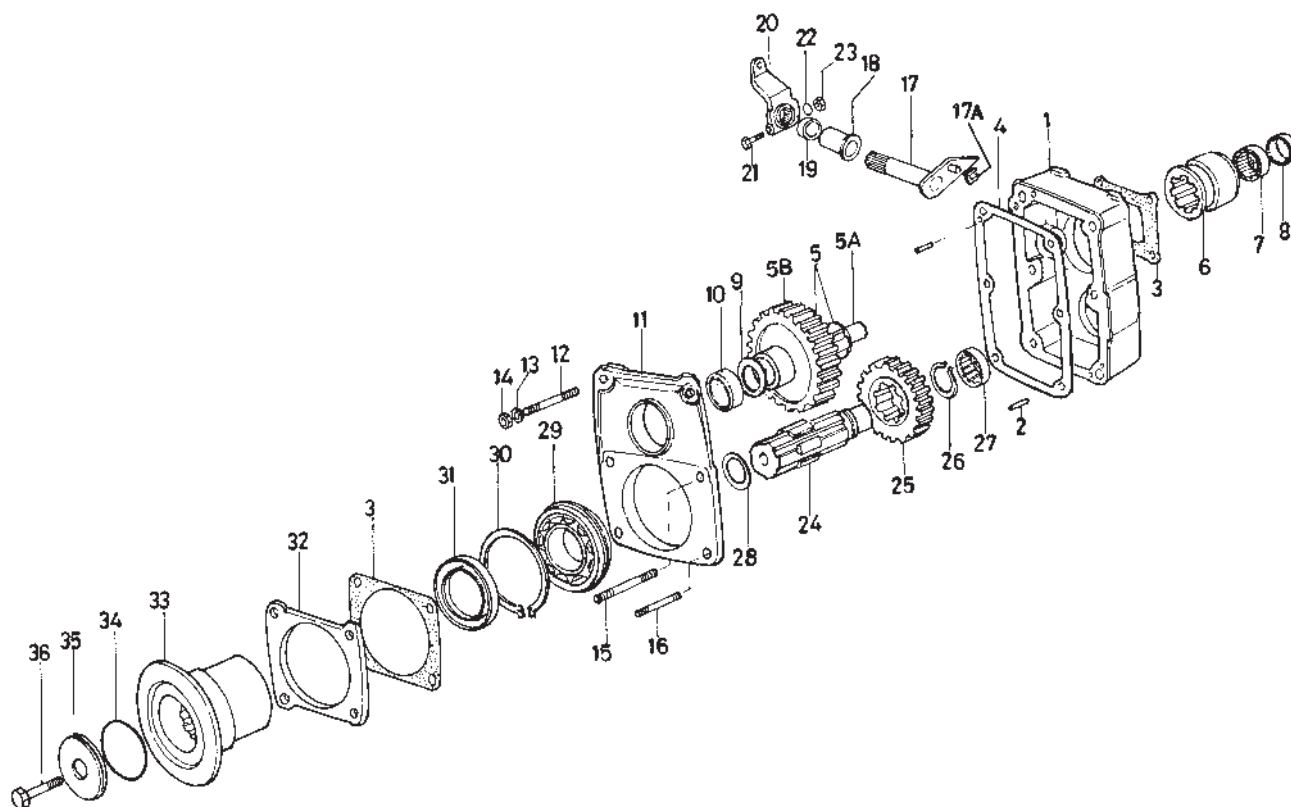
2. Check for air leakage at points thus 's' illustrated.



Tighten pipe end fittings /  
Replace 'O' ring, washer to arrest  
leakage.



## 26.10 REAR MOUNTING POWER TAKE OFF



Representative Diagram - Rear Mounting PTO

ILL. NO.	DESCRIPTION	QTY.
1	PTO HOUSING	1
2	DOWEL	2
3	JOINT (PTO HSG TO GEAR/C& COVER TO OIL SEAL HSG)	2
4	JOINT (PTO COVER TO PTO HSG)	1
5	S/A OF INPUT SHAFT	1
5A	INPUT SHAFT	1
5B	INPUT GEAR	1
6	SLIDING DOG SLEEVE	1
7	NEEDLE CAGE	1
8	PLUG	1
9	LOCK WASHER	1
10	NEEDLE BUSH (ONE END CLOSED TYPE)	1
11	PTO COVER	1
12	STUD M12X1.5 105 LONG	2
13	KOLOK WASHER 12mm DIA	6
14	NUT M12X1.5	6
15	STUD M12X1.5 125 LONG	2
16	STUD M12X1.5 60 LONG	2
17	ACTUATOR SHAFT	1
17A	WEAR PAD	1
18	COLLARED BUSH	1
19	OIL SEAL	1
20	ACTUATOR LEVER	1
21	SETSCREW M8X1.25 35 LONG	1
22	WASHER KOLOK M8 DIA	1
23	NUT M8X1.25	1
24	OUTPUT SHAFT	1
25	OUTPUT GEAR	1
26	CIRCLIP	1
27	NEEDLE BUSH ONE END CLOSED	1
28	WASHER - OUTPUT SHAFT	1
29	BALL BEARING WITH SNAP RING	1
30	CIRCLIP 80X2.5	1
31	OIL SEAL-OUTPUT FLANGE	1
32	OIL SEAL HOUSING	1
33	OUTPUT FLANGE	1
34	'O' RING	1
35	SPECIAL WASHER	1
36	LOCKING BOLT M12X1.75	1

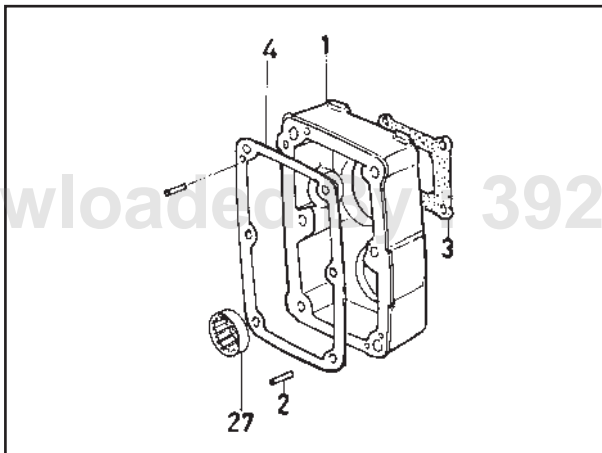
### 26.10.0 Dismantling

Drain oil from gear box by removing drain plug.  
Disconnect the actuation mechanism linkage from actuation lever.  
Loosen and remove PTO mounting nuts (14).  
Remove PTO assembly from gear box rear end.  
Drain the left out oil from the PTO.  
Loosen flange locking bolt (36) and remove locking bolt / flange (33).  
Dismantle the oil seal housing, PTO cover, output shaft, input shaft assembly, actuation shaft and etc.,

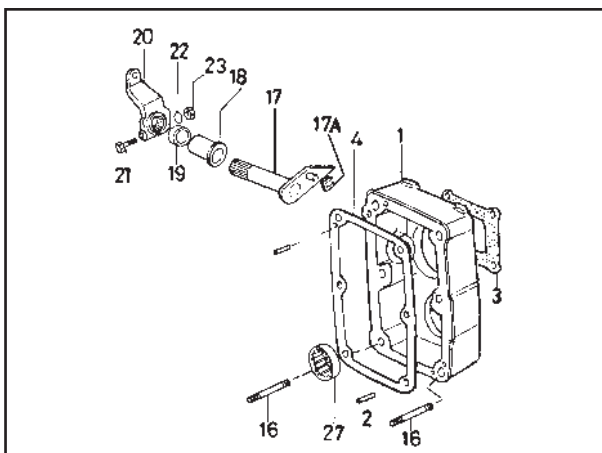
### Cleaning and Inspection

Wash and clean all the parts and inspect for worn out parts.

### 26.10.1 Assembly



Wash and clean all the parts.  
Position the PTO housing (1) base on suitable fixture.  
Fix the needle bush (27) in output shaft bore in PTO housing (1).  
Fit 2 nos dowels (2) into the PTO housing (1).



Fit 2 nos studs (16) into the PTO casing and tighten to torque 50 lb. ft.

Fit collared bush (18) into PTO housing (1) for actuator shaft and oil seal (19).

Insert the actuator shaft (17) into the collared bush on PTO housing. Fit a actuator lever (20) into the actuator shaft and fit pinch bolt to hand tight.



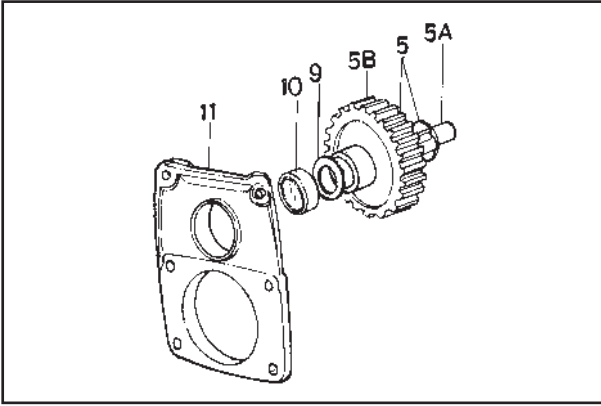
Position the output shaft (24) on suitable fixture.  
Fit the output gear (25) in the output shaft and position the circlip (26).  
Press the ball bearing (29) onto the output shaft (24).



Fit washer (28) output shaft.



Then place output shaft assembly onto the PTO cover.



Press the needle bush (10) in the input shaft bore on PTO cover (11).

The place washer (9) over it on a way it sit on PTO cover groove.

Fit input shaft sub assembly in the bearing bore on the PTO cover (11).

Position the wear pad (17A) on to the actuator shaft assembly.

Position the sliding dog sleeve (6) locating wear pad in the groove.

Position the joint (4) over PTO housing face and fix the PTO cover sub assembly onto the PTO housing fitting face by locating 2 nos dowels and 2 nos studs.



Fit the circlip (30) into the oil seal housing (32).

Position the oil seal housing (32) suitably and press the oil seal (31) on the oil seal housing.

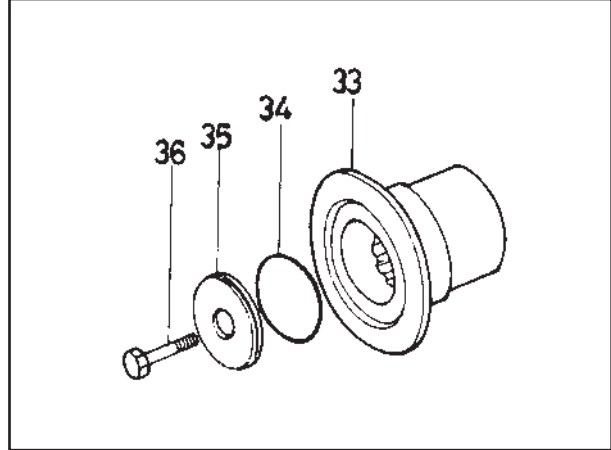


Fit the gasket (3) on the oil seal housing face.

Fit oil seal housing assembly on to the PTO cover with two nuts.

Fit output flange (33) on to the output shaft locating on the splines.

Place the 'O' ring (34) on the special washer (35).



Fit the locating bolt (36) along with the special washer (35) and tighten the bolt (36).

Ensure gears meshing properly.

Fit the joint (3) of PTO housing to gear casing and ensure needle bearing (7) and plug (8) on the layshaft to seat input shaft spigot end.

Tighten 4 nos. studs on the PTO mounting onto the gear box to torque tighten - 66 lb. ft.

Place the PTO unit onto the gear box mounting face and tighten with 4 nuts.

Tighten flange mounting locking bolt to torque of 5 kgm (36 lb. ft.).

Fill the gear box oil to the level and fit filler plug.

Connect the actuation linkages.



## 26.11 ZF GB - SIDE &amp; REAR PTO MOUNTING PARTS MATRIX

Sl. No.	Description	8.97 ZFGB		7.43 ZFGB		6.5/7.2 ZFGB		S5-36/S6-36	
		ALPTO11 (Side Mounting)		ALPTO11 (Side Mounting)		ALPTO11 (Side Mounting)		ALPTO12 (Rear Mounting)	
		ALPTOM1		ALPTOM2		ALPTOM3		ALPTOM3	
		Part No.	Off-Take	Part No.	Off-Take	Part No.	Off-Take	Part No.	Off-Take
1	Distance Piece	F1242122(A)	1	F1241622	1	F1242522	1	-	-
	Thickness (mm)	19.0 /18.95	-	17.13 /17.18	-	12.93 /12.98	-	-	-
2	Stud	F3776215	4	F3772015	4	F3778815	4	F3775315	2
3	Stud	F3776315	2	F3772115	2	F3778915	2	F3775215	2
4	Dowel	F0959815	2	F0959815	2	F0959815	2	-	-
5	Joint	F1761700	3	F1761700	3	F1761700	3	-	-
6	Shim	F4455910	AR	F4455910	AR	F4455910	AR	-	-
7	Washer	L4111000	6	L4111000	6	L4111000	6	L4111200	4
8	Nut	L3021018	6	L3021018	6	L3021018	6	L3011218	4
9	Needle Bearing	-	-	-	-	-	-	F0248110	1
10	Plug	-	-	-	-	-	-	F1138513	1

AR = AS REQUIRED

## 26.12 STUD MATRIX

SL.NO.	PART NO.	TOTAL LENGTH (MM)	THREAD SIZE	APPLICATION
1	F3722115	45	M10X1.5	PTO13
2	F3722215	40	M10X1.5	PTO13
3	F3722415	30	M10X1.5	PTO13
4	F3772015	175.8	M10X1.25/M10X1.5	SIDE PTO
5	F3772115	81.8	M10X1.25/M10X1.5	SIDE PTO
6	F3775215	120	M12X1.5/M12X1.75	PTO12
7	F3775315	105	M12X1.5/M12X1.75	PTO12
8	F3775415	65	M12X1.5	PTO12
9	F3776215	177.8	M10X1.25/M10X1.5	ZF8.97- PTO
10	F3776315	83.8	M10X1.25/M10X1.5	ZF8.97- PTO
11	F3778815	171.8	M10X1.25/M10X1.5	SIDE PTO
12	F3778915	77.8	M10X1.25/M10X1.5	SIDE PTO

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# **PROPELLER SHAFT**



**ASHOK LEYLAND**



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**GROUP - 31**  
**PROPELLER SHAFT**

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**31.0 DESCRIPTION**

The purpose of the propeller shaft is to transmit the power from the gear box to the rear axle. The propeller shaft consists of a hollow tube with a fixed joint at one end, and a slip joint at the other end. The universal joint at this end is fixed to a sleeve yoke and a flange yoke. The sleeve yoke has internal splines and slides over the splined shaft thus adjusting itself to the required length when the vehicle is in operation. The flanged yoke has got serrations on the flange.

A dust cap with a splined gasket and washer prevents the entry of dust into the sleeve yoke and the leakage of the lubricant. A lubricator is provided to lubricate the splines. The main propeller shaft is fitted between the gearbox and the rear axle. An inter-axle propeller shaft is fitted between the two rear axles. Models with longer wheel base are supported by a centre bearing at an appropriate place.

**31.1 UNIVERSAL JOINT**

The universal joint consists of a cross with 4 hardened trunnion arms, over which hardened bearing cups with needle rollers are fitted. The bearing cups are light push fit in the yokes and are retained by snap rings. Gaskets provided over the trunnion arms seal the open ends of the bearing cups against the leakage of the lubricant and the entry of dust into the needle rollers.

The lubrication is provided by means of grease nipples.

**31.2 PROPELLER SHAFT**

Main propeller shaft is installed between gearbox and rear axle.

The main propeller shaft fitted between the gearbox and rear axle has a slip joint at front and a flange yoke at the end. An inter-axle propeller shaft is fitted between two rear axles and has a slip joint at front and a flange yoke at the end.

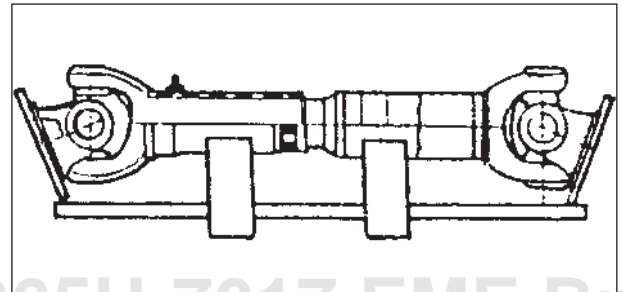
**Models with longer wheel base**

Two propeller shafts are installed between gear box and rear axle supported by a centre bearing.

The shaft between the gear box and the centre bearings has flange yoke at one end and a companion flange at the centre bearing end. The shaft between the centre bearing and rear axle has a flange yoke and a slip joint at centre bearing end, and a flange yoke and fixed joint at the rear axle end.

**31.3 HANDLING**

- Shafts to be transported in the horizontal position with suitable supports and due care to avoid impacts and shocks that could damage, the parts, or machined surfaces.
- Care to be taken during handling to ensure that balance weights, Dust Cap, Sleeve Yoke Plug, Grease Nipple and Rubber Seals are not disturbed or damaged.
- Shafts to be stored side by side on Wooden Racks with Flange Yokes resting loosely.

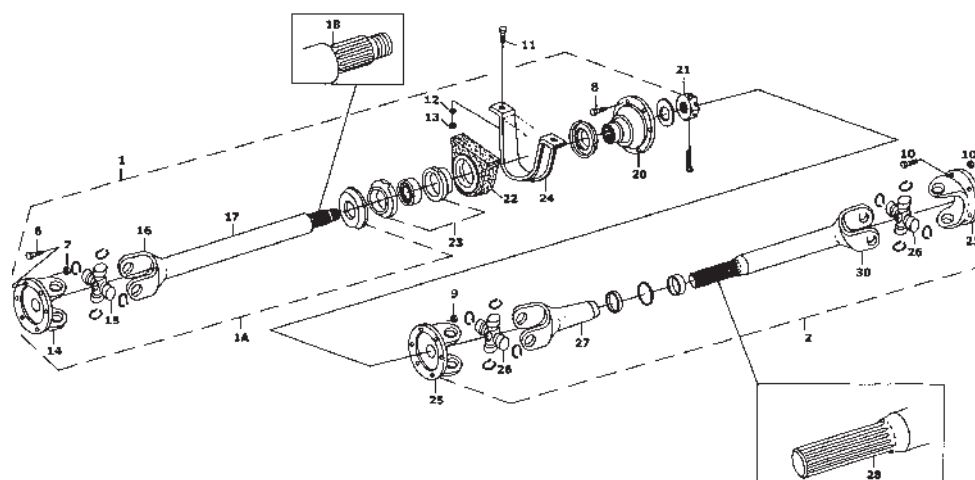


- Do not stack one shaft over another.

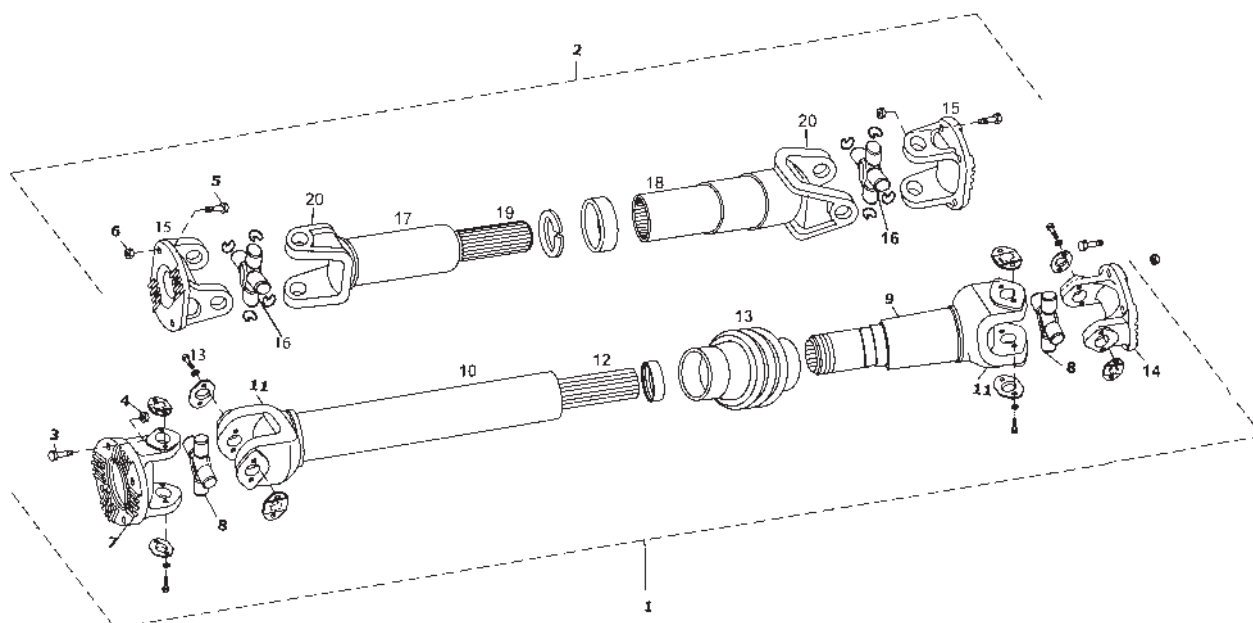
**31.4 REMOVAL**

Never let the propeller shafts hang from the bearing after uncoupling one end. Sling to a convenient part of the chassis. The rear propeller shaft should be removed before the front one.

- Disconnect both joints and lift out the rear propeller shaft.
- Disconnect the front joint at the gear box. Lower the shaft.

**Exploded view of Propeller Shaft with centre bearing arrangement**

1	S/A Of First Propeller Shaft With Centre Brg
1A	First Propeller Shaft
2	Main Propeller Shaft
6	Bolt M12 X 1.5 X 45 Long 1
7	M12x1.5-Gr.10-Nyloc Nut
8	3/8" BSF Bolt X 1.3/8" Long
9	Simmonds Nut
10	3/8" BSF Bolt X 1.3/8" Long
10A	Simmonds Nut
11	Setscrew M12 X 1.5
12	Washer 12Dia Plain
13	Clevaloc Nut M12x1.5
14	Flange Yoke
15	Cross Assy
16	Tube Yoke
18	Midship Tube Shaft
20	Companion Flange
21	Shaft Nut
22	Centre Bearing Rubber
23	Centre Bearing With Retainer
24	Centre Bearing Bracket
25	Flange Yoke
26	Cross Assy
27	Slip Yoke Assy
28	Tube Shaft
30	Tube Yoke



**Exploded view of Main and Inter Axle Propeller Shaft (without centre bearing)**

ILL. NO	DESCRIPTION	Qty
1	1710HD Series	1
2	SPL90 interaxle shaft	1
3	BOLT - HEX M14 X 1.5 FP X 55 LONG X GR 10.9	8
4	NYLOC NUT M14 X PC 8 X 1.75 FP PLATED	8
5	BOLT M12 X 1.5 X 45 LONG 10.9 GRADE	8
6	NUT - NYLOC HEX M12 X 1.5FP X 14 LONG X GR 10	8
<b>FRONT P/S (FC700610) INTERNAL COMPONENTS</b>		
7	FLANGE YOKE	2
8	CROSS ASSEMBLY	2
9	SLIP YOKE ASSEMBLY	1
10	TUBE	1
11	TUBE YOKE	1
12	TUBE SHAFT	1
13	CAP SCREW	16
<b>INTERAXLE P/S (FC700710) INTERNAL COMPONENTS</b>		
15	FLANGE YOKE FINISH	2
16	UJ KIT	2
17	TUBING	1
18	SLIP YOKE ASSEMBLY	1
19	TUBE SHAFT ASSEMBLY	1
20	TUBE YOKE	1

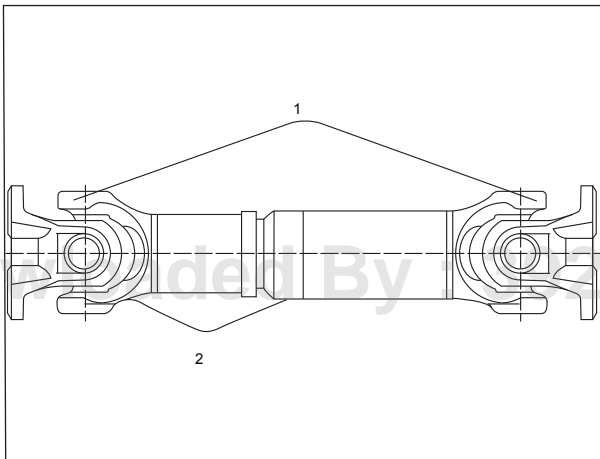
**31.5 INSTALLATION**

Whenever people or material might be endangered by rotating propeller shafts, the user must take for the corresponding safety measures.

- Safety relevant components of the Vehicle and brake lines, electric lines, hydraulic and fuel lines must be arranged in such a way that they cannot be damaged by a defective propeller shaft.
- The shaft flanges and companion flanges must be free of dust, grease or paint in order to guarantee a safe connection. The anti-corrosive on cross-serration flange teeth need not be removed. Other particle must be removed.

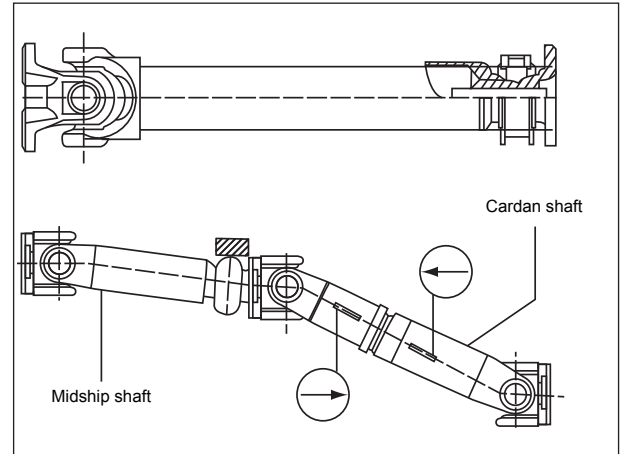


**Be careful when handling the propeller shaft. Freely moving yokes may cause injuries!**



- Check position of the yokes (1) of the shaft. Observe the arrow markings (2). (They must be in alignment.) The spline components are matched for a smooth fitting and must not be interchanged or remounted at a different angle.
- Before installation remove any transport retainer device
- Do not turn the joint of the propeller shaft with assembly levers because this may damage the grease nipples or seal arrangement on the bearing.
- When painting, ensure that the sliding range of the seal (length compensation) is protected.
- Secure Protective coated splines (sleeve muff or sleeve yoke) against
  - Heat
  - Solvents
  - Mechanical damage
- When cleaning propeller shafts, do not use aggressive chemical agents or pressurized water or steam jets because the seals may be damaged and dirt or water may penetrate.

- If propeller shafts are subjected to higher temperature, e.g due to noise-reduction measures or retarders, suitable means should be provided to ensure that the limit values are not exceeded.

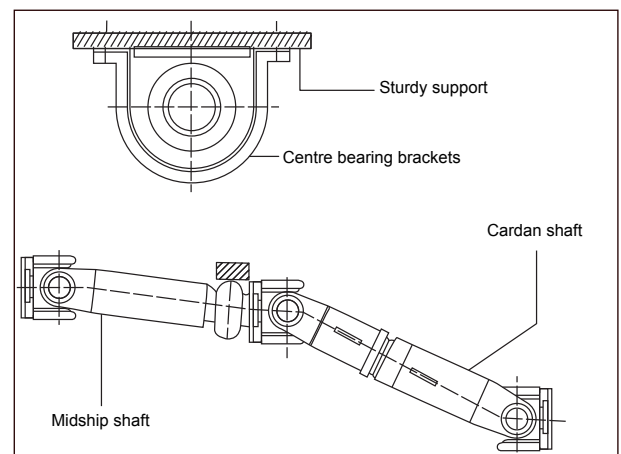
**31.5.0 Installation of drive lines**

To avoid cases of non-uniformity, drive lines consisting of the midship shaft with the centre bearing and the normal propeller shaft must be installed in accordance with the yoke position of the joints.

Generally the bolts can be introduced from the joint side. If a correct handling of this standard was made, the bolt fitting is according to latest state of art sufficient protected against loosening. Additional safety elements for example spring washers or safety washers should not be used.

**Tightening torques**

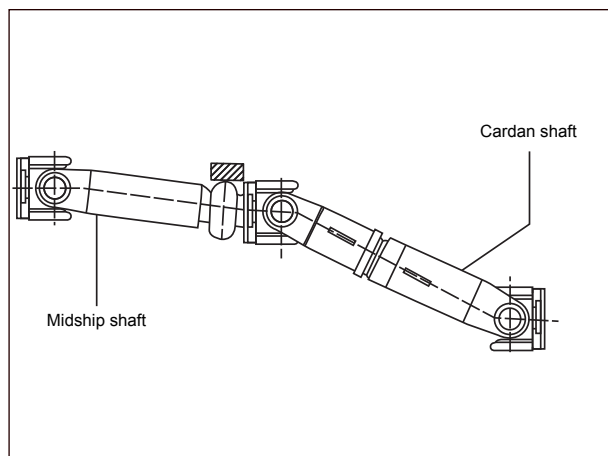
When installed, the centre bearing must be vertical in all directions with regard to the horizontal axis of the midship shaft and be in a central position. Suitable mounting supports must be provided on the frame side. A continuous stable support must be provided between the centre bearing bracket and the mounting support (see illustration).



- To guarantee a safe bolting of the centre bearing bracket of the midship shaft to the frame of the vehicle, always use the prescribed bolts.



- These bolts must be strictly secured against working loose.
- The centre bearing of the midship shaft must be installed without force. Therefore the centre bearing must not be bolted to the frame of the vehicle until the drive and the driven sides of the drive line have been bolted down.
- To avoid damage to the joint bearings it is important to protect them against excessive sagging or deflection during the entire installation procedure.



### 31.5.1 Flange Bolting

To connect the propeller shaft to the companion flanges it is imperative to use high-tensile bolts as prescribed by the manufacturer. Complete sets of bolting are available for all DIN and cross-Serrations flanges.

## 31.6 DIRECTIONS OF DISASSEMBLY

### 31.6.0 Flange Bolting

Rusty flange bolting should be sprayed with corrosion solvents, see specification handling device. Use qualified tooling for loosening the bolts. Remove the bolts, screws and nuts.

### 31.6.1 Cross Serrated Flanges

Flange yokes with Cross Serration can be disconnected by pressing in a qualified tool in the openings beside the teeth areas of adapting flange.

### 31.6.2 Dismantling

Before dismantling secure the propeller shaft against the sliding elements coming apart.

Before removing the shaft from the companion flange, make sure it cannot fall down. The yoke may tilt over when removing the propeller shaft from the companion flange.

## 31.7 SCOPE OF MAINTENANCE

### 31.7.0 Minor inspection

The "minor inspection" includes checking the propeller shaft installed in a vehicle.

Check the bolts of the Flanges and of the centre bearing bracket for tightness (e.g. undamaged paint coat). If necessary, retighten the bolts with a suitable torque wrench and the specified torque.

Check whether there are snap rings on all bearing bushes.

Check whether balance weights are loose or missing.

Check the bottoms of the bearing bushes for change of colour or form due to excessive heat.

Visual inspection of the seals of bearing bushes and the length compensation.

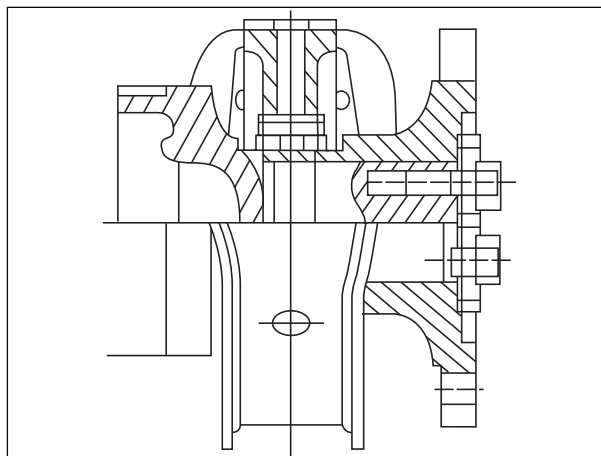
Defective seals may result in excessive grease loss and breakdown of the propeller shaft.

Check whether there are grease nipples on the journal crosses are in good condition (exception: maintenance-free joints).

Check whether the protective coat on the sleeve is damaged or shows abrasion.

Visual inspection of the centre bearings of drive lines with regard to:

- Correct position of the rubber cushion in the centre bearing bracket
- Correct position of the flange shaft



If the distance between the rubber cushion and the outer flinger is too large, the centre bolt may work loose. In this case a check should be made as a part of a major inspection.

Carry out a visual inspection for possible damage, e.g.,

- Damaged paint coat
- Deformed tubes
- Eccentricity of the length compensation cover tube
- Cracks on components and tube

Check the joints and the length compensation for visible or tangible backlash.



If the inspection shows that the propeller shaft is damaged, it must be removed.

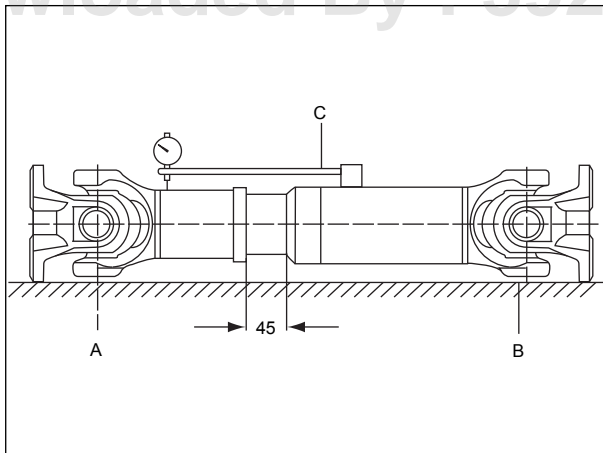
Further more, the vehicle must be immediately taken out of operation in the case of any extraordinary noise, vibration or otherwise abnormal behavior. Before recommissioning the propeller shaft it must be checked within the scope of a "minor inspection".

### 31.7.1 Major Inspection

Each "major inspection" includes the scope of checking prescribed for a minor inspection. In addition, the propeller shaft must be removed from the vehicle for the "major inspection".

The following checking or work must be carried out on the propeller shaft:

- Checking the joint bearings
- Check the two flange yokes, for tangible backlash or resistance (e.g hooking)
- By deflecting those by hand into vertical and horizontal positions (swing them to and fro).
- Checking the length compensation components
- The involute spline is centred and guided on the spline outer dia.



- Extend the propeller shaft by approx. 45 mm and place the lugs of the inner yokes at points A and B on a solid support (see illustration).
- Fix the dial gauge holder at point C next to the weld on the tube and place the dial gauge directly next to the weld of the protective sleeve (cover tube). Lift the propeller shaft at its centre of gravity so that the supports at points A and B become free.
- Read axial backlash on the dial gauge.
- The maximum permissible value is 0.17mm.

### 31.7.2 Visual checking of the parts.

Extend the propeller shaft completely and check the length compensation for damage to the inside and outside areas of the spline muff and the teeth of the yoke shaft.

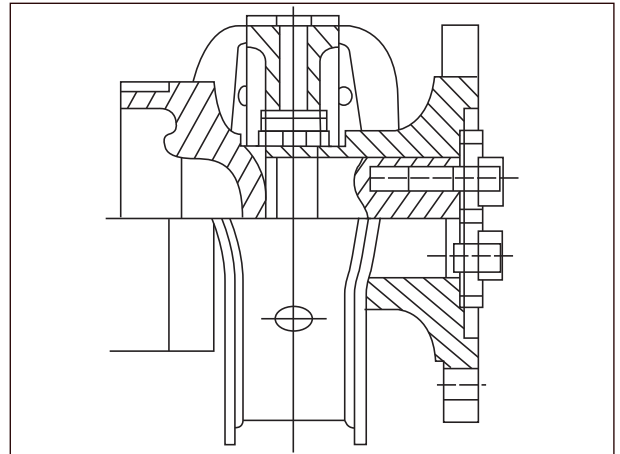
Check the seal of the cover tube for damage.

If the length compensation is undamaged bring the length compensation together to its original length.



**Make sure that the marking arrows are opposite one another.**

Check the centre bearing of drive lines with regard to:



- Damage to the rubber cushion
- Firm seat of the ball bearing in the rubber cushion

Retighten the central bolt with a torque of 350 Nm.



**Centre bearings of older designs with a central nut or holding plate and two bolts (pic. shown) must not be retightened because the bonding may become damaged and the securing function of the bolting is no longer guaranteed. After checking (by retightening) or loosening the bolting a completely new bonding is required.**

#### Attention:

After each repair the propeller shaft must be rebalanced dynamically.

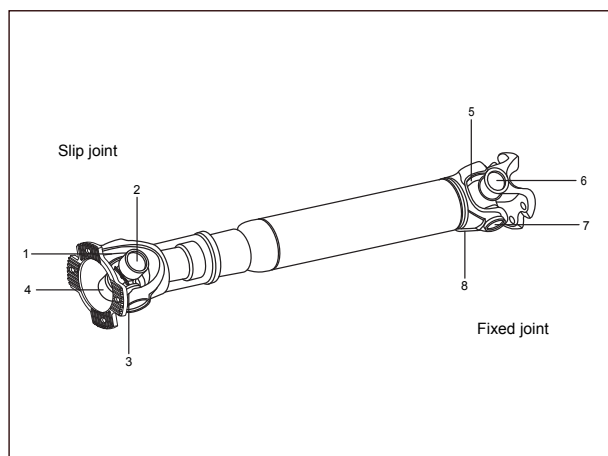
If the propeller shaft is obviously twisted due to over-loading (plastic deformation), it can no longer be used or repaired.



## 31.8 DISMANTLING/ ASSEMBLY INSTRUCTIONS

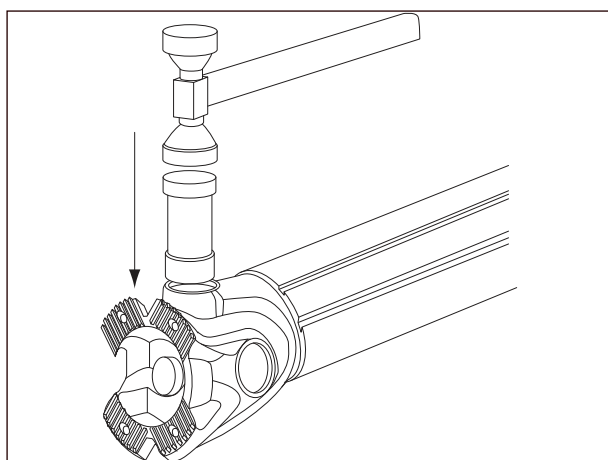
### 31.8.0 Preparation and carrying-out of the dismantling

Before the beginning of the dismantling



- Neither high pressure or steam water nor aggressive chemicals may be used for this
- Continuous numbering of the individual propeller shaft bearing faces on the relevant yokes with the numbers 1 to 8 as per the sketch.
- The circlips serve to maintain the fixing and axial movement of the Ups. They are adjusted for thickness and may on no account be swap over.
- Therefore the marking of each individual circlip is important immediately after its dismantling. For the marking, strips of adhesive tape may be used, which may be marked and attached to the circlips. The circlips should receive the same number as the relevant bearing. If the circlips are mixed this leads to high out-of-balance values.

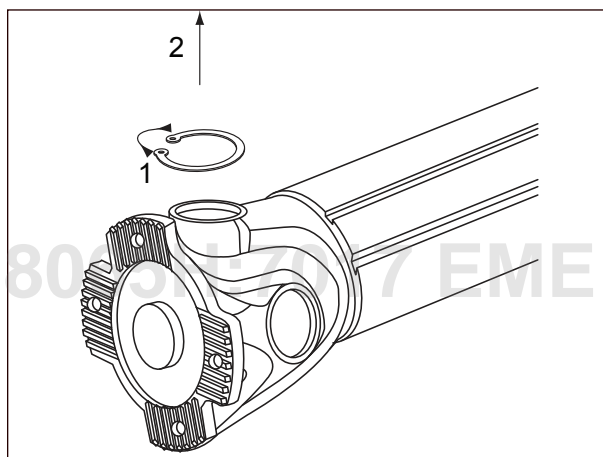
#### Dismantling (Fixed Joint)



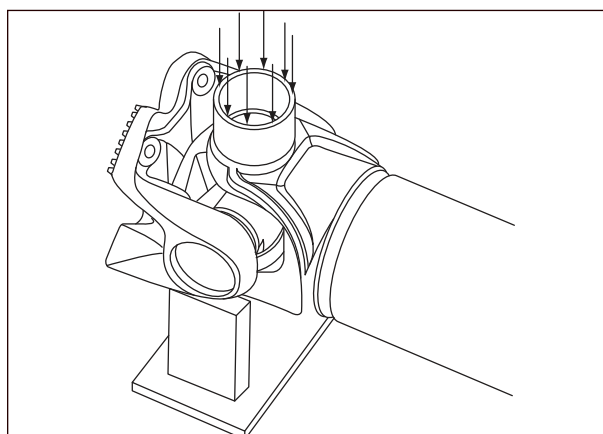
- Place joint on work bench, put mandrel into the lug hole and make the bearing cup "sit" by use of a heavy blow with a hammer. For mandrel dimensions see table 1

Table 1

Propeller shaft Size	Dia A (mm)	Madrel dia D (mm)	Maximum permissible Press Power (KN)
C-2040	47.6	46.0	25.0
C-2045	52.0	51.0	30.0
C-2047	52.0	51.0	30.0
C-2055	57.0	56.0	35.0
C-2060	59.0	58.0	35.0
C-2065	65.0	64.0	40.0



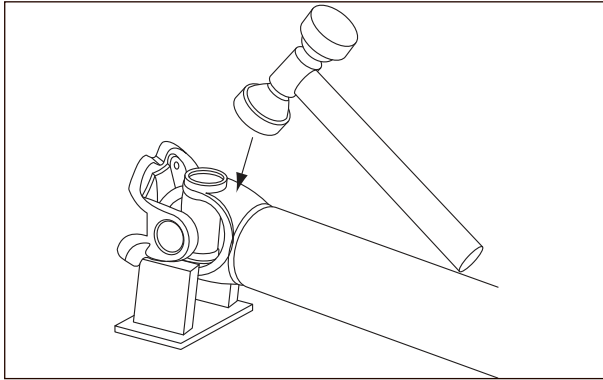
- Remove circlip with dismantling pliers. Turn joint and remove the remaining circlips.



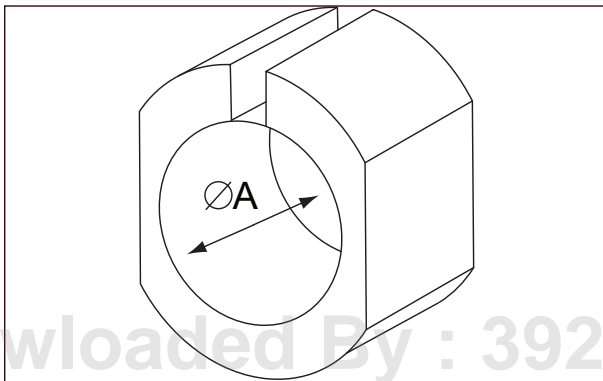
- Force the bearing cup out of the tube yoke with a press. Additionally, support the flange yoke and force the tube yoke downwards. So that the bearing cup comes out at the top of the tube yoke. Then turn the propeller shaft 180° and force out the other bearing cup in doing this attention should be paid that the tube yoke does not come into contact with the bearing cross.



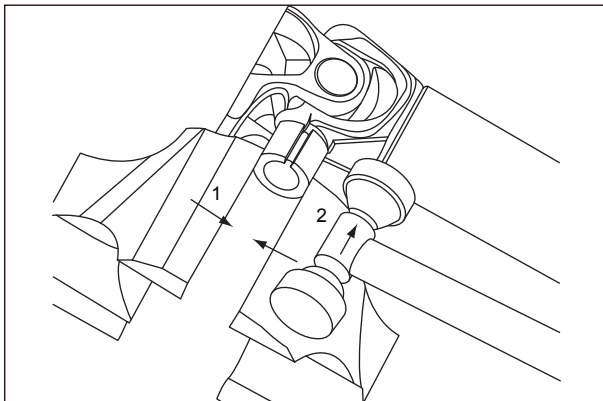
## Alternative Method



- In case where no press is available the bearing cups may also be driven out by means of hammer blows (soft metal). Oiling of the bearing cups eases the driving out. Use a vice as support.

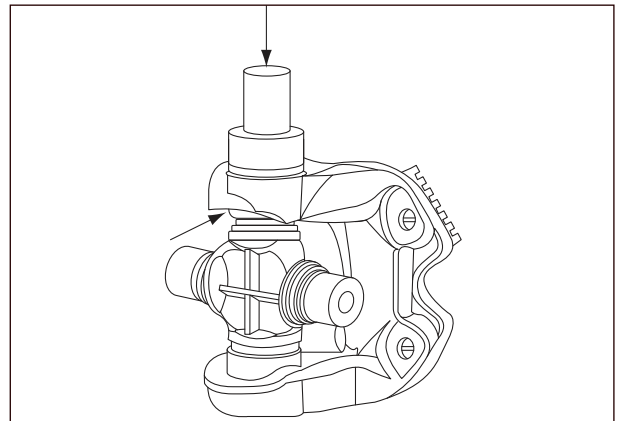


- The bearing cups should be dismantled with the figure shown above (clamping sleeve) while fixed in a vice.  $\Phi A$  = Bearing cup- $\Phi$

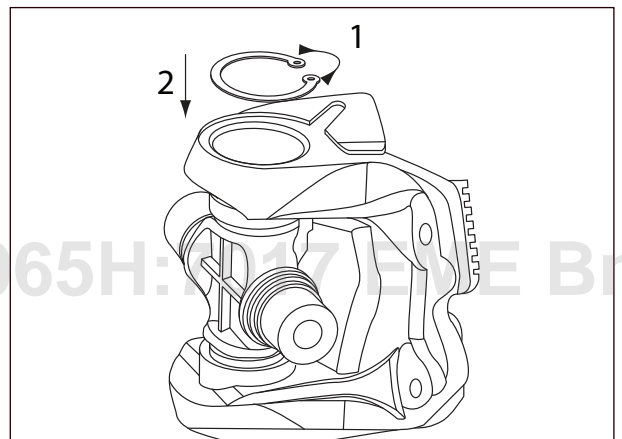


- The bearing cups should be taken out of the tube yoke. In addition the bearing cups should be held in the vice and driven out by light blows to the yoke ears. The flange yoke with the fitted journal cross should be removed.
- The bearing cups should be removed from the flange yoke in the same manner. For this the bearing cups should be held with the fixture clamping sleeve in the vice and pulled out through light hammer blows on the flange yoke ears. Take the journal cross out of the flange yoke ear. The fixed joint is now disassembled.
- The dismantling of the slip joint takes place in the same manner as the dismantling of the fixed joint.

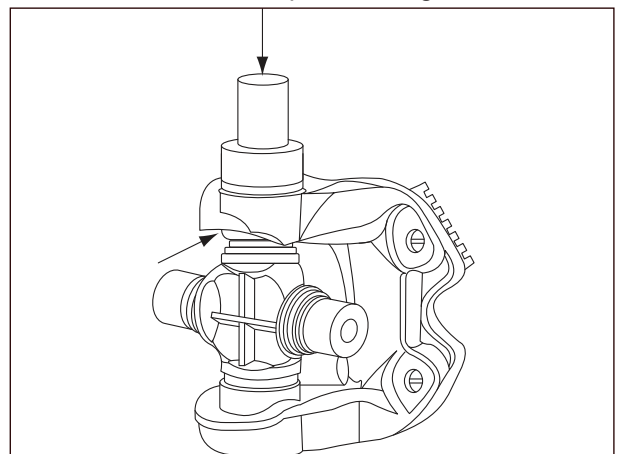
## 31.8.1 Assembly of Propeller Shaft



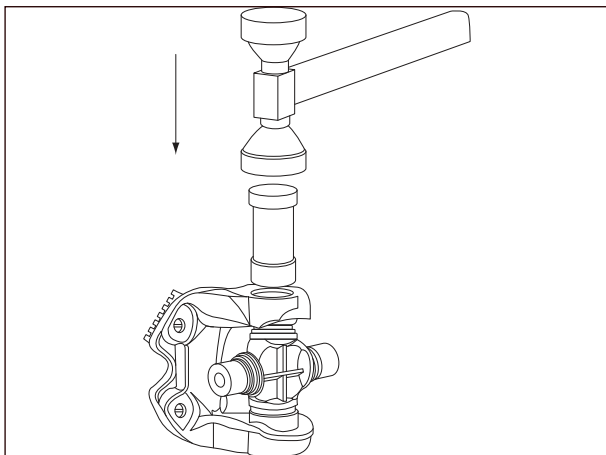
- Fit bearing cup and press in until it is visible on the inner side of the yoke ear (see arrow). The journal cross should be laid in the flange yoke. The assembly pressure to be used to press home the bearing cup should be taken from table 1.



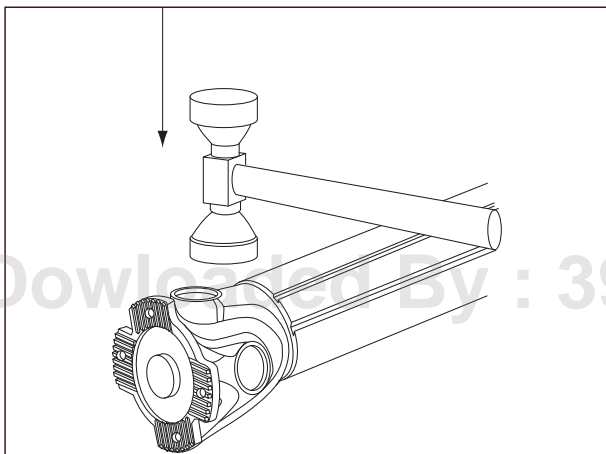
- Insert circlip. Here it is most important to retain the correct order of circlips to the lug holes.



- Press the bearing cup with the journal cross and the opposing bearing cup against the circlip. The bearing cups are fitted with plastic thrust washers. So that the thrust washers are not crushed in the assembly of journal crosses into yoke ears, the maximum pressure force values (according to table 1 may not be exceeded).



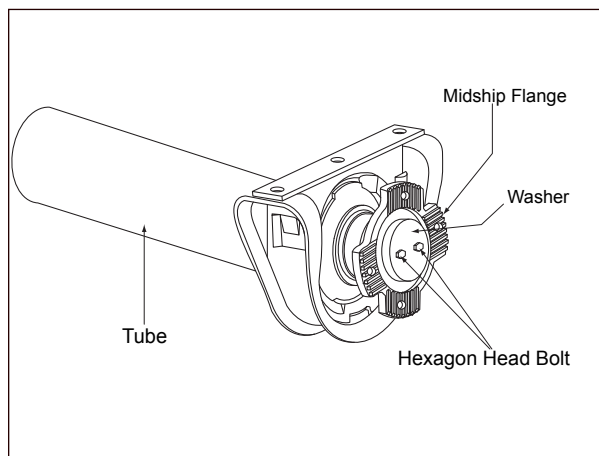
- Insert the 2nd circlip, so that the ring fits exactly into the groove. We recommend to give a hammer blow onto a mandrel that is laid onto the circlip (mandrel dimensions see table 1).



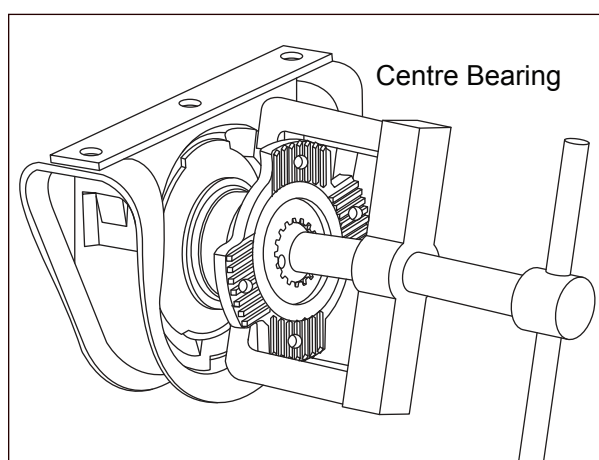
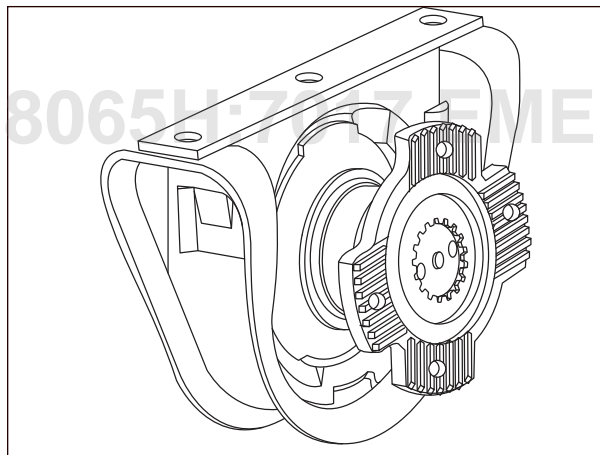
- The journal cross with the already fitted flange yoke should be inserted into the ears of the tube yoke. The remaining process is as per the assembly of the flange yoke journal cross "Ease" joints (through hammer blows on the yoke ears).
- After completion of the assembly, the joints should be checked for ease of movement. Their setting is correct if the flange yokes can be moved by hand in both planes and they do not pull down by their own weight when the propeller shaft is in a horizontal position.
- Should the play be too great or too little, the setting of the joint play can be adjusted through use of the next thinnest or thickest circlip. Then a new balancing of the propeller shaft is necessary.
- The assembly of the sliding joint is carried out in the same manner to that of the fixed joint.
- The unit pack assembly and the grease cushion should be taken out of the packaging. The four bearing cups should be removed from the journal cross. The yokes which are to be assembled should be cleaned. The grease reservoirs in the journal crosses should be filled from the grease cushions provided.

## 31.9 EXCHANGE OF CENTRE BEARING AT MID-SHAFTS.

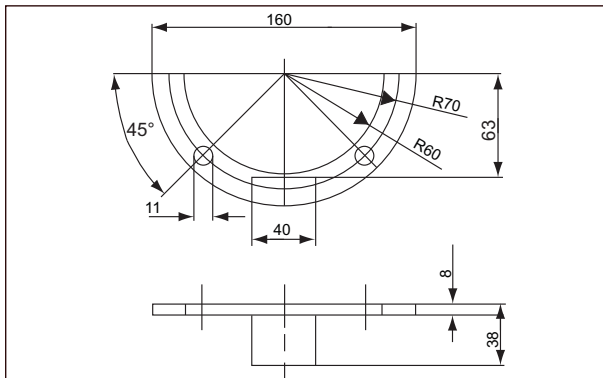
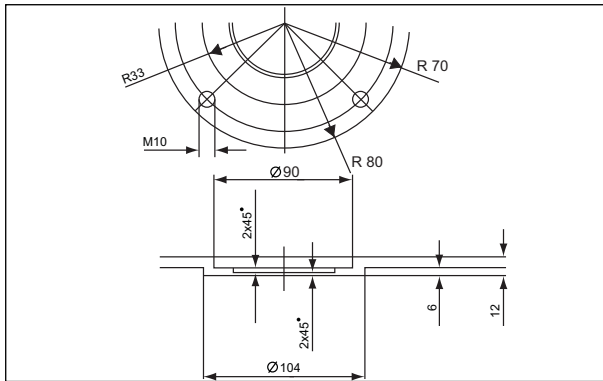
### 31.9.0 Disassembly



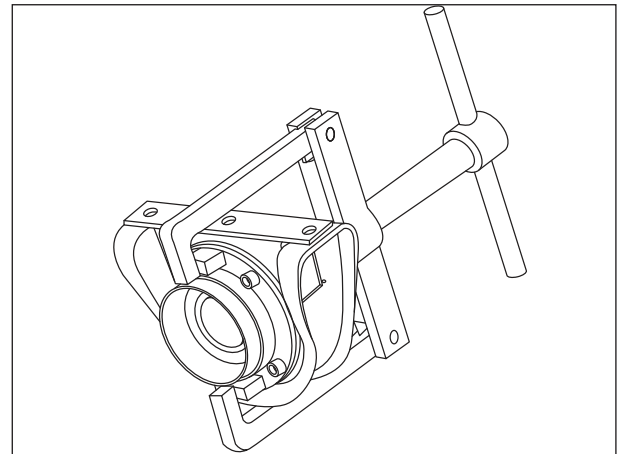
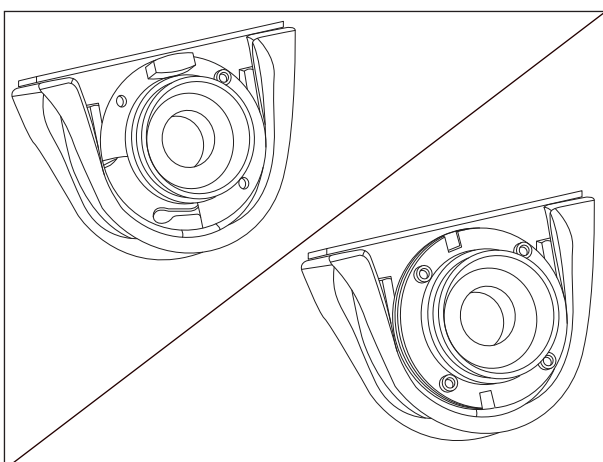
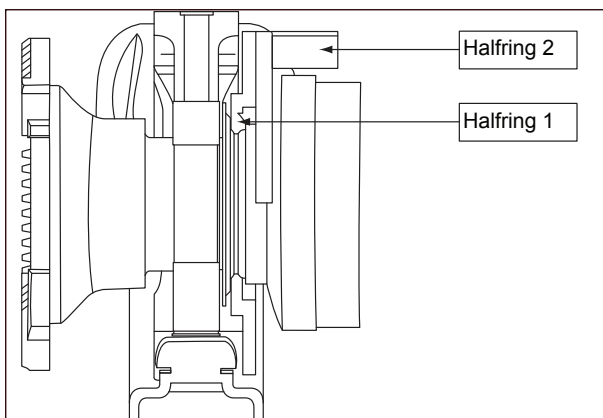
- Mark the original position of the midship flange in relation to the tube.
- Unscrew the hexagon head bolts M12 with a suitable tool



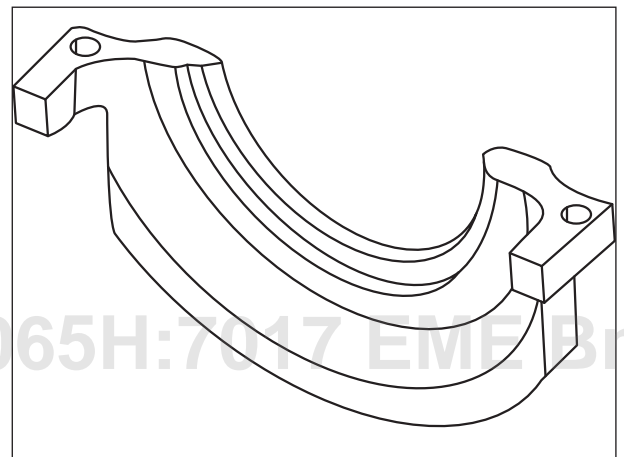
- Take off the midship flange from the midship stub shaft.
- To take off the Centre Bearing  $\Phi 55$  four disassembly half rings are necessary.



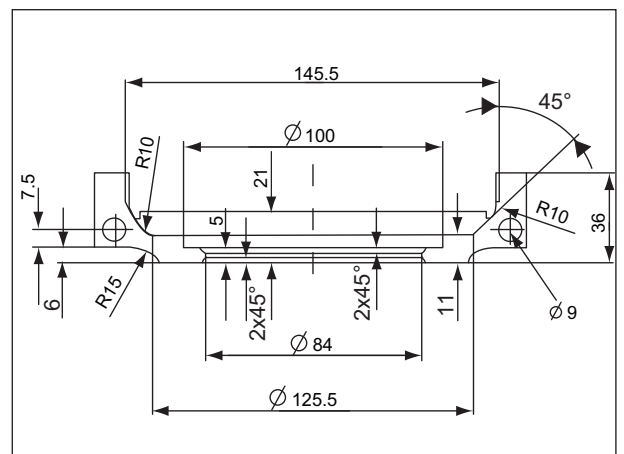
- The Half rings will be screwed together with 4 bolts M10x16-DIN912 turned by 90° to each other. Make sure that the inner -  $\Phi$  of Half ring 1 is placed in the groove of the outer flinger.



- Take off the Centre Bearing from the midship stub shaft.



To take off the Centre Bearing  $\Phi 70$  two disassembly half rings are necessary



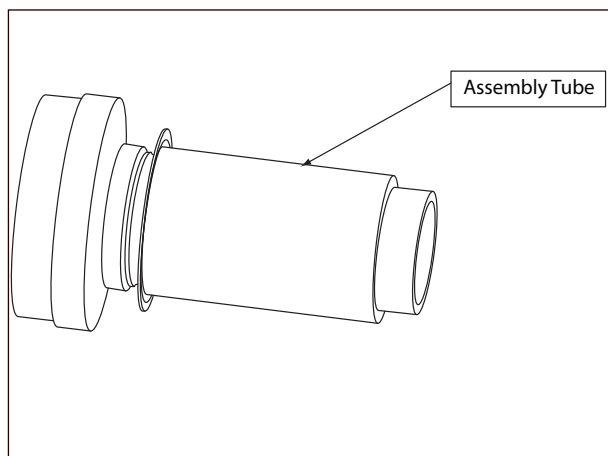
Material = Steel

Rm min = 900 N/mm<sup>2</sup>

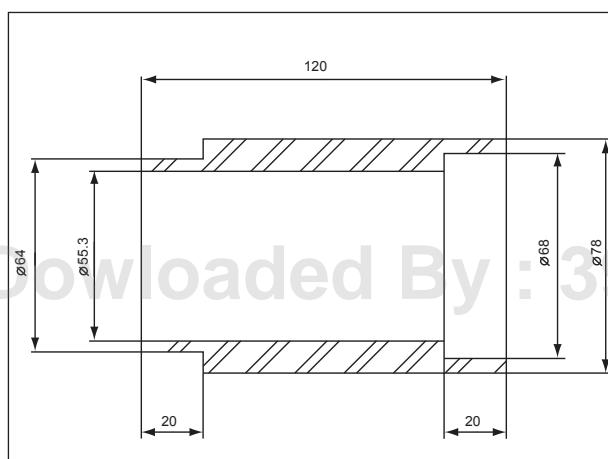
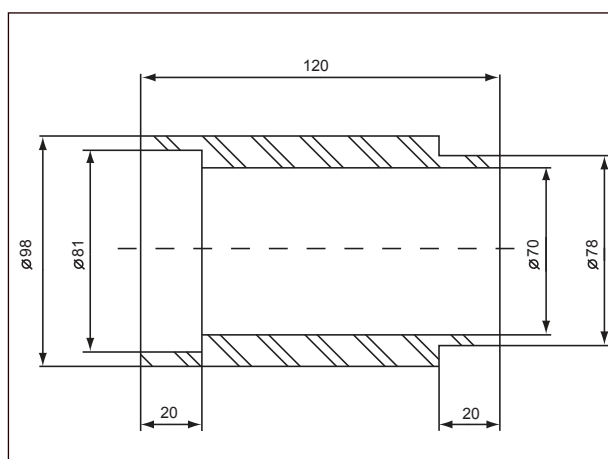
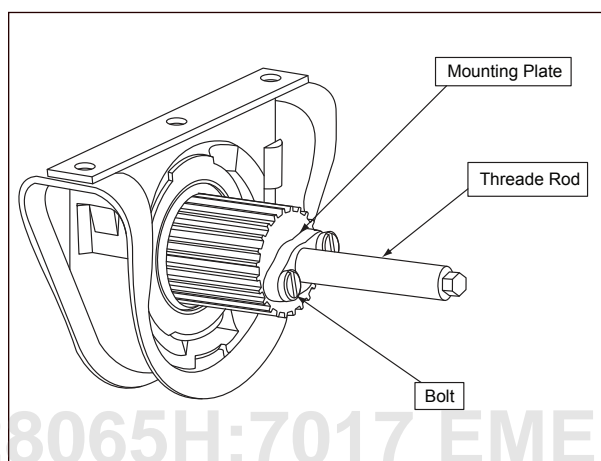
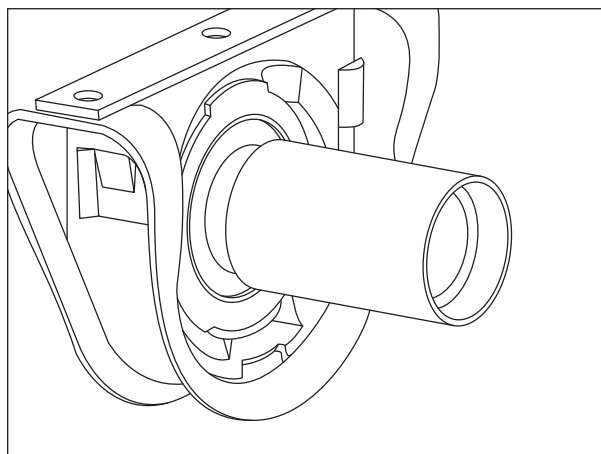
Disassembly half ring for bearing dia 70



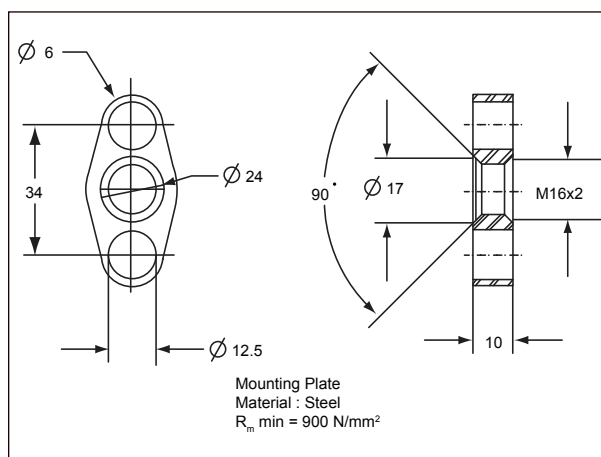
## 31.9.1 Assembly



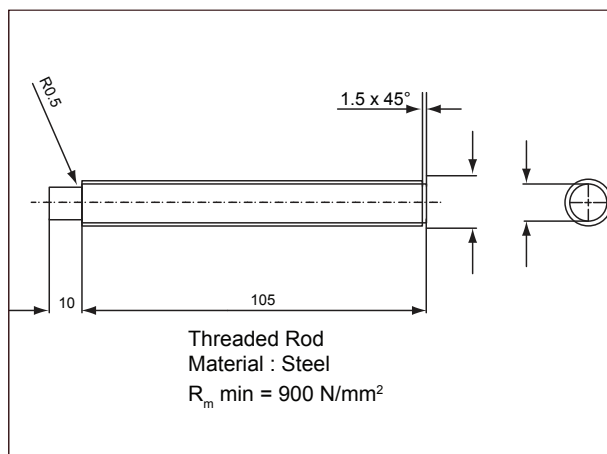
In case of deformation or damage of the outer flinger at the midship flange, take it off. The new outer flinger will be mounted, using an assembly tube to press on.

Assembly Tube for Bearing  $\Phi 55$  / Material: steelAssembly Tube for Bearing  $\Phi 70$  / Material: steel

Mount with the same assembly tube the centre bearing.



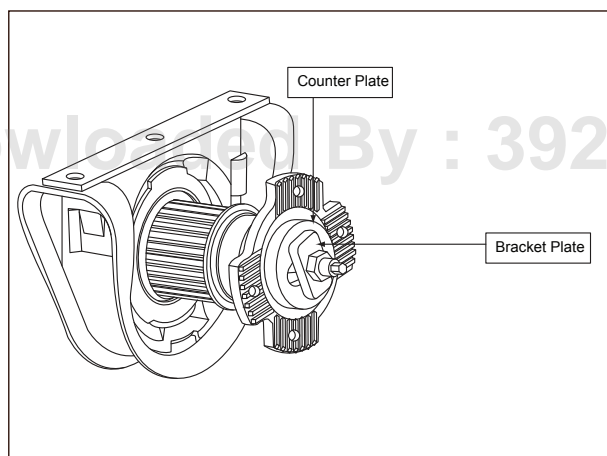
Fix the mounting plate with 2 bolts M12 x 1.5 x 30 - 8.8 DIN 920 on the midship stub shaft.



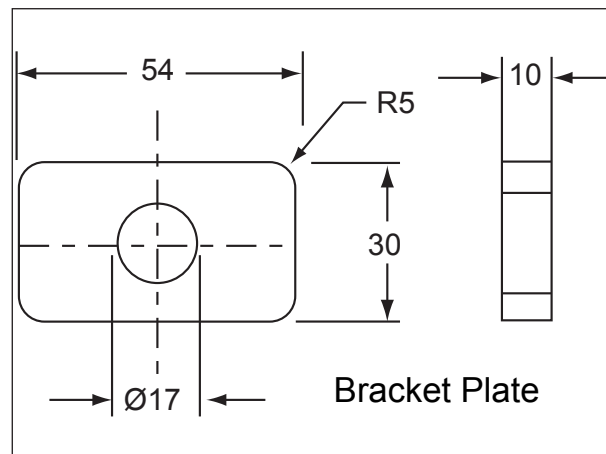
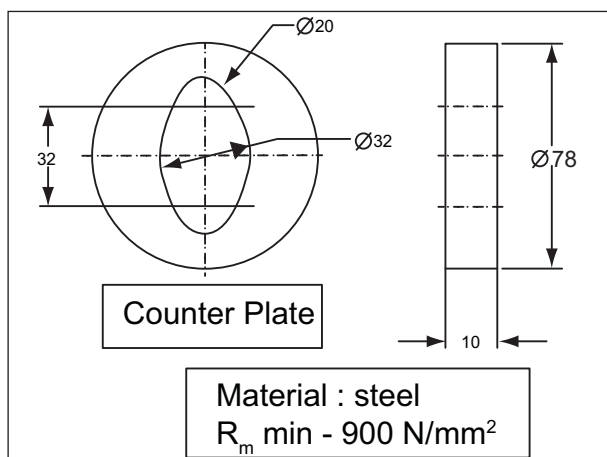
Screw in the threaded rod as deep as possible to the mounting plate.

Coat the spline of the midship stub shaft with  $\text{MoS}_2$  - assembly paste.

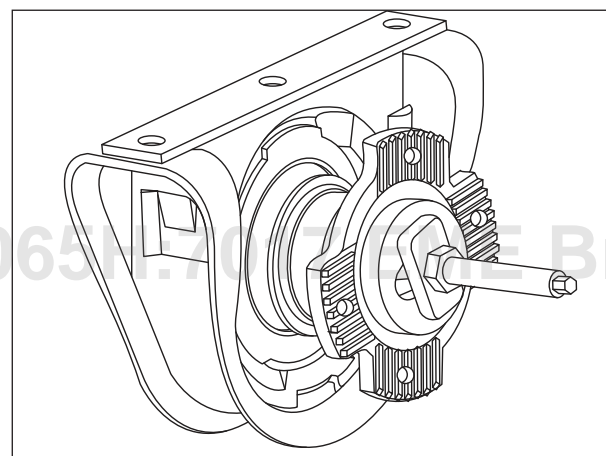
If a new midship flange is used, apply the old marking to the new flange. The correct hole pattern has to be secured, to avoid misalignment.



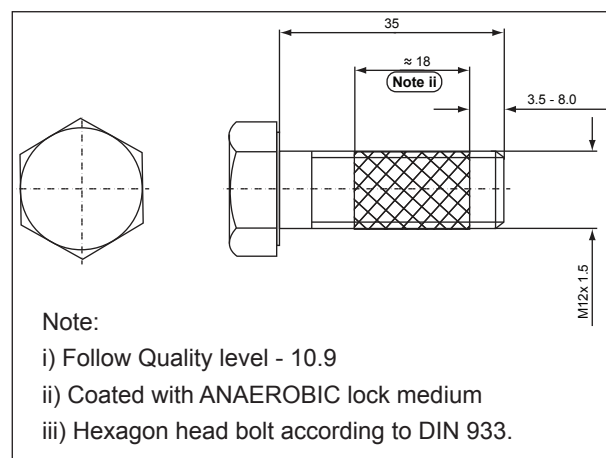
With attention to the markings of midship flange and tube push on the flange as much as possible.



Put the counter plate with recess oriented according to the mounting plate against the midship flange and screw it together with the bracket plate and a hexagon nut M 16- 8 by hand up to the bracket plate is close to the counter plate.



Push on the midship flange to the midship stub shaft with a suitable tool through the hexagon nut up to the shoulder of the flange is close to the ball bearing.



Remove the assembly parts and fix the washer with 2 new hexagon bolts M12 as shown in fig.

Tightening torque: 137 Nm



## 31.10 TROUBLE SHOOTING

FAULT	POSSIBLE CAUSES	REMEDY
Vibration/Noise	* Loose drive or coupling shaft flange bolts	Check all flange bolts. If loose check for damage to bolt holes and bolts. Renew flange bolts and nuts as necessary.
	* Universal joint bearings breaking up or seized	Check oil universal joints for excessive free play. If the joint shows signs of lack of lubricant or rust coloured deposits around the spider, disconnect shaft and check to ensure joint articulates freely.
	* Drive or coupling shaft out of balance	Check shafts for attached deposits of mud, cement, tar or similar foreign material. Clean off as necessary. Check shafts for evidence of any balance weights fitted in production (usually spot welded in place) having fallen off. Renew shaft if necessary
	* Drive or coupling shaft bent damaged	Check shafts for damage or distortion. If necessary remove one axle shaft and rotate drive line by hand or engine and check for run out or shaft flutter. Renew shaft(s) as necessary.
	* If vibration has only appeared since shaft or axle repair or renewal	Warning : Rotating shaft can be dangerous. You can snag cloth, skin, air, hands etc. this can cause serious injury. Do not work on a shaft (with or without a guard) when the engine is running.
	a) Drive line 'out of phase'	Check that universal joints are 'in phase'. If no fault found reset flanges at 180° to one another and retest.
	b) Flanges not reassembled flush to One another	Check that flanges are assembled correctly. Disconnect and check flange faces etc. Stone off any buffers if present and reassemble ensuring flush face to face alignment.
	c) Coupling refitted under tension	Slacken off support bolt, reset mounting to relieve tension and retighten bolts.

**31.11 TIGHTENING TORQUES**

	Kgm	lb.ft	Nm
<b>Propeller shaft 1710 series</b> (PROP.SHAFT TO G/B FLANGE & AXLE FLANGE)			
Propeller shaft flange (Spl. bolt and nut)	20.4	147.5	200
Centre Bearing Nut	55.4 - 56.8	400 - 410	543 - 557
<b>Propeller shaft 1710 series</b> (INTERAXLE SHAFT TO AXLE FLANGES)			
Propeller shaft flange (Spl. bolt and nut)	12.4	89.9	122
<b>Propeller Shaft 1500 Series</b>			
Propeller shaft flange (Spl. bolt and nut)	9.7 - 11.0	70 - 80	95 - 108
Centre Bearing Nut	55.4 - 56.8	400 - 410	543 - 557
<b>Propeller Shaft 1600 Series</b>			
Propeller shaft flange (Spl. bolt and nut)	5.2 - 5.8	38 - 42	51 - 57
Centre bearing nut	55.4 - 56.8	400 - 410	543 - 557

**31.12 RECOMMENDED LUBRICANTS**

Aggregate	Minimum Ambient Temp. °C	Co-branded Lubricant	Approved Lubricant
		Gulf Oil India	Indian Oil Corporation
Propeller shaft	-20	Gulf MP Grease Max NLGI 2	Servo Grease ALT

NOTE : Do not mix lubricants of different brands/grades.

**31.13 MAINTENANCE SCHEDULE**

MAINTENANCE ACTIVITY		PDI	Weekly	Every km x 1000	REMARKS
<b>A</b>	<b>Lubrication</b>				
1	Lubricate propeller shaft UJ cross	✓			Weekly for Tippers and Monthly for all other applications
2	Lubricate centre joint bearing (other than sealed bearing)	✓			
3	Lubricate propeller shaft splines	✓			
<b>B</b>	<b>Maintenance</b>				
1	Check and tighten propeller shaft flange bolts	✓	✓		
2	Check centre bearing for oil seal leakage			8	
3	Check and tighten centre bearing housing bolts			8	
4	Check and tighten centre bearing housing bracket mounting bolts			8	
5	Check UJ cross and cup for wear and replace if found worn out.			8	
6	Check for spline wear and replace propeller shaft if found worn out			8	
7	Check runout at 2" from weld at both the ends and also at centre of tube, replace propeller shaft if runout exits 0.025"			16	



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# **REAR AXLE**

## **C100 / RS120**



**ASHOK LEYLAND**

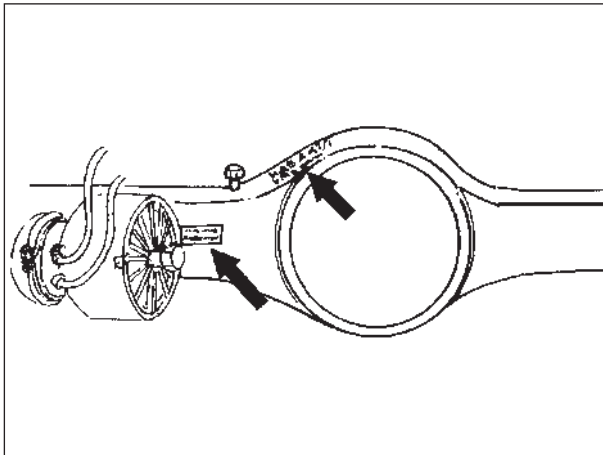
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**12.0 GENERAL****12.0.0 Rear Axle Type and Sl. No.**

AL rear axle type and serial number are punched on the LH side top doom area.

The AAL Identification plate is riveted on LH rear side of Rear Axle Casing.

**12.0.1 Design and Operation**

The rear axle is a fully floating pressed type banjo axle with a hypoid differential carrier (Single reduction carrier without differential lock).

The single reduction carrier models are front mounted into the axle housing. These carriers have a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

Straight roller bearing (Spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings. The pinion shaft flange is serrated.

When the carrier operates, there is normal differential action between the wheels all the time.

**Differential Assembly**

The pinion shaft is mounted on preloaded taper roller bearings and housed in the lower half of the differential carrier. The ring gear and main differential assembly runs on taper roller bearings and is secured in the casing by the bearing caps, adjustment for backlash and tooth contact is by the adjuster-nuts for the ring gear and by shims for the pinion. The pinion oil seal prevents ingress of dirt and loss of lubricant to the bearings. The whole differential assembly is secured to the axle by studs and nuts. The pinion shaft flange is serrated.

**End assemblies**

Final drive to road wheels is taken through the axle shafts connected to the hubs mounted on two opposed tapered roller bearings at the end of both axle tubes.

**12.0.2 Description of Leading Components**

**Rear axle casing** - of AAL make, pressed steel in banjo shape to house differential carrier (AAL supply), axle shaft and hub ends.

**Differential cage assembly** - supplied as part of differential carrier by Automotive Axles Ltd.

**Crown wheel pinion** - Hypoid type lower pinion axis w.r.t. crown centre enables better lubrication and higher load carry capacity.

**Differential carrier** - supplied as sub assembly along with casing by AAL (Automotive Axles Ltd.).

**Axle shaft** - of forged alloy steel heat treated with machined splines at one end and flange at other end.

**Hub ends** - of spheroidal cast iron machined to accommodate inner / outer wheel bearings, oil seals, wheel bolts. The hub has spigot dia to locate brake drum, wheel rims.

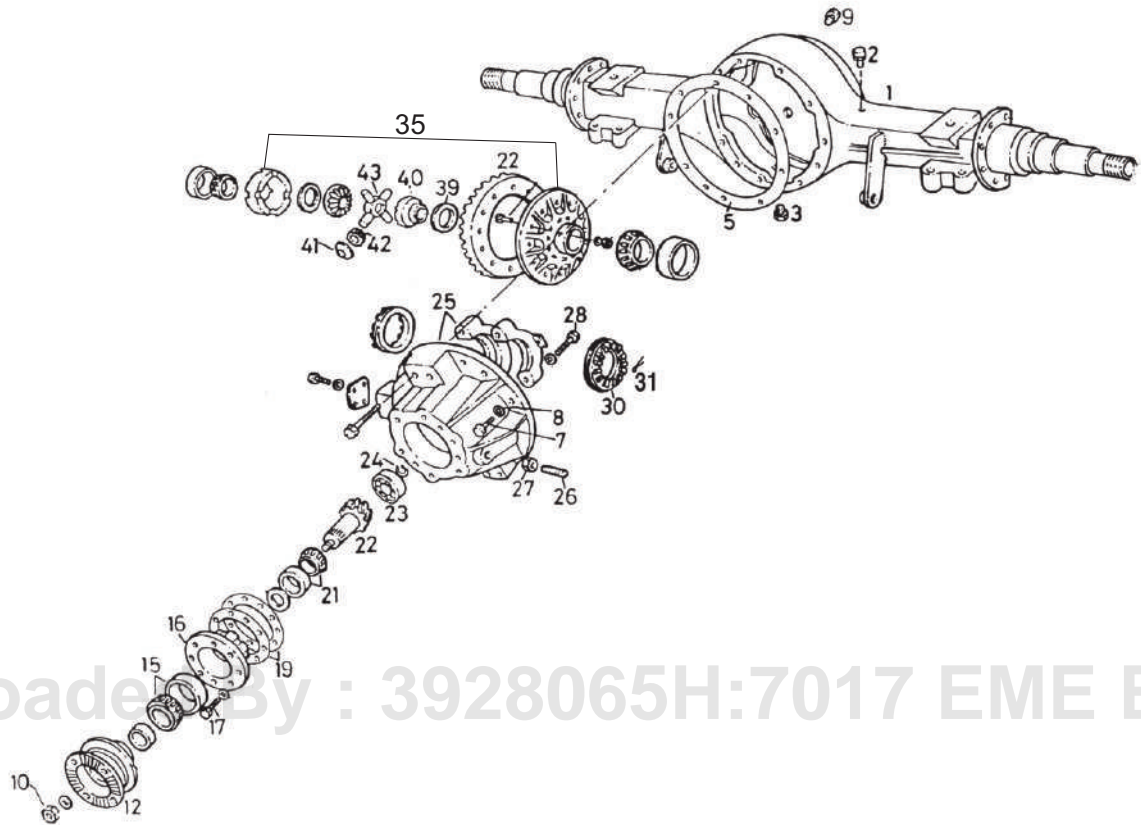
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**12.3 TECHNICAL DATA**

Data	C100	RS120
Type	Fully floating single reduction carrier	
Axle Weight Rated (kgs)	5000	7500
Pinion Input Torque (kgm)		
Arm Section ( Depth X Width X Thick)	108 x 97	108 x 97
Bowl Diameter (mm)	306	306
Ring Gear Size (mm)	304.8	337
Gear PCD (mm)	304.8	336.5
Crown Wheel Pinion Backlash - Reused (mm)	0.20-0.46	0.20 - 0.46
Crown Wheel Pinion Backlash - New (mm)	0.3	0.3
Diff Side Bearing ID (mm)	63.5	77.788/66.675
Diff Side Bearing OD (mm)	110	121.442/110
Diff Side Bearing Width (mm)	22	24.608/30.612
Pinion Bearing ID-INNER (mm)	41.275	50.8
Pinion Bearing OD—INNER (mm)	92.075	111.125
Pinion Bearing Width—INNER (mm)	26.195	30.162
Pinion Bearing ID-OUTER	36.512	47.625
Pinion Bearing OD—OUTER	88.501	95.25
Pinion Bearing Width—OUTER	25.4	30.162
Crown Wheel Lateral Runout/face out (mm)	0.2	0.2
Pinion Bearing Preload (kg)	1.0-3.5	1.0-3.5
Diff Side Bearing Preload (lb. ft.)	15-35	15-35
Axle Shaft Dia (mm)	35	42
Available Ratios	4.33/4.56/5.29	6.14
Axle shaft splines	38 x 37 T	45 x 34 T
Oil Capacity (Lits)	6	6.5
Spring Track (mm)	1001	1029
Wheel Track (mm)	1617	1700
Spring Pad Width	108X97	108X97
Wheel Bearing Seating -inner Dia On Casing	73.001	76.157
Wheel Bearing Seating -outer Dia On Casing	63.476	63.457
Wheel Bearing Inner - OD	5.000"	
Wheel Bearing Inner - ID	2.875"	
Wheel Bearing Inner - Interference Fit On Casing (mm)	0.000 - 0.005	0.000 - 0.005
Wheel Bearing Inner - Interference Fit On Hub (mm)	0.000 - 0.005	0.000 - 0.005
Wheel Bearing Outer - ID	2.5000"	
Wheel Bearing Outer - OD	4.4375"	
Wheel Bearing Outer - Interference Fit On Casing (mm)	0.000 - 0.005	0.000 - 0.005
Wheel Bearing Outer - Interference Fit On Hub (mm)	0.000 - 0.005	0.000 - 0.005
Thrust Screw Clearance (mm)	0.65 - 1.14	0.65 - 1.14
Hub End Play (mm)	0.025 - 0.076	0.025 - 0.076



## 12.4 EXPLODED VIEW OF REAR AXLE C100 &amp; RS120



III. No.	Description	QTY.
1	AXLE HOUSING ASSY	1
2	BREATHER ASSY	1
3	MAGNETIC DRAIN PLUG	1
4	DIFF CARRIER ASSY	1
5	GASKET - CARRIER TO HOUSING	1
6	CAP SCREW-LONG	9
7	STUD	3
8	WASHER -CARRIER TO HSG	12
9	PLUG OIL FILLING	1
10	NUT DRIVE PINION	1
11	WASHER DRIVE PINION	1
12	COMPANION FLANGE	1
13	DEFLECTOR COMPANION FLANGE	1
14	OIL SEAL PINION	1
15	PINION OUTER BRG	1
16	PINION CAGE,CUP&CONE ASSY	1
17	CAP SCREW-PINION CAGE	8
18	WASHER	8
19	SHIM PINION BRG GAUGE	1
20	SPACER KIT DRIVE PINION	1
21	PINION INNER BRG	1

III. No.	Description	QTY.
22	DRIVE GEAR & PINION ASSY	1
23	SPIGOT BEARING DRIVE PINION R/A	1
24	LOCK RING	1
25	DIFF.CARR.& CAP ASSY	1
26	SCREW THRUST	1
27	NUT SPECIAL	1
28	CAP SCREW DIFF.BRG CAP	4
29	WASHER DIFF.BRG.CAP	4
30	ADJUSTING RING	2
30A	COTTER PIN-ADJ RING	2
32	DIFF BEARING R/A	1
35	DIFF CASE	1
39	THRUST WASHER -SIDE GEAR	2
40	SIDE GEAR DIFF	2
41	THRUST WASHER DIFF.PINION	4
42	PINION -DIFF	4
43	SPIDER DIFF	1
44	WASHER DIFF CASE	12
45	NUT DIFF CASE TO GEAR	12

**12.5 REAR AXLE PRELIMINARY CHECKS**

It is mandatory to carry out few preliminary check on rear axle before dismounting from the vehicle. The following cause and effects can lead to overhauling decision.

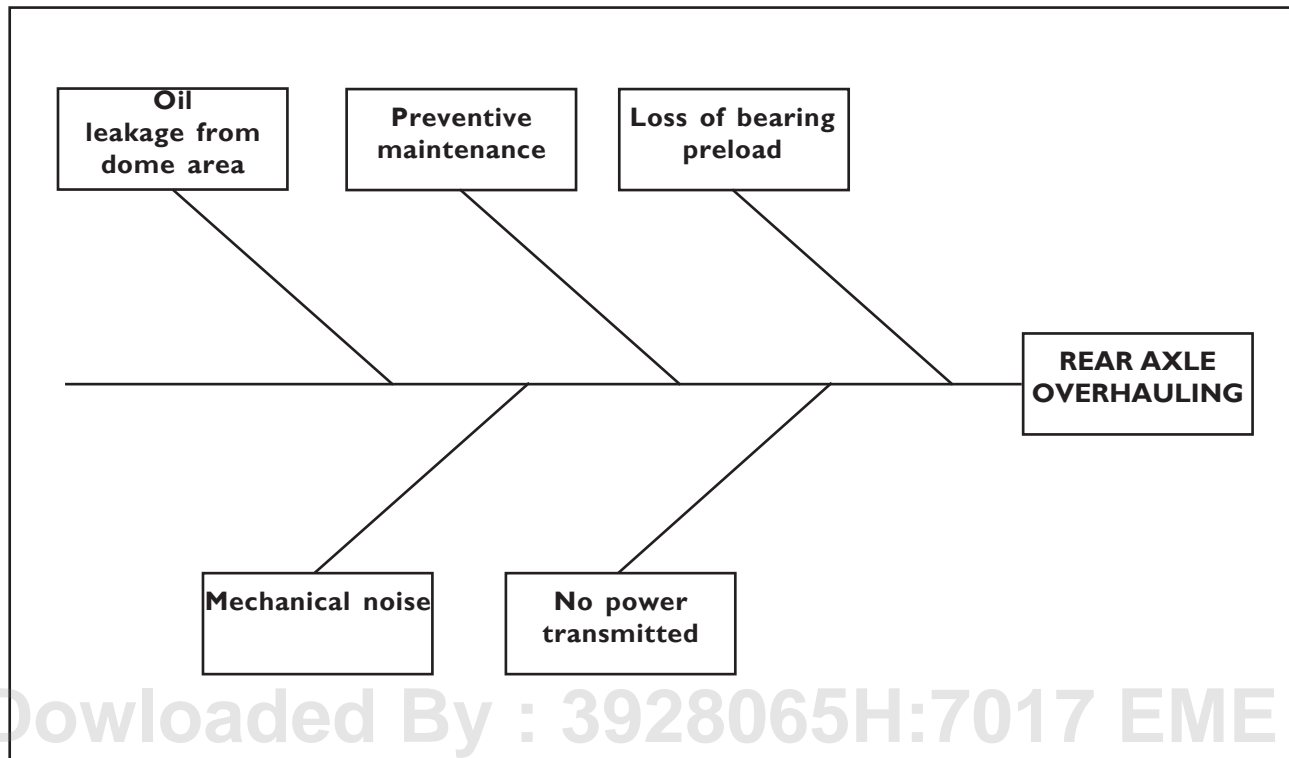


Fig. 3 Cause and Effect Diagram - Rear axle overhauling

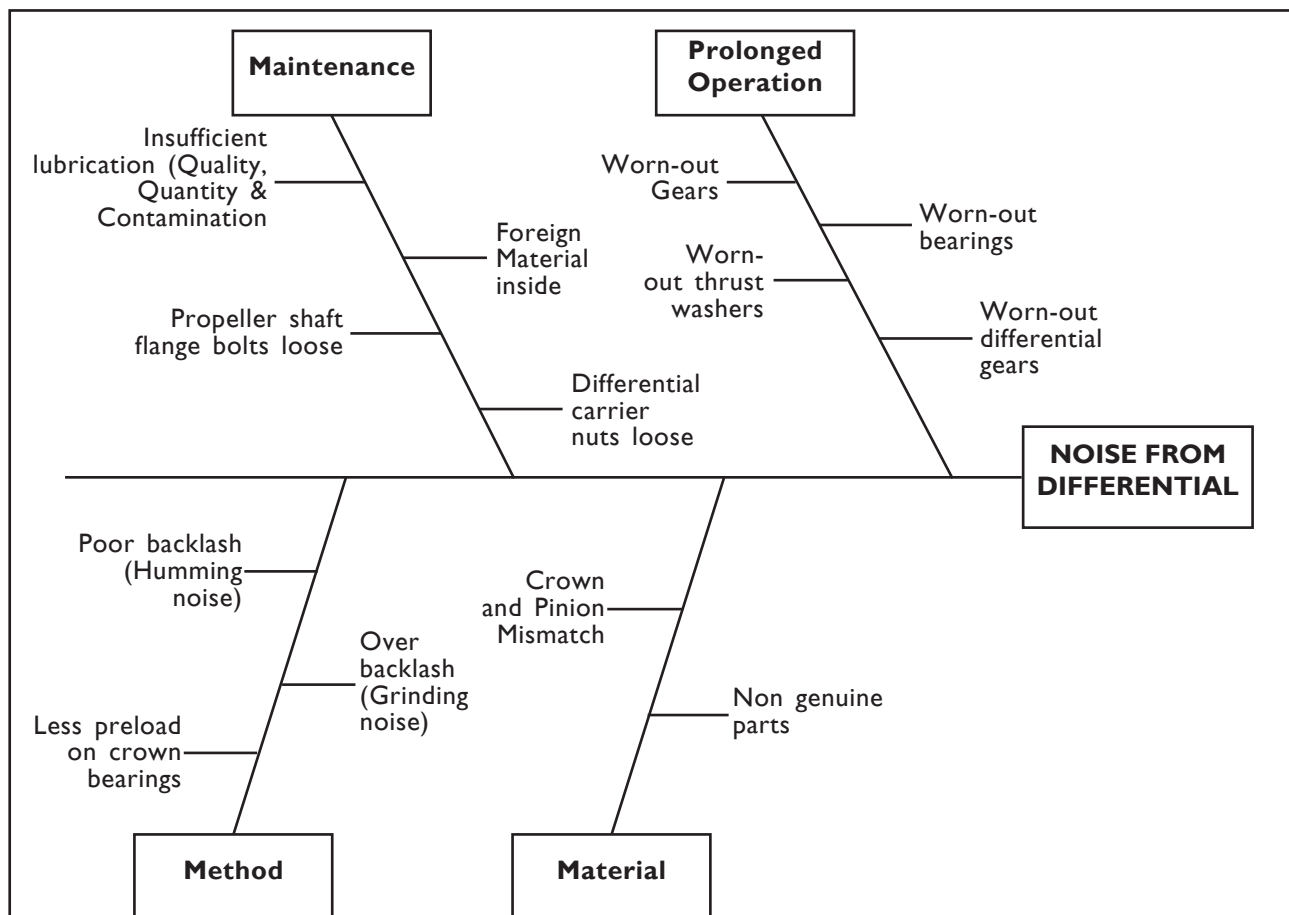


Fig. 4 Cause and Effect Diagram - Noise from Differential

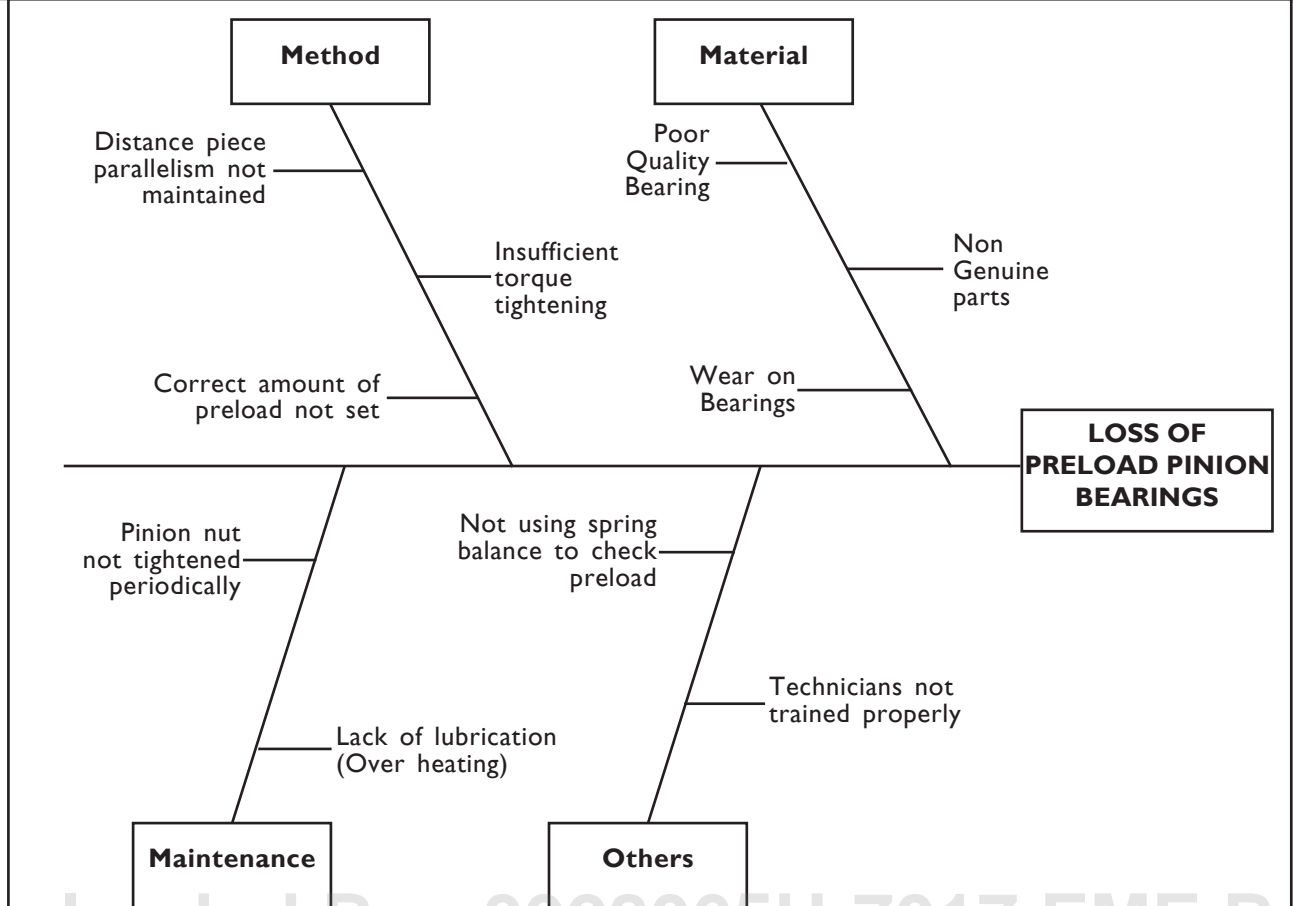


Fig. 5 Cause and Effect Diagram - Loss of Preload Pinion Bearings

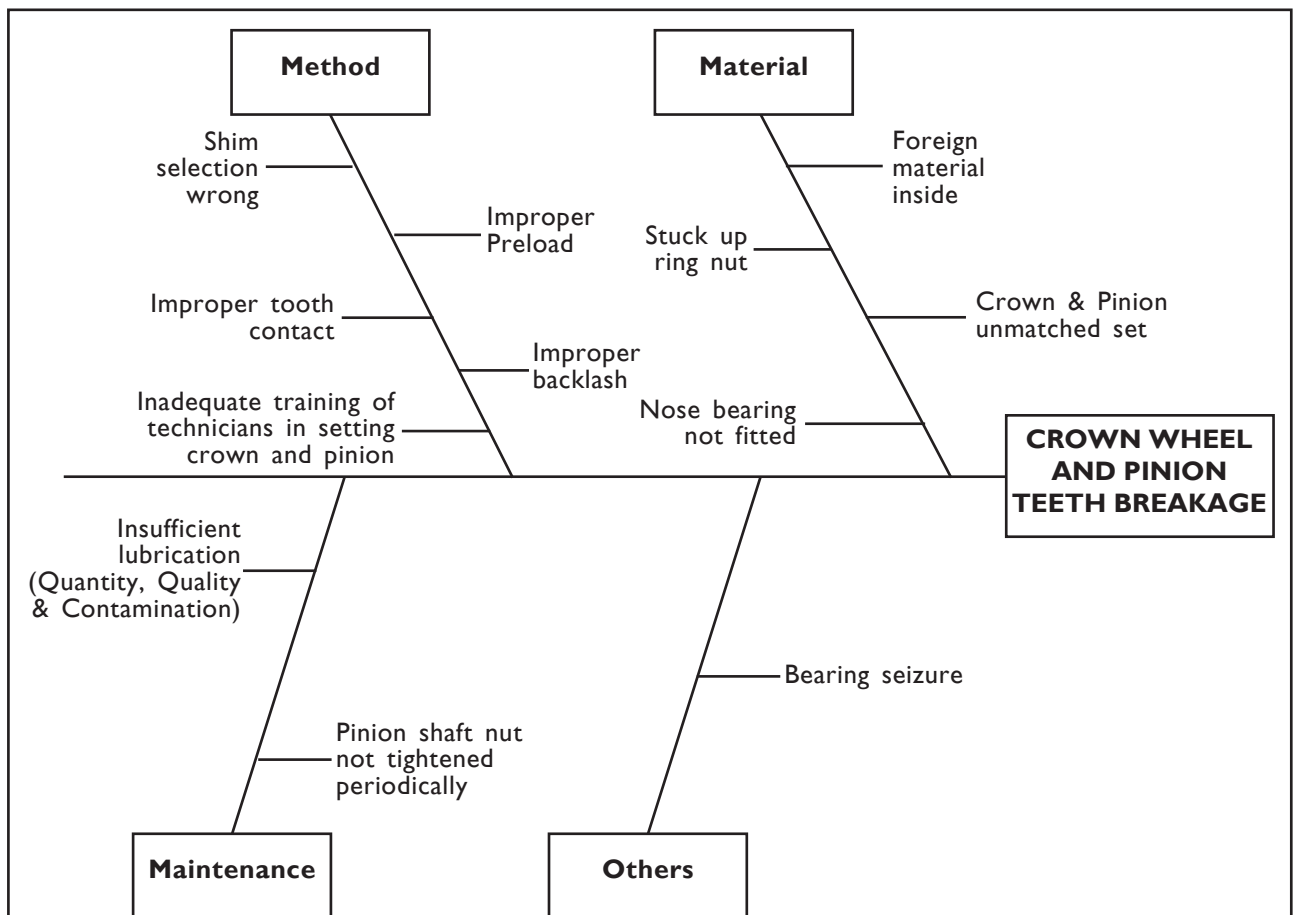


Fig. 6 Cause and Effect Diagram - Crown Wheel and Pinion Teeth Breakage




**12.6 REAR AXLE REMOVAL AND FITMENT**
**Removal**

- Apply the parking brake, chock the front wheels and disconnect the battery.
- Slacken the rear wheel nuts.
- Raise the rear of the vehicle and support it with chassis stands placed forward of the rear axle and at sufficient height to allow the axle to hang unsupported with the wheels just clear of the ground.
- Drain the rear axle oil.
- Disconnect the drive shaft and support it clear off the axle.
- Remove the road wheels from both sides of the rear axle using a suitable wheel trolley.
- Support the rear axle on a transmission jack and cradle or on a suitable trolley jack, partly compressing the rear springs to relieve any weight from the shock absorbers and "U" bolts.
- Secure the axle to the jack with a tie chain.
- On full air brakes disconnect the flexible pipes from the union block.
- Disconnect both lower shock absorber retaining bolts, and swing them clear of the axle.
- Remove the "U" bolts and the top clamp plates.
- Carefully lower the axle away from the springs and withdraw the assembly from under the vehicle.
- Retain any spacer plates (where fitted) and locating dowels for reassembly.

**Cleaning and Inspection**

The actual amount of cleaning and inspection required when removing a complete axle depends on whether the reason for its removal is for further attention to the axle itself or to the rear of the vehicle. The following points should be observed before refitting the axle to the vehicle.

- Ensure the mating faces of the springs the plates and spacers when fitted are cleared.
- Renew all self-locking nuts and split pins.

**Rear Axle Installation**

- Support the axle on a transmission jack and cradle, or on a suitable trolley jack and locate the axle into position under the rear of the vehicle.
- Locate the spacer plates (where fitted), and locating dowels when fitted, onto the axle pads

and carefully raise the axle to the springs ensuring the dowels and/or spring centre bolts are correctly aligned.

- Raise the jack to partially compress the rear springs.
- Fit the spring top plates (where fitted) and the "U" bolts. Do not fully tighten at this stage.
- Fit the "U" bolts nuts and securely tighten progressively and evenly.



If new springs, "U" bolts, and / or "U" bolts nuts have been fitted the torque should be checked in accordance with the Service Schedule, as if for a new vehicle.

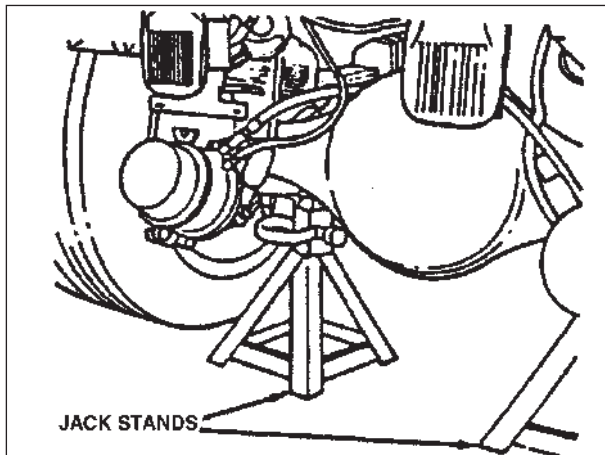
- Reconnect the shock absorbers and tighten the retaining bolts and nuts to the specified torque.
- Connect the drive shaft and tighten the securing nuts and bolts to the specified torque.
- Refit the rear wheels and securely tighten the wheel nuts.
- Remove the chassis stands and lower the rear of the vehicle to the ground.
- Tighten the "U" bolts nuts to the specified torque.
- Tighten the axle drain plug to the specified torque, fill the axle to level with the specified oil and tighten the level plug to the specified torque.
- Reconnect the batteries and run the engine to charge the air reservoirs.
- Apply the parking brake and remove the chocks from the front wheels.
- Road test the vehicle until the axle reaches normal operating temperature and check for any extraneous noises.
- Check and torque the "U" bolts nuts and the road wheel nuts.
- After road test, check for freedom from oil leaks and top up the oil level if necessary.



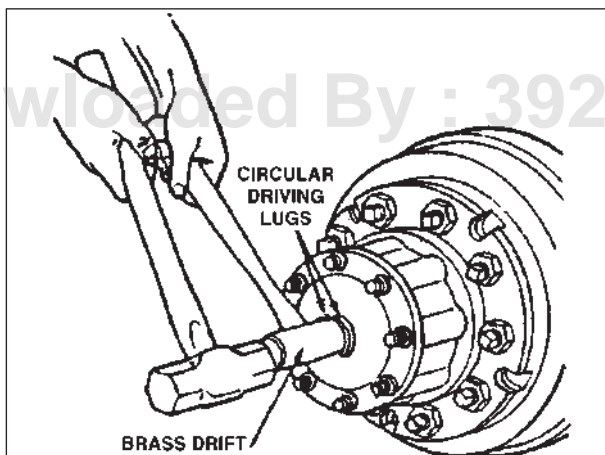
The road wheel nuts should be checked and retorqued again after approximately 250 kms.

**12.7 TO REMOVE AND REFIT DIFFERENTIAL CARRIER & OVERHAUL**

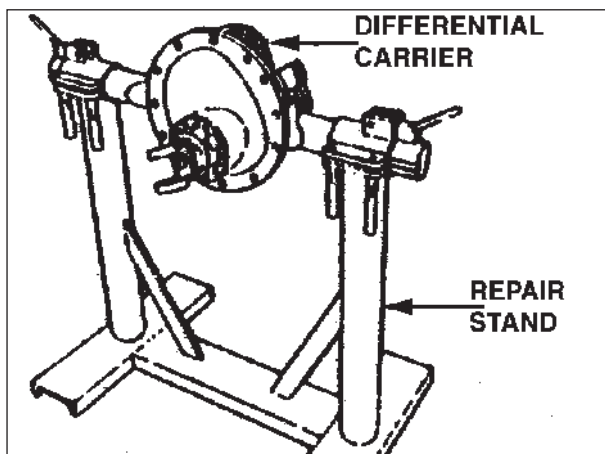
Raise the rear end of the vehicle by using suitable jack.  
Put on jack stands.



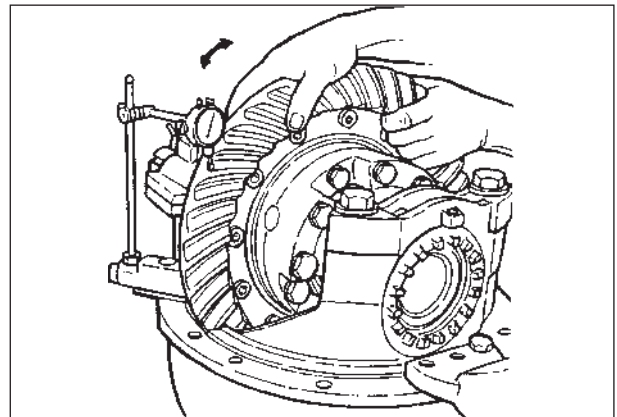
Disconnect the propeller shaft from input flange.  
Remove drain plug and drain differential oil.  
Remove nuts and washers from the axle shafts.  
Loosen the taper dowels using brass drift and hammer.



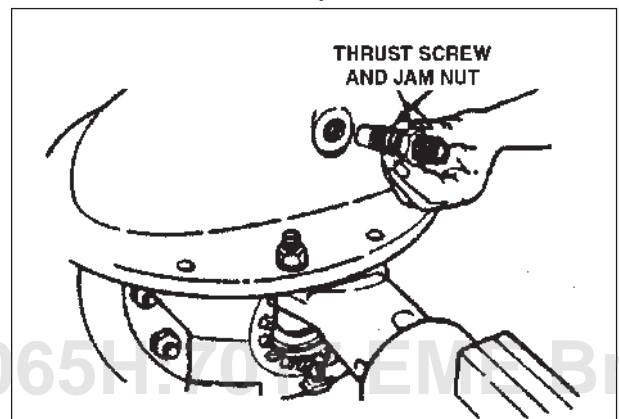
Remove axle shafts using puller screws.  
Remove all the carrier mounting fasteners.  
Remove the carrier from the housing.



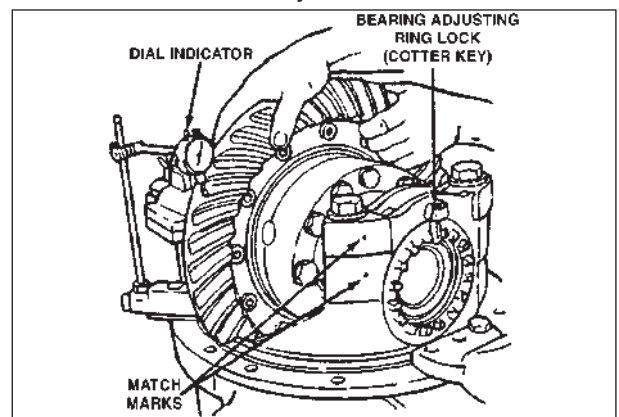
Mount the carrier on a repair stand. **Use SMT No. 05006 - Stand for Drive Head Assembly.**

**12.7.0 Dismantling of Differential Carrier Assembly**

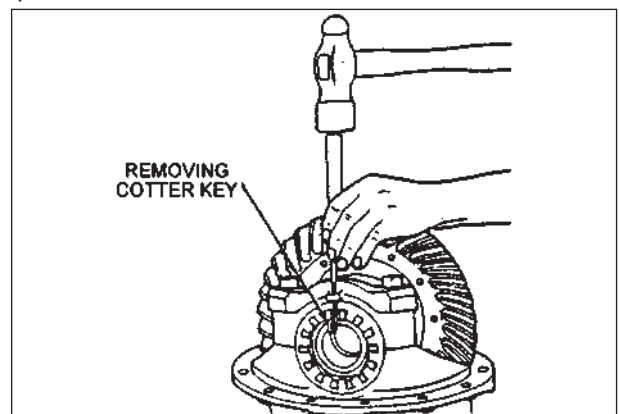
If the same gear set is to be reused record the backlash before disassembly.



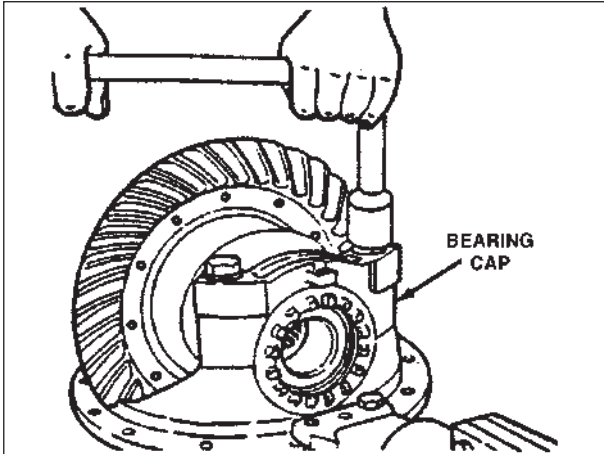
Remove thrust screw and jam nut.



Make match marks on one carrier leg and bearing cap.

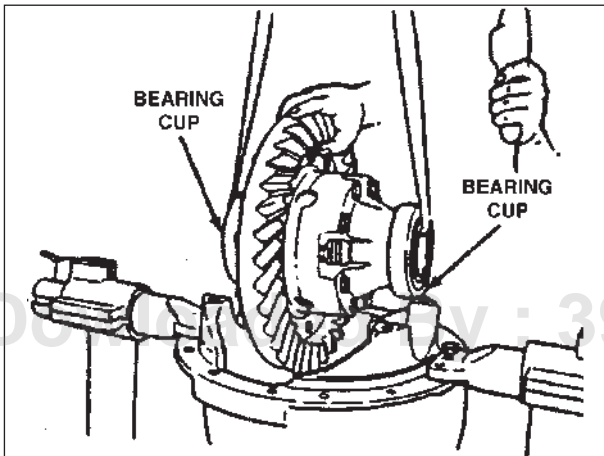


Remove cotter pins using a small drift and hammer.

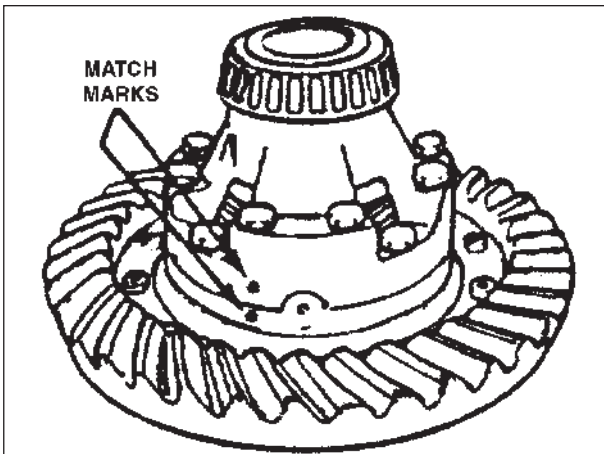


Remove cap screws and washers of bearing caps.

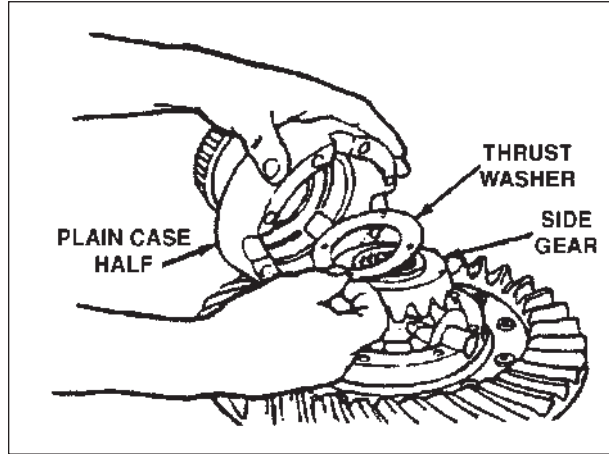
Remove bearing adjusting rings.



Lift the differential case and ring gear assembly.



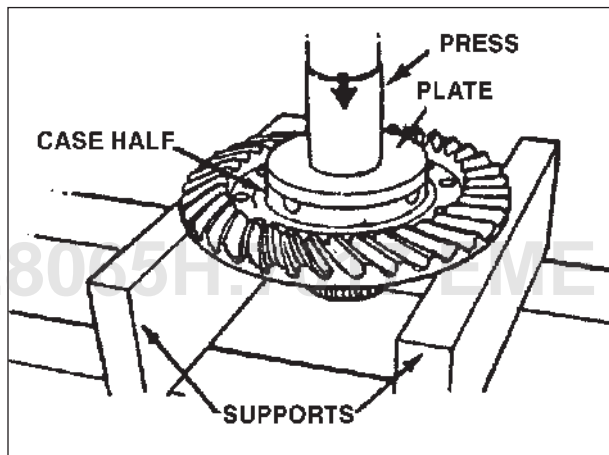
Make match marks on the differential case halves.



Remove the lock wires and differential case bolts.

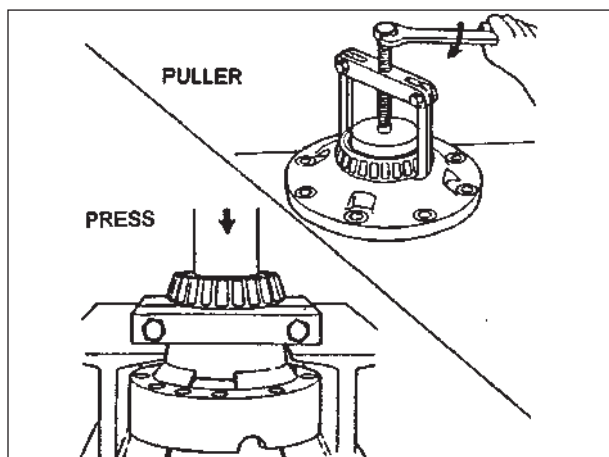
Separate case halves.

Remove spider, pinions, side gears and thrust washers.

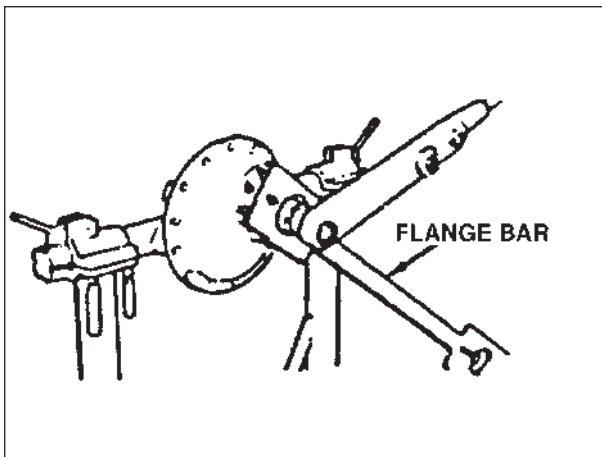


Remove the gear mounting bolts and lock plates.

Remove the ring gear from differential case using a press.

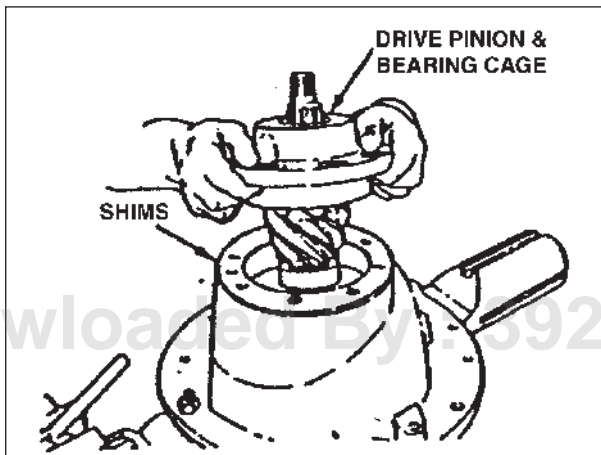


Remove the bearings from differential case using bearing puller/press.



Fasten a flange bar to the companion flange.

Remove pinion nut and washer.

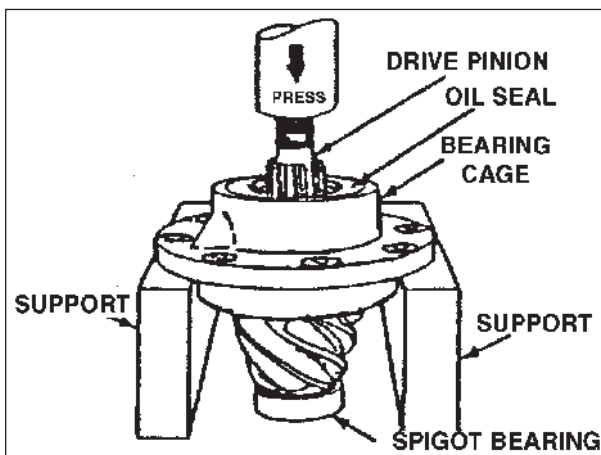


Remove the companion flange using a suitable puller.

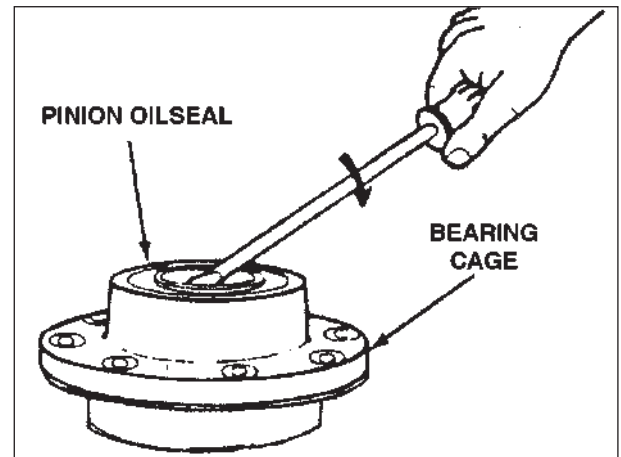
Remove cap screws and washers of bearing cage.

Remove bearing cage and shims.

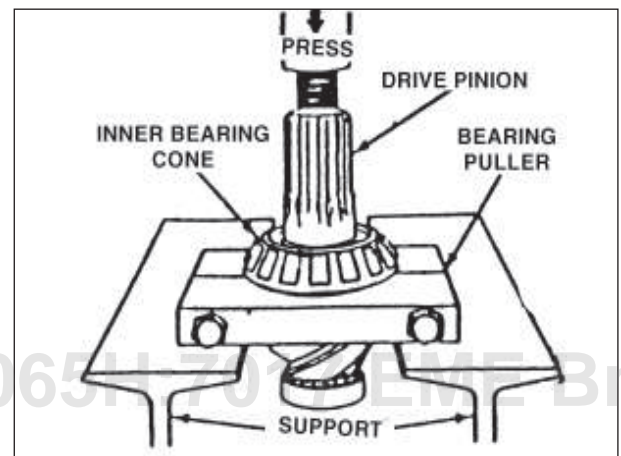
Measure and note down the total thickness of removed shims.



Remove drive pinion from bearing cage using a press



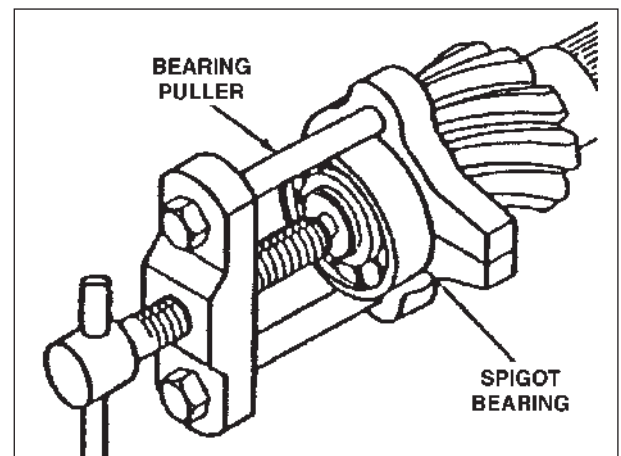
Remove the oil seal.



Take out the outer bearing cone.

Remove the bearing cups from the cage using a small drift and hammer.

Remove the inner bearing cone using the split puller and press.



Remove the snap ring.

Remove the spigot bearing using **Special Tool 0507004 - Puller Spigot Bearing**.



### 12.7.1 Cleaning and Inspecting of Parts

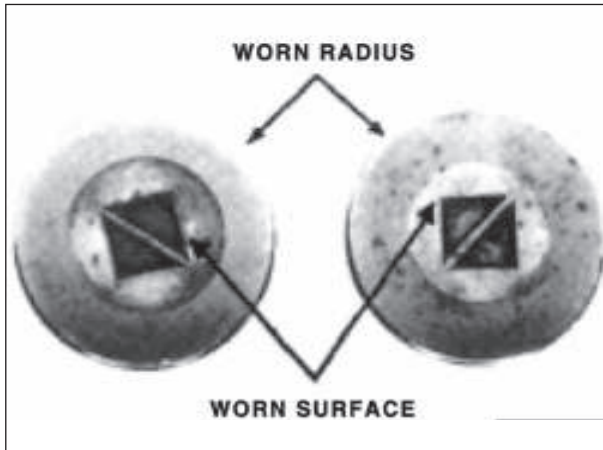
Use kerosene or diesel to wash the parts.

Dry the parts immediately after cleaning.

Apply axle lubricant/rust preventive over the reusable parts to prevent rust and corrosion.

Inspect roller bearings replace if any of the following conditions exist.

- i. Centre of bigger end of rollers worn to the level or below the outer surface.



- ii. Radius at the bigger end of the rollers worn out sharply.



- iii. Bright wear mark on the outer surface of roller cage.

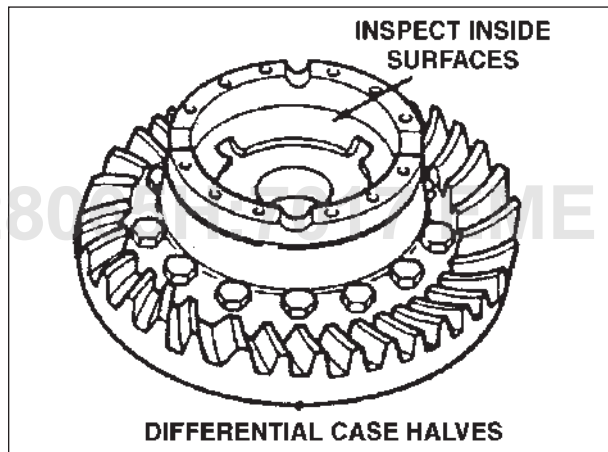


- iv. Etching and pitting marks on roller and on contact surfaces.

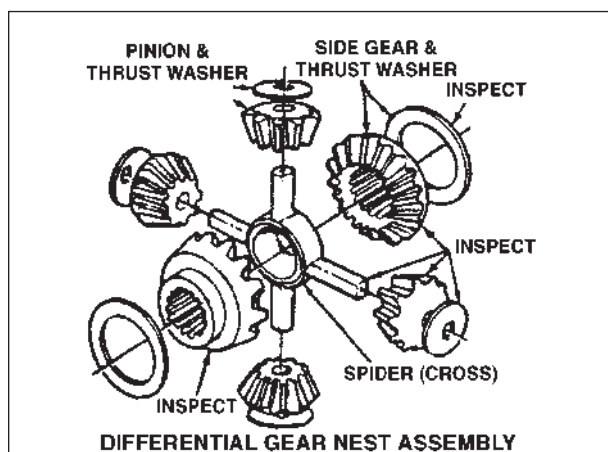


- v. Spalling and flaking marks on the cup and cone inner race surfaces.

Inspect the following parts for wear or stress.



- i. Inside surfaces of differential case halves.

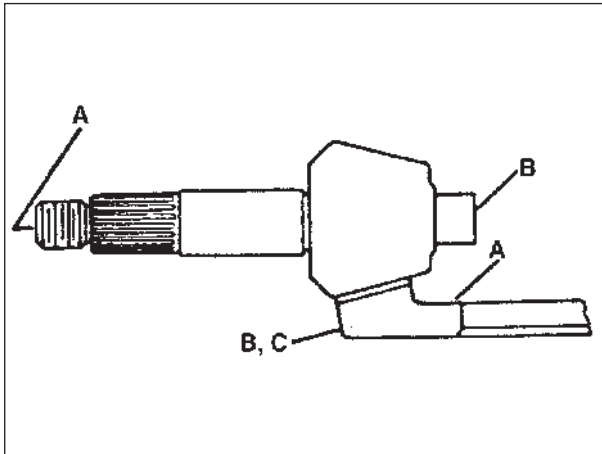


- ii. Both surfaces of all thrust washers.
- iii. Four trunnion ends of spider.
- iv. Teeth and splines of side gear.
- v. Teeth and bore of differential pinions.

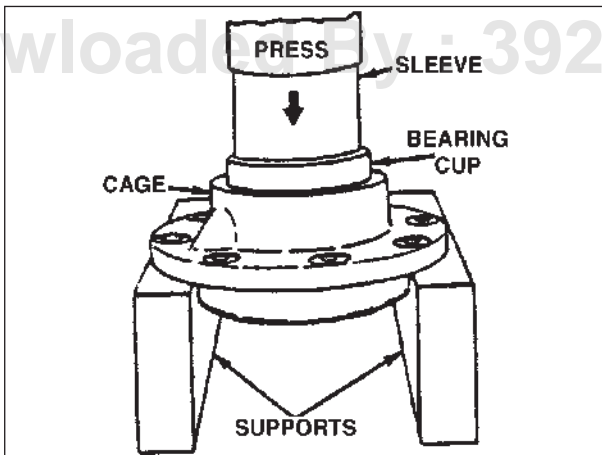
**12.7.2 Assembling of Carrier**

Before installing a new gear set ensure set number etched on the ring gear and the drive pinion are same.

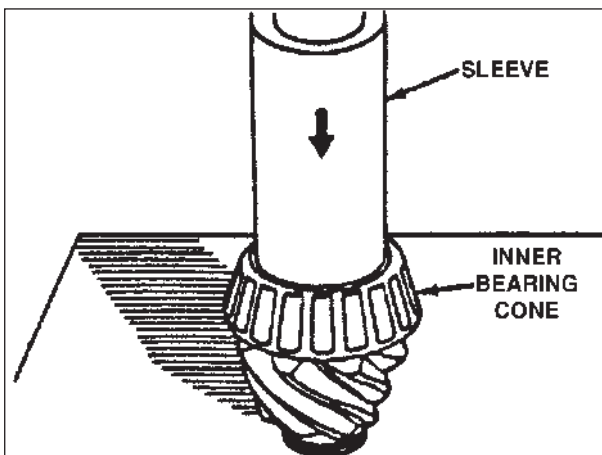
Location of marks are as shown in below



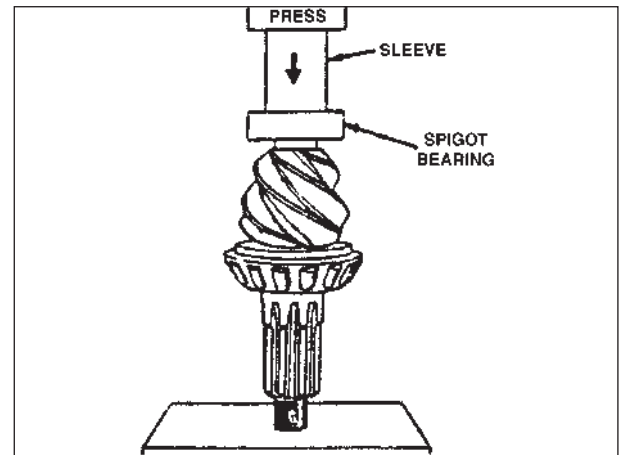
- Tooth combination number
- Set number
- Part number
- Pinion cone variation number



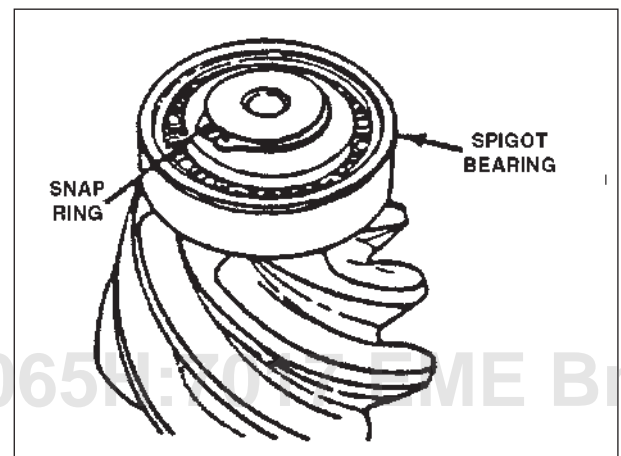
Press inner and outer bearing cups into bearing cage using correct sleeves.



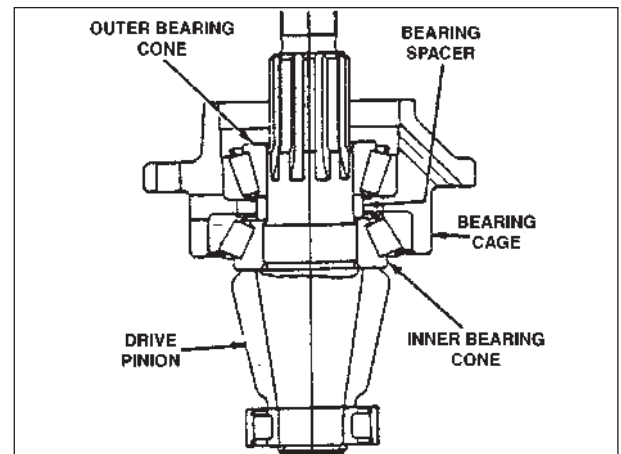
Press the inner bearing cone on the pinion till it sits firmly.



Press the spigot bearing on the drive pinion.



Install the snap ring into the groove.



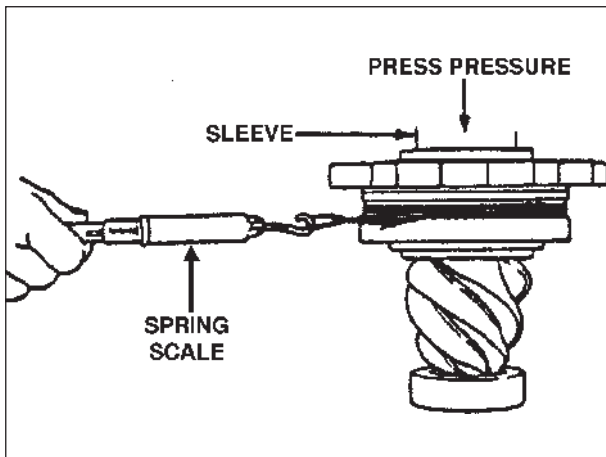
Position the bearing cage over inner bearing cone.

Apply axle lubricant on bearings.

Install the bearing spacer.

Press the outer bearing cone on the pinion till it sits firmly on the spacer.





Check and correct preload of pinion bearings. Adopting following procedure.

Place the pinion case assembly in a press.

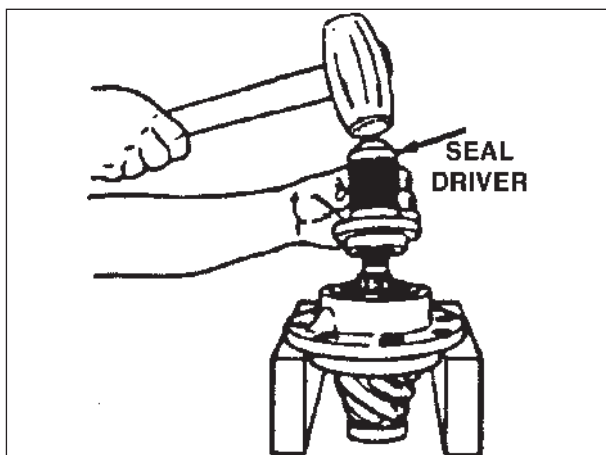
- Install a sleeve on outer bearing.
- Apply 30,000 lb. (15 tons) pressure.
- While pressure is held, wind a cord around the cage with the spring scale. **Fig - 32** (If the press is not available install companion flange and tight pinion nut to the torque of 300 - 400 lb. ft.)

Pull the cord on horizontal line. As the cage rotates read the scale. Spring scale read between 1 - 3.5 kg.

If the scale reading is not within the specifications.

- a) To increase preload reduce bearing spacer thickness.
- b) To reduce preload increase bearing spacer thickness.

Apply grease to the oil seal lips and the cavity between lips.



Use a mallet and the sleeve to install the seal.

Install washer and pinion lock nut tighten the pinion nut to the torque of 300-400 lb.ft.

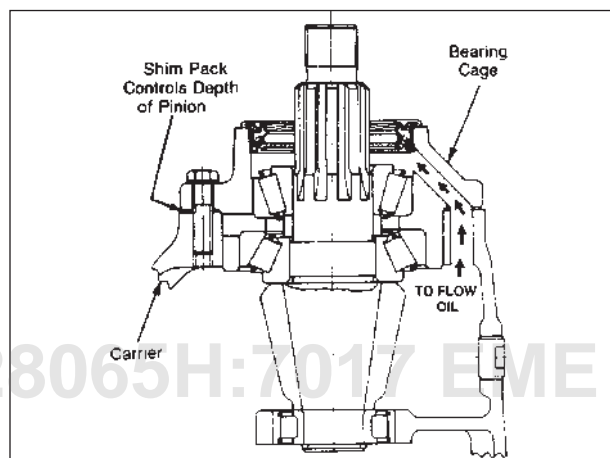
If original gear set is reused install the original shim pack.

If new gear is used, to arrive at correct mounting distance of drive pinion adopt following procedure.

- a) Note pinion cone variation no. etched on removed gear.
- b) If this is a plus(+), subtract (-) the no. from old shim pack thickness (or) If it is minus (-), add (+) the no. to old shim pack thickness.
- c) The value arrived as above, is the thickness of standard shim pack.
- d) If pinion cone variation no. of new gear set is minus (-), subtract the no. from standard shim pack arrived as above. (or) If it is plus(+), add to standard shim pack thickness.

Refer examples - chart 1

Install pinion bearing cage assembly with the new shim pack, calculated above with the differential carrier.



Align the capscrews with the above shim pack with the bearing lub hole on the differential carrier. **Fig - 34**

Torque tighten capscrews uniformly and alternatively so that pinion cage sits firmly.

**12.7.3 ADJUSTMENTS AND SPECIFICATIONS**

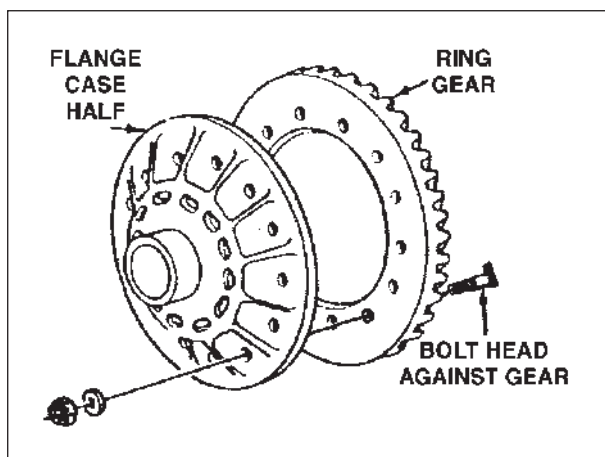
	Inches	mm
<b>Example 1:</b>		
Old Shim Pack Thickness	0.030	0.76
Old PC Number, PC + 2	- 0.002	- 0.05
Standard Shim Pack Thickness.	0.028	0.71
New PC Number, PC + 5	+ 0.005	+ 0.13
New Shim Pack Thickness	0.033	0.84

<b>Example 2:</b>		
Old Shim Pack Thickness	0.030	0.76
Old PC Number, PC - 2	+ 0.002	+ 0.05
Standard Shim Pack Thickness	0.032	0.81
New PC Number, PC + 5	+ 0.005	+ 0.13
New Shim Pack Thickness	0.037	0.94

<b>Example 3:</b>		
Old Shim Pack Thickness	0.030	0.76
Old PC Number, PC + 2	- 0.002	- 0.05
Standard Shim Pack Thickness	0.028	0.71
New PC Number, PC - 5	- 0.005	- 0.13
New Shim Pack Thickness	0.023	0.58

<b>Example 4:</b>		
Old Shim Pack Thickness	0.030	0.76
Old PC Number, PC - 2	+0.002	+0.05
Standard Shim Pack Thickness	0.032	0.81
New PC Number, PC - 5	- 0.005	- 0.13
New Shim Pack Thickness	0.027	0.68

Heat the ring gear in a water/oil bath to about 170°F (80°C) for 15 minutes.



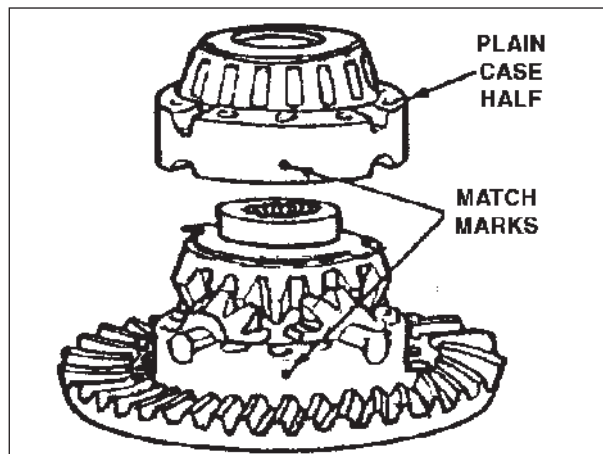
Install the ring gear on flange half immediately aligning mounting holes.

Install mounting bolts, washers and nuts.

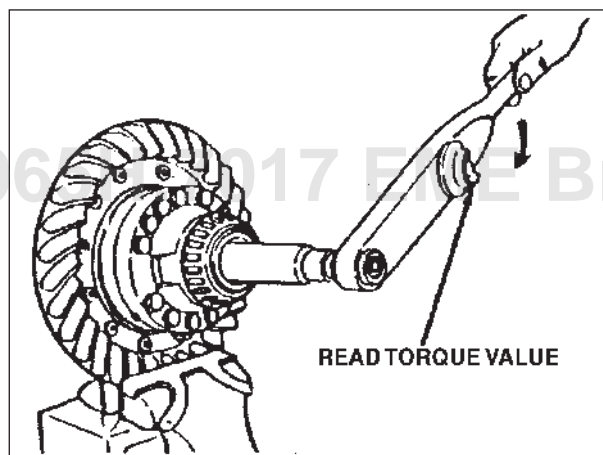
Tighten the bolts to the recommended torque.

Install the bearing cones on both differential cases

Install spider, side gear, differential pinions and thrust washers into flange half.



Install plain half aligning match marks.

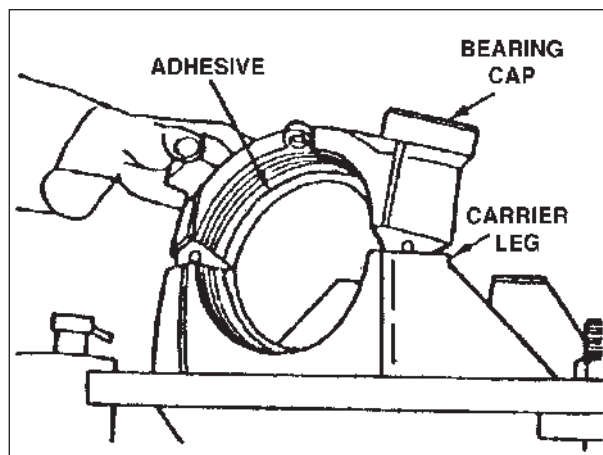


Tighten the differential case bolts as recommended.

Check the rotating resistance of differential gears.

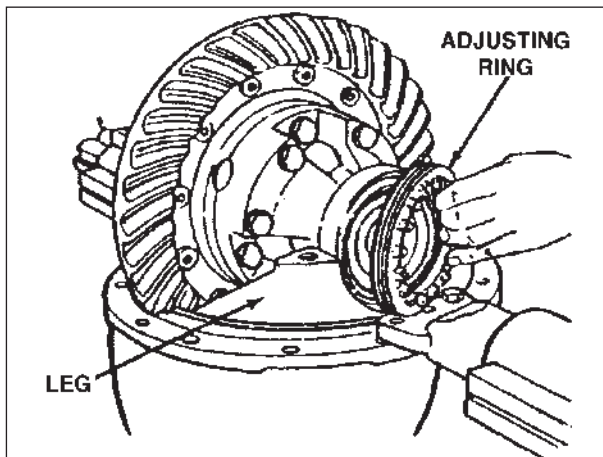
Recommended torque is 5 - 20 lb. ft.

If torque is more, check case halves, spider, differential gears thrust washers. Replace the parts as necessary.



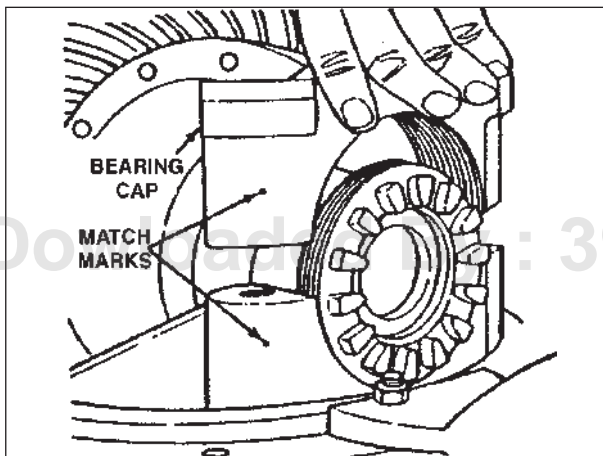
Apply adhesive to bearing bores.

Install differential assembly into the carrier

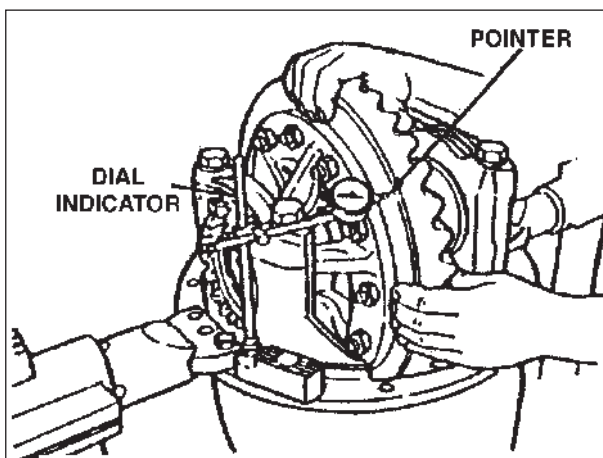


Install both side adjusting rings and hand tighten till these touches the differential side bearings.

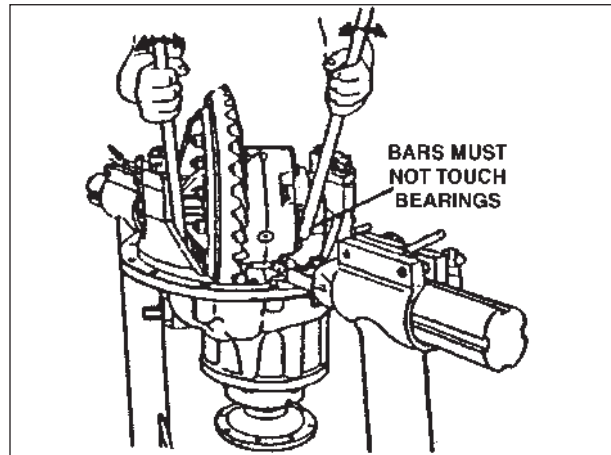
Install the bearing caps aligning the match marks.



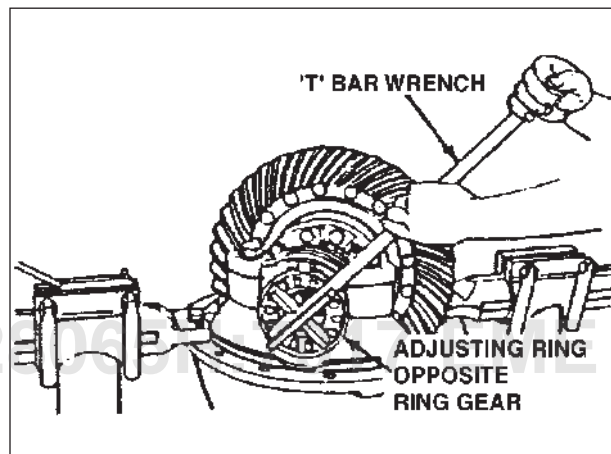
Tighten the bearing cap bolts until the bolt head sits on the bearing caps.



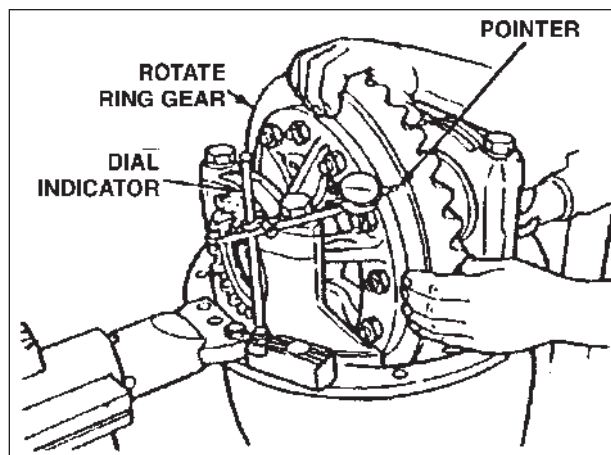
Attach a dial indicator so that the plunger is against the back face of the ring gear.



Move the differential to the left and right with pry bars and ensure small amount of end play.



Tighten the adjusting ring opposite to ring gear till the indicator shows zero end play.

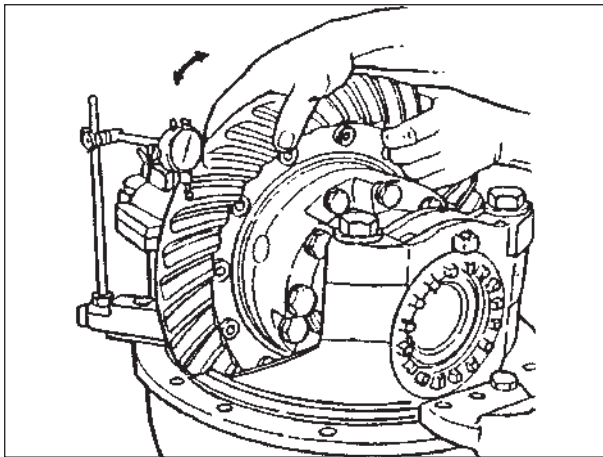


Tighten both adjusting rings one notch to preload the differential bearings.

Adjust dial indicator to zero.

Rotate the ring gear to check the run out.

Run out should be within 0.008" (0.20mm)



Position the dial indicator so that the plunger is on the drive side of the tooth.

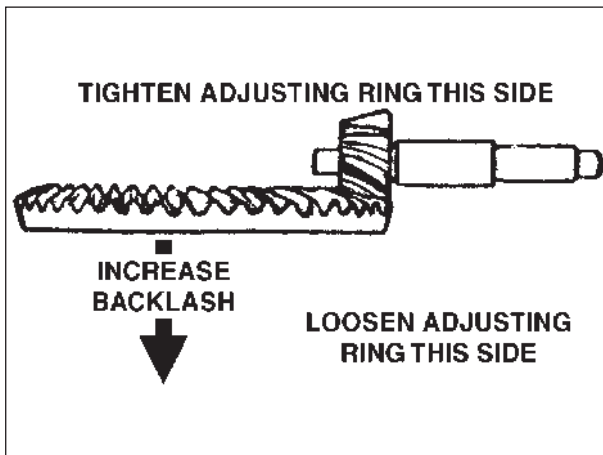
Adjust the backlash by loosening the one of the adjusting rings and tightening the other adjusting ring to the equal amount.

**Backlash specification:**

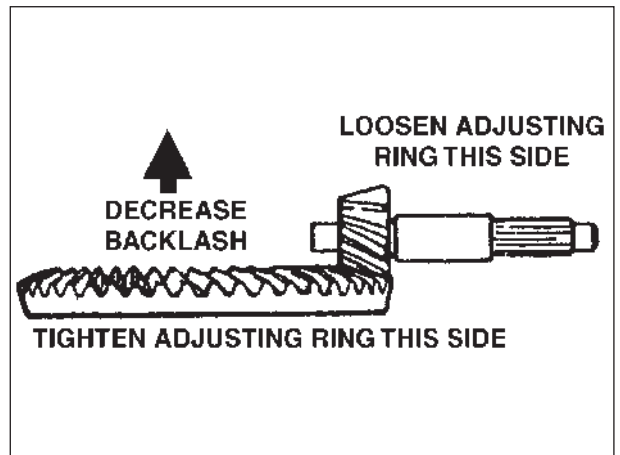
Backlash range = 0.008" - 0.018"  
(0.20 - 0.46 mm)

Backlash for new gear set = 0.012" (0.30 mm)

While reusing old gear set adjust the backlash noted during dismantling.

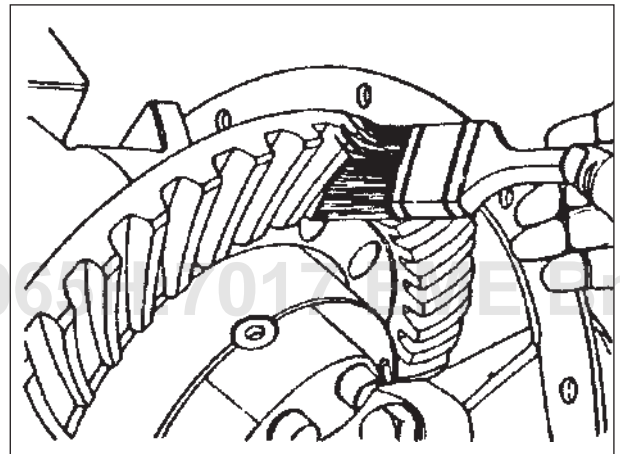


To increase backlash move the ring gear away from the drive pinion.



To decrease backlash move the ring gear towards the drive pinion.

Apply marking compound to six teeth of ring gear.



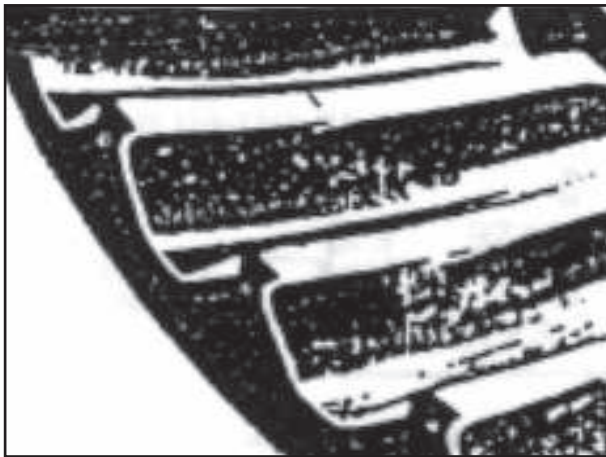
Rotate the ring gear forward and backward so that these teeth go past pinion to obtain clear pattern.



Compare the contact pattern

**Good contact pattern** - towards the toe of the gear teeth and in centre between top and bottom of teeth.



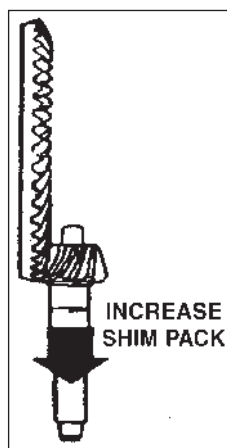
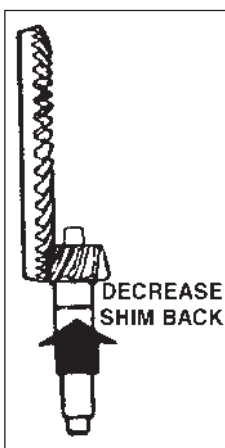


**High pattern** - this indicates that the drive pinion is not installed deep enough into the carrier.



**Low pattern** - this indicates that the drive pinion is installed too deep in the carrier.

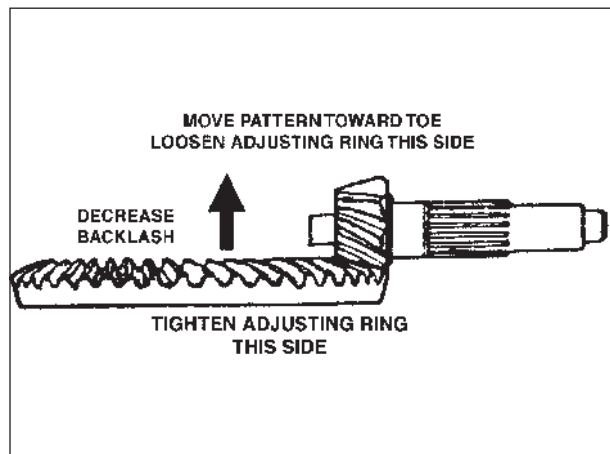
To correct the pattern proceed as follows.



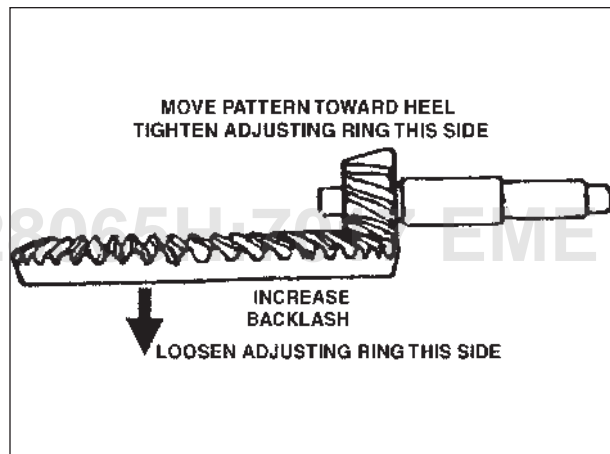
**High pattern** - decrease the thickness of shim pack under bearing cage. This will move the pinion towards ring gear.

**Low pattern** - increase the thickness of shim pack under bearing cage. This will move the pinion away from ring gear.

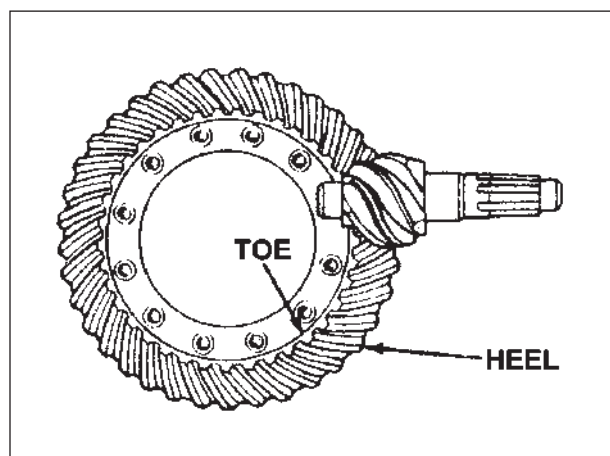
**Location of patterns** - to move the contact patterns to the correct location in the length of teeth, adjust the backlash within specified range as follows.



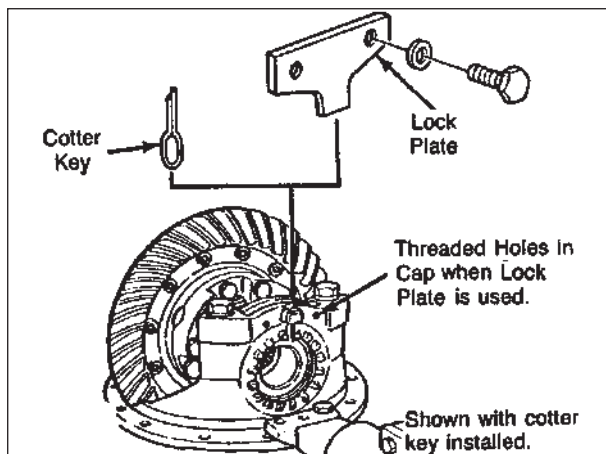
To shift the pattern towards toe of the teeth to decrease the backlash.



To shift pattern towards heel of the teeth to increase backlash.

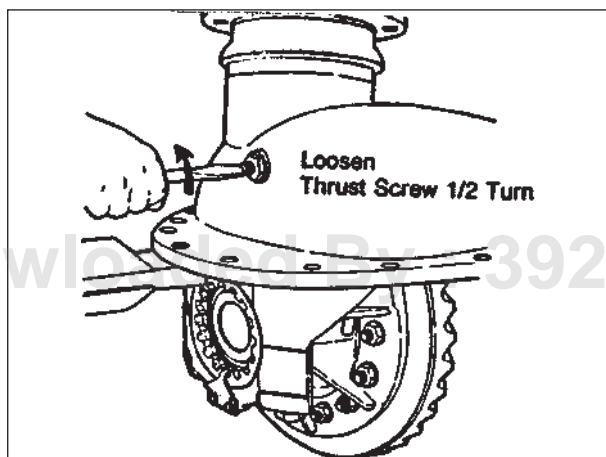


Tighten the bearing cap bolts to the recommended torque.



Install the cotter pins in the adjusting rings using a drift and hammer.

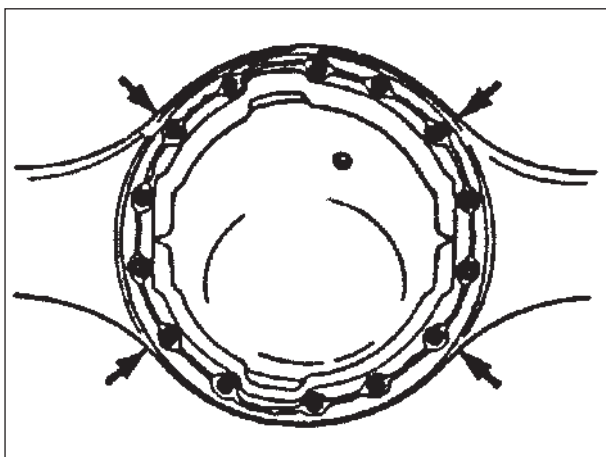
Install the thrust screw and tighten until it touches the ring gear.



Loosen the thrust screw  $\frac{1}{2}$  turn (180°). Clearance between thrust screw and ring gear should be 0.025" - 0.045" (0.65 - 1.14 mm)

Tighten jam nut to the recommended torque.

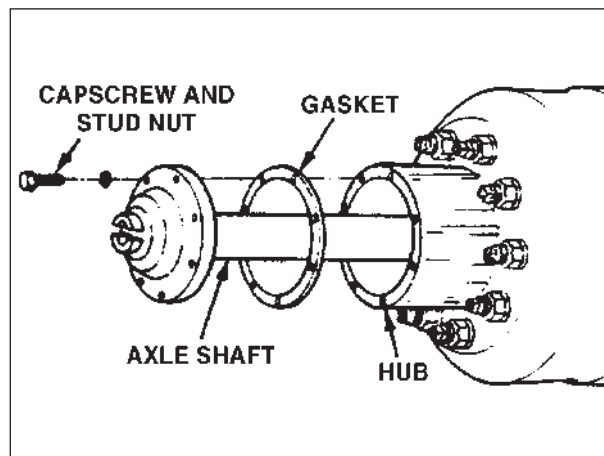
Clean the housing mounting face. Remove the old gasket material.



Apply silicon gasket material uniformly on the mounting surface of the housing.

Install the carrier into the housing.

Install washers, nuts and capscrews. Tighten to the recommended torque.



Install the gaskets and axle shafts.

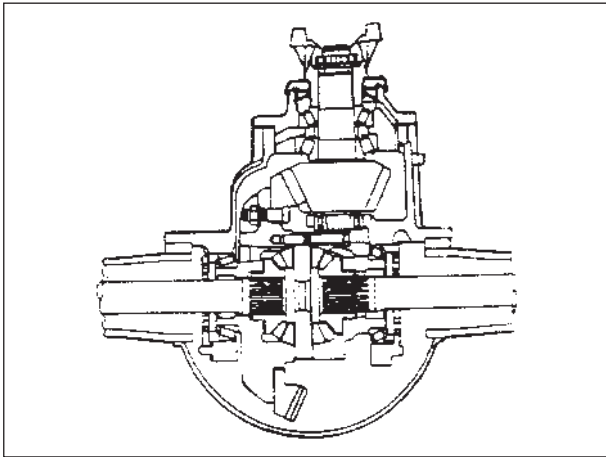
Install the washers and cap screws and tighten to the correct torque value.

Connect propeller shaft to the input flange.

Install drain plug and fill up with lubricant to the required level.



## 12.8 INSTALLATION OF DIFFERENTIAL CARRIER WITH AXLE HOUSING

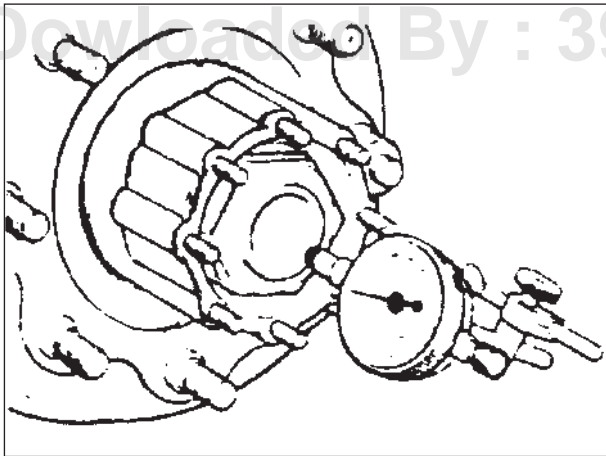


Apply silicone gasket material / Anabond 666 to the mounting surface.

Install carrier into the axle housing.

Install washers / nut / capscrews holding the carrier and tighten a pattern opposite each other.

Install gaskets and axle shafts into the axle housing and carrier. install fasteners and tighten.



### Rear Hub Setting and End Play

#### Dismantling and Inspection

1. Remove the wheels and brake drum.
2. Remove axle shaft.
3. Loosen outer wheel bearing locknut & pierced washer & inner nut.
4. Pull out hub along with outer bearing.
5. Remove inner bearing.
6. Clean, Inspect and replace worn out parts and seals.

#### Hub Setting

- Repack inner, outer bearing and hub cavity with grease.

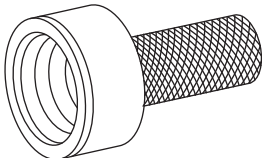

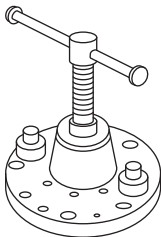

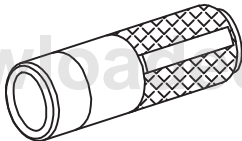

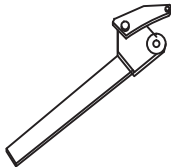
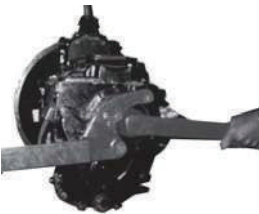
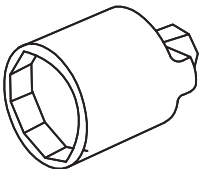

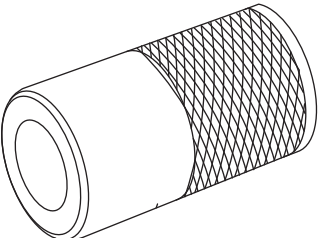
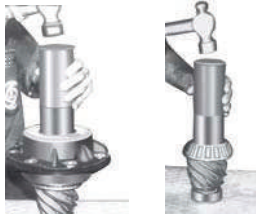
- Pack the grease inside the hub.
- Place inner bearing in outer race. Install the inner oil seal on the hub using bung and hammer.
- Position the hub on the axle housing and fit outer bearing (pre-greased) and fasten adjusting nut to the bearing surface and tighten to the torque (138 Nm).
- Loosen the nut and retighten to torque (69 Nm)
- Back-off adjusting nut by 1/6 to 1/4 turn.
- Ensure the end play within 0.025 mm - 0.076 mm.
- If the end play is not within limits, adjust the nut for required end play.
- Locate the washer in adjusting nut dowel and fit lock nut. Tightening torque of the lock nut is 350 Nm.

## 12.9 REPAIR WELDING OF HOUSING

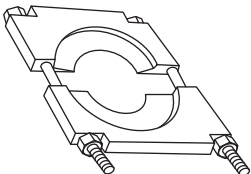
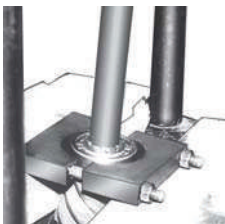
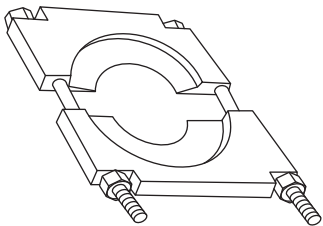

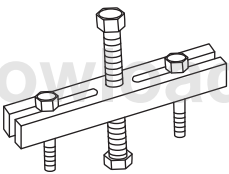
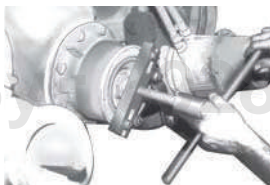
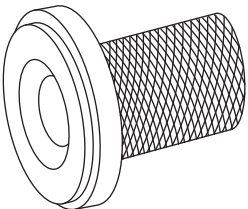

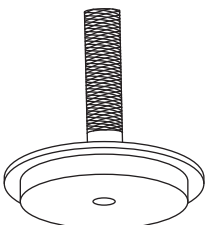

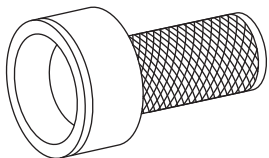

1. Repair weld is permitted only on the areas of cover weld, seam weld, and bracket welds.
  2. Drain the lubricant from axle assy. Remove axle shafts and differential carrier.
  3. Clean the cracked area inside and outside the housing with a cleaning solvent.
- Grind the damaged weld to the base metal.
  - Warm the complete housing to the temperature of 70°F - 80°F (21°C to 27°C) or higher
  - Heat the damaged area to approximately 300°F (149°C).
  - Use a 70,000 psi tensile weld rod of 4 to 5 mm diameter. Recommended electrodes are SUPER CITO of Advani Oerlikon and Supratherm of D & H.
  - Opening in cover weld must be filled to the level with old weld.
  - Clean the new weld area, remove the weld spatters.
  - Install the differential carrier and axle shafts.



## 12.10 SPECIAL MAINTENANCE TOOLS

SPECIAL MAINTENANCE TOOL	APPLICATION	DESCRIPTION
0507006 - DRIFT SPIGOT BEARING		
		TO INSTALL SPIGOT BEARING
0507003 - PULLER HUB REAR AXLE		
		TO EXTRACT HUB REAR AXLE Q109
0605007 - DRIFT-CIRCLIP, EXPANDER ASSEMBLY		
		TO INSTALL CIRCLIP ON EXPANDER ASSY.
0301007 - FLANGE HOLDER		
		TO HOLD GB OUTPUT FLANGE WHILE TIGHTENING OR LOOSENING FLANGE NUT
0505002 - SPANNER HUB NUT		
		TO TIGHTEN OR LOOSEN HUB NUT REAR
0507007 - DRIFT INNER & OUTER BEARING		
		TO INSTALL INNER AND OUTER BEARING - PINION

**12.10 SPECIAL MAINTENANCE TOOLS**

SPECIAL MAINTENANCE TOOL	APPLICATION	DESCRIPTION
<b>0507004 - PULLER SPIGOT BEARING</b>		
		TO EXTRACT PINION SPIGOT BEARING
<b>0507005 - SPLIT PULLER INNER BEARING</b>		
		BEARING PINION
<b>0507002 - PULLER FLANGE</b>		
		TO EXTRACT COMPANION FLANGE
<b>0507009 - DRIFT OIL SEAL PINION HOUSING</b>		
		TO INSTALL OIL SEAL - PINION HOUSING
<b>0501004 - DRIFT REAR HUB INNER SEAL</b>		
		TO INSTALL INNER SEAL ON REAR HUB
<b>0507010 - DRIFT DIFFERENTIAL BEARING</b>		
		TO INSTALL DIFF. SIDEBEARINGS



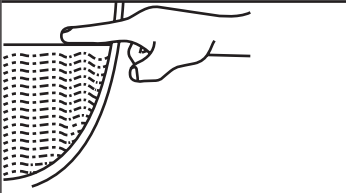
## 12.10 SPECIAL MAINTENANCE TOOLS

SPECIAL MAINTENANCE TOOL	APPLICATION	DESCRIPTION
0507001 - TOOL ADJUSTING RING		
		TO ADJUST CROWN WHEEL AND PINION BACKLASH
6809 - REPAIR STAND		
		TO MOUNT THE CARRIER ON A REPAIR STAND

## 12.11 TIGHTENING TORQUES

Description	C100 Rear Axle			RS120 Rear Axle		
	Kgm	lb.ft	Nm	Kgm	lb.ft	Nm
Differential case capscrew	10-12	75-90	100-125	14-17	105-125	145-170
Crown wheel to differential case	12-16	85-115	115-155	9-11	65-80	90-110
Pinion bearing cage capscrew	6-7	40-50	55-65	10-12	75-90	100-125
Capscrew-Carrier and Cap	25-30	180-220	245-300	25-30	180-220	245-300
Thrust screw & jam nut	20-26	150-190	205-255	20-26	150-190	205-255
Drive pinion nut	41-55	300-400	405-540	102-127	740-920	1005-1250
Carrier to housing capscrew	10.4-12.4	75-90	102-122	10.4-12.4	75-90	102-122
Breather Assy	2.7	20	28	2.7	20	28
Oil plug (Filler & Drain)	4.8	35	45	4.8	35	45
Adjusting Nut	14	101	138	14	101	138
Jam Nut	27-40	196-40	267-401	27-40	196-40	267-401
Wheel bolt	NA	NA	NA	NA	NA	NA
Axle shaft mounting bolt	5.1-7.1	37-52	52-70	5.1-7.1	37-52	52-70
Bolt - Brake Carrier Assy	9.7-10.7	70-77	95-105	9.7-10.7	70-77	95-105

## 12.12 FILLING CAPACITY

Sl.No	Aggregate	Filling Capacity Approx.	Hub Grease	CORRECT
1	C100	6 Ltrs.	375±25 grams/per hub	 Fill up the oil up to filler plug level
2	RS120	6.5 Ltrs.		

## 12.13 RECOMMENDED LUBRICANTS

Aggregate	Minimum Ambient Temp. °C	Co-branded Lubricant	Approved Lubricant
		Gulf Oil India	Indian Oil Corporation
Rear Axle Hypoid drive (For All applications)	-10	Gulf Gear DB Dura Max 85W-140	Servo Gear Axle ALT85W140
Wheel Bearing Rear Hub Greasing	-20	Crown Max RR3	Servo Gem ALT

NOTE : Do not mix lubricants of different brands/grades.

## 12.14 MAINTENANCE PROGRAMME

MAINTENANCE ACTIVITY		PDI	Weekly	Every km x 1000	Remarks
1	Check oil level and top up if required. - Ecomet BSIII & Lynx BSIV	✓			
2	Check oil level and top up - Stag BSIII & Lynx BSIII		✓	8	
3	Change oil (drain oil when hot). Refill up to correct level			80	
	For all applications other than tippers				
	Hypoid gear drive head.				
	For Tippers			1500 hrs	
	Hypoid gear drive head.				
4	<b>For all applications other than tippers</b>			48	
	Repack the hubs with recommended grease.				
	Check the condition of hub bearings and change if necessary.				
	Adjust hub end play.				
	Check and reset pole wheel sensor air gap.				
5	<b>For Tippers</b>			500 hrs	
	Repack the hubs with recommended grease.				
	Check the condition of hub bearings and change if necessary.				
	Adjust hub end play.				

# **FRONT AXLE**

**(FA85)**



**ASHOK LEYLAND**



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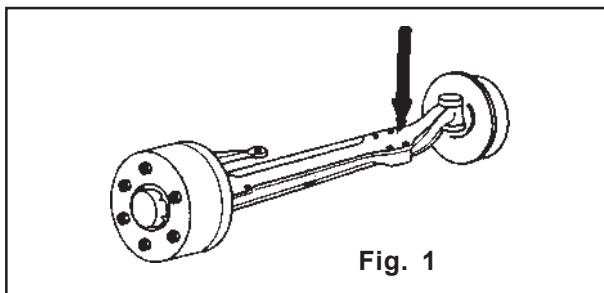
## CHAPTER - 42

## FRONT AXLE - FA 85

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**42.0 GENERAL****Front Axle Sl. No. and Type**

The front axle serial number and type of front axle are punched near boss of axle beam. (see fig.1)

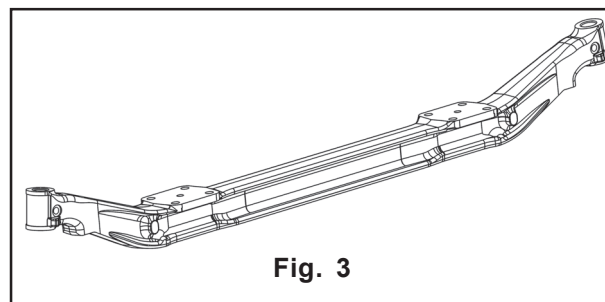
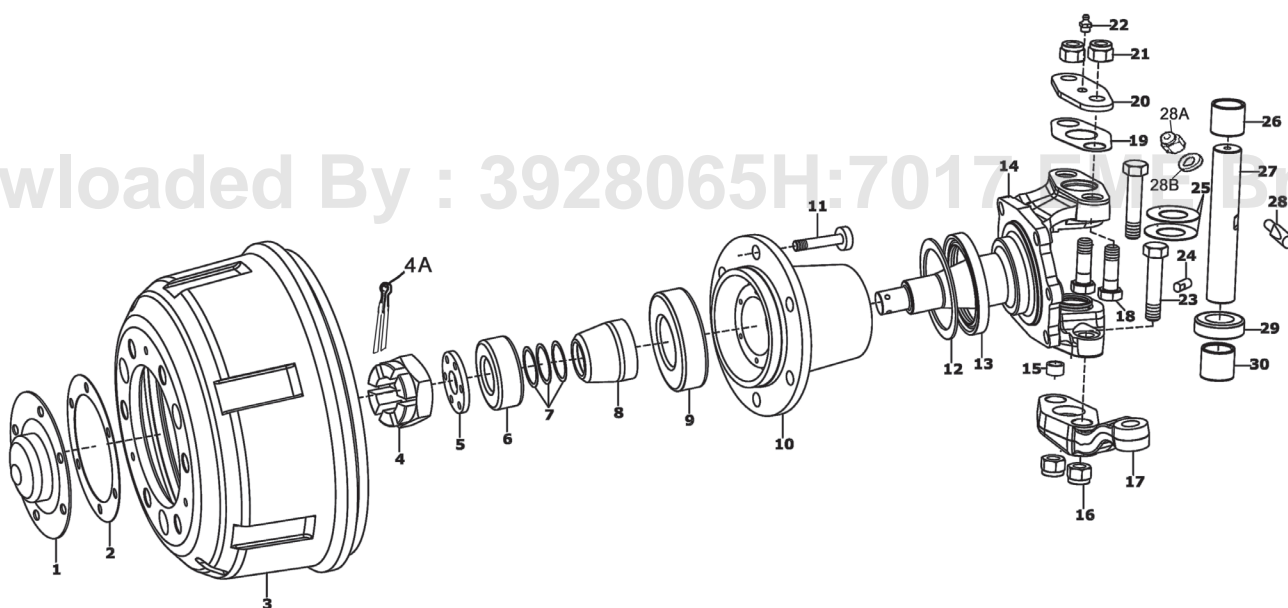
**Fig. 1****Design and Description**

The front axle & suspension system (see fig.2) is conventional in design, and consists of an 'I' section axle beam, to which is connected at each end an axle arm. The axle arm carry wheel hub and drum assemblies as fitted.

The axle beam is suspended on springs which are attached to the vehicle chassis frame. Shock absorbers are fitted to dampen the effect of the road shocks.

**Axle Beam**

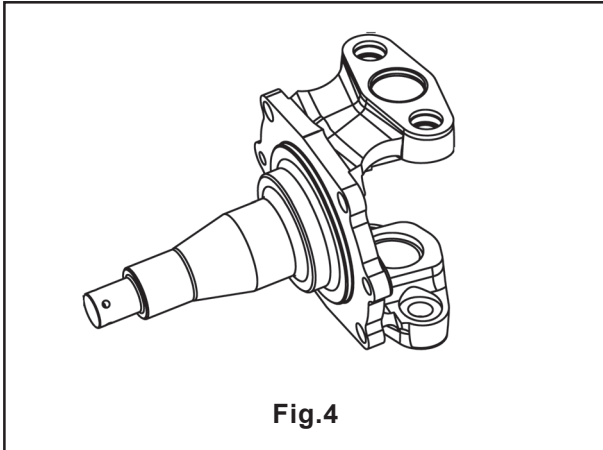
The axle beam is an 'I' section steel forging, with two locating flanges on the top surface for mounting the road springs, and an inclined eye at each end to locate & support the king pins. (see fig.3)

**Fig. 3****Fig. 2**

Description	ILL No.	Description	ILL No.
HUB CAP	1	TRACK ROD LEVER	17
GASKET	2	BOLT	18
BRAKE DRUM	3	GASKET	19
CASTEL NUT	4	KING PIN COVER	20
SPLIT PIN	4A	NUT	21
WASHER	5	GREASE NIPPLE	22
TAPER ROLLER BRG - OUTER	6	BOLT	23
SHIMS	7	MAX CUT SCREW	24
DISTANCE PIECE	8	SHIMS FOR AXLE ARM PLAY	25
TAPER ROLLER BRG - INNER	9	BUSH	26
FRONT HUB	10	KING PIN	27
WHEEL BOLT	11	COTTER PIN	28
PLATE OIL SEAL	12	NUT	28A
HUB OIL SEAL	13	WASHER	28B
AXLE ARM	14	THRUST BEARING	29
HOLLOW DOWEL	15	BUSH	30
NUT	16		

**Axle arm**

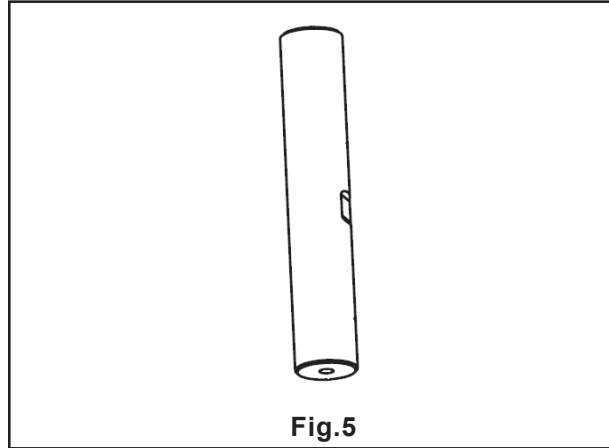
The forged steel axle arm have two bosses which are bored and fitted with bushes to accommodate the king pins. The vertical load on the axle arm is transferred to the axle beam via a thrust bearing. The upper and lower steering arm are fitted to the axle arm, the method of fitment being dependent on the type of axle. The axle arm also incorporates a flange to provide a mounting for the brake backplate. (see fig.4)

**Fig.4**

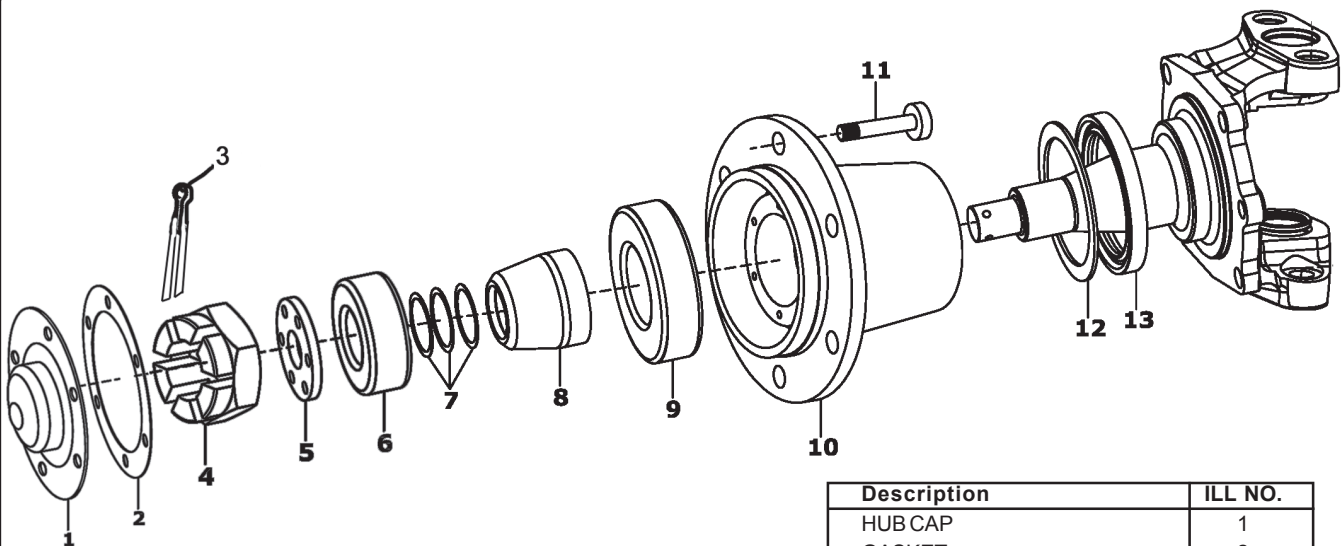
The steering arm is bolted to the axle arm and in addition the brake backplate is retained by the steering arm bolts. On these axles it is necessary to remove the brake backplate to remove the trackrod lever.

**King Pins**

The axle arms are connected to the axle beam by hardened steel king pins. Each pin is located and secured in the axle beam eye by taper cotter pin with lock nut arrangement. (see fig.5)

**Fig.5****Front Hubs**

The hubs are mounted on the axle arm spindles by two taper roller bearings. Correct wheel bearing adjustment is achieved by means of a distance piece and shims arrangement. The wheel bearings are to be packed by kneading the grease into the bearings. The front axle grease cup has to be packed fully with grease. (see fig.6)

**Fig.6**

Description	ILL NO.
HUB CAP	1
GASKET	2
SPLIT PIN	3
CASTEL NUT	4
WASHER	5
TAPER ROLLER BRG - OUTER	6
SHIMS	7
DISTANCE PIECE	8
TAPER ROLLER BRG - INNER	9
FRONT HUB	10
WHEEL BOLT	11
PLATE OIL SEAL	12
HUB OIL SEAL	13



## 42.0.1 Data

	ALFA85
Type	Reverse Elliot
Axle Capacity	3800 kg
King pin Inclination	7°
King pin centre	1546/1542
Camber (+ve)	1.5° (Proposed 0.8°)
Toe-in	0 - 1.6 mm
Spring Centre	779.5 mm
Kingpin bore in axle beam -	
Standard	31.27mm to 31.30mm
OS 1	31.57 - 31.60mm
OS 2	31.87 - 31.90mm
OS 3	32.27 - 32.30mm
King pin dia	
Standard	31.257 - 31.27mm
OS 1	31.557 - 31.57mm
OS 2	31.857 - 31.87mm
OS 3	32.257 - 32.27mm
King pin bush inner dia before pressing	
Standard	31.36/31.39mm
OS 1	31.66/31.69mm
OS 2	31.96/31.99mm
OS 3	32.36/32.39mm
King pin bush inner dia after pressing	
Standard	31.31/31.35mm
OS 1	31.61/31.65mm
OS 2	31.91/31.95mm
OS 3	32.31/32.35mm
King pin bore in thrust brg	
Standard size	32.0 <sup>+ 0.240mm</sup> <sub>+ 0.035mm</sub>
OS 1	32.3 <sup>+ 0.208mm</sup> <sub>+ 0.055mm</sub>
OS 2	32.6 <sup>+ 0.247mm</sup> <sub>+ 0.095mm</sub>
OS 3	33.0 <sup>+ 0.208mm</sup> <sub>+ 0.056mm</sub>
King pin bush outer dia	37.105 -37.195mm
Bore dia in axle arm for bushes	37.085 - 37.135mm
Interference of bushes in axle arm	0.03 – 0.11mm

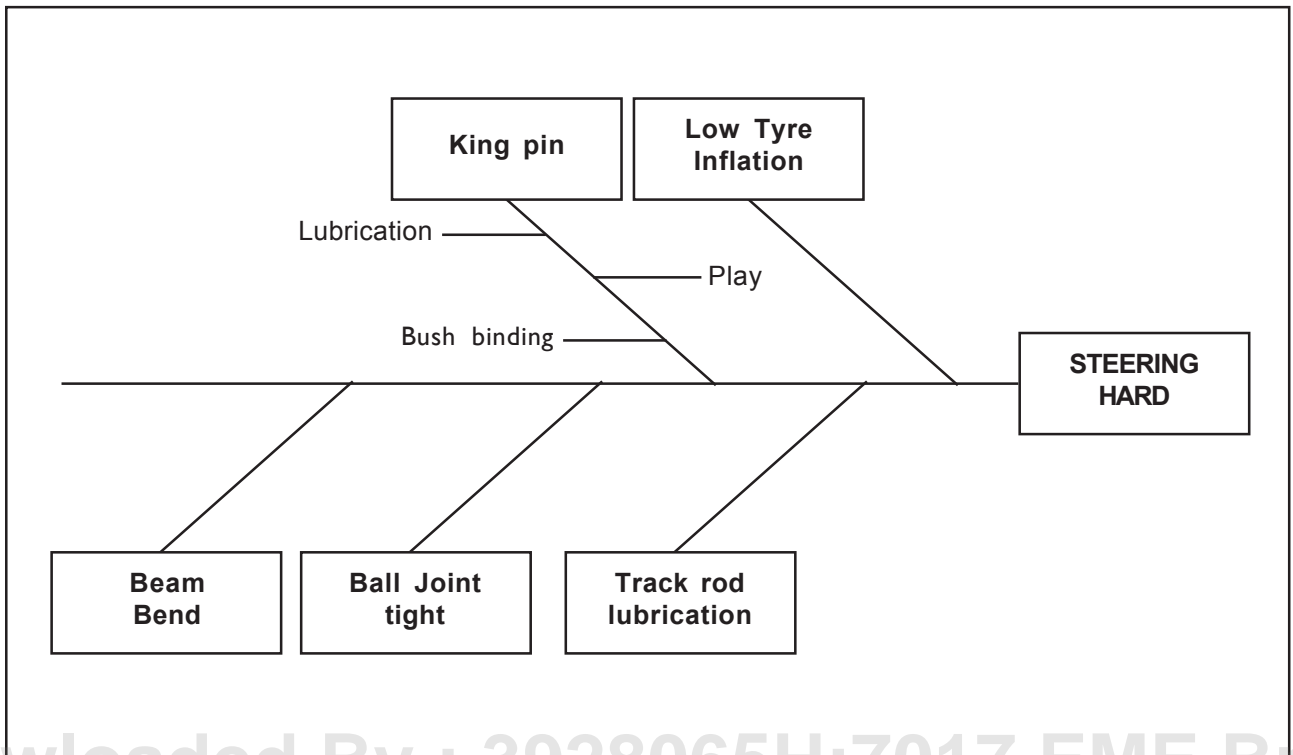
**42.0.1 Data**

	<b>ALFA85</b>
Thrust taken on	Taper roller Thrust bearing
Axle arm end play	0.025 – 0.10 mm
Shims available for axle arm end play	0.003", 0.005", 0.01", 0.02", 0.04"
Wheel bearings	
Inner brg	
Inner dia	57.15 - 57.163 mm
Outer dia	112.712 – 112.737 mm
Outer brg	
Inner dia	38.1 – 38.113mm
Outer dia	79.375 - 79.4mm
Axle drop	55 mm
Hub	
Inner bearing seating Dia	112.662 – 112.69 mm
Fit of inner race	0.005 – 0.031 mm
Fit of outer race	0.022 – 0.075 mm
Outer bearing seating Dia	79.337 – 79.362mm
Fit of inner race	0.005 – 0.031 mm
Fit of outer race	0.013 – 0.063 mm
Hub end play	0.025 – 0.10 mm
Shims available for hub end play adjustment	0.002", 0.003", 0.005", 0.010", 0.020"
Brake drum size	350 – 350.25mm

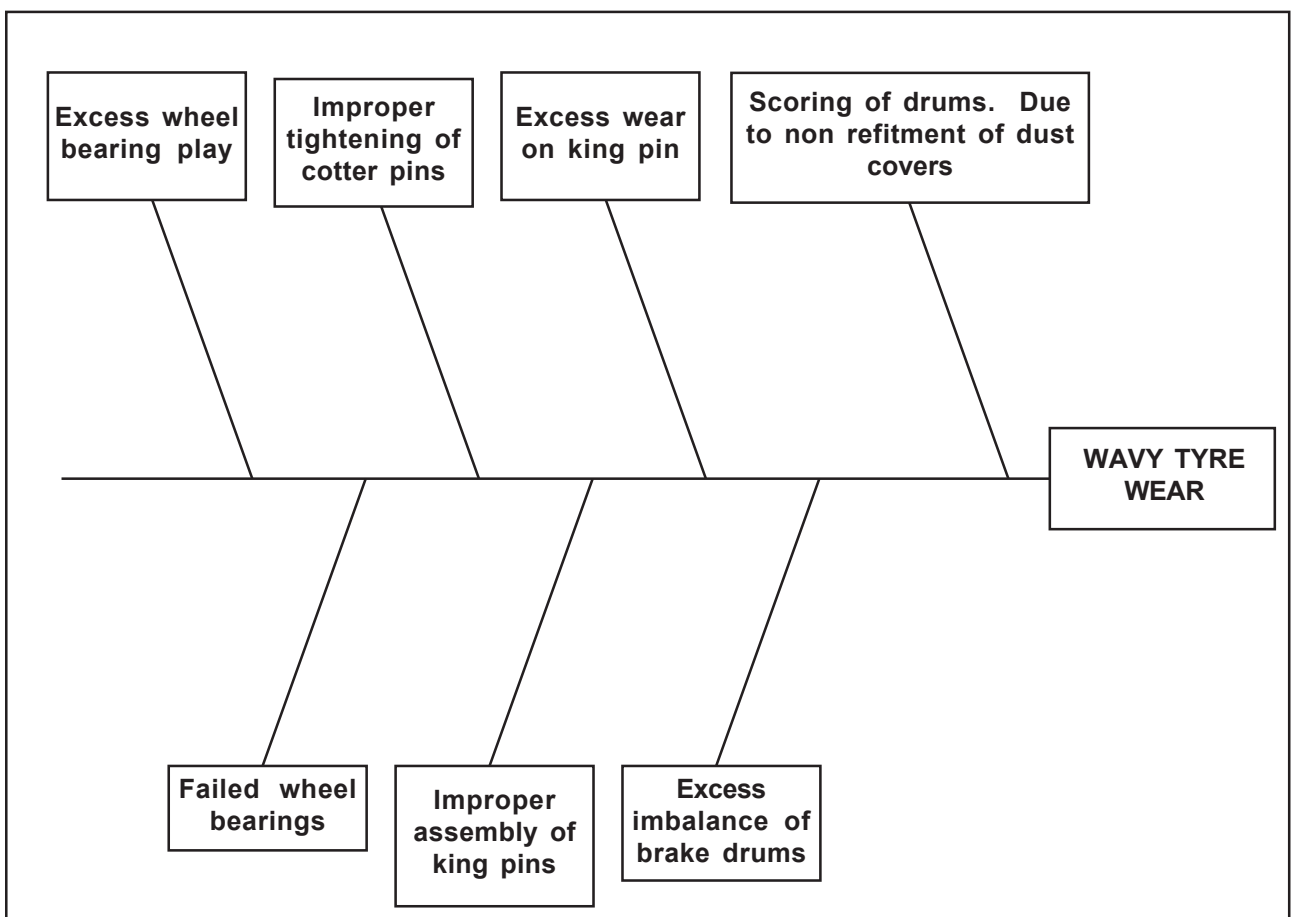
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## 42.0.2 Front Axle Preliminary Checks

It is mandatory to carry out few preliminary check on front axle before dismounting from the vehicle. The following cause and effects diagram can lead to overhauling decision.

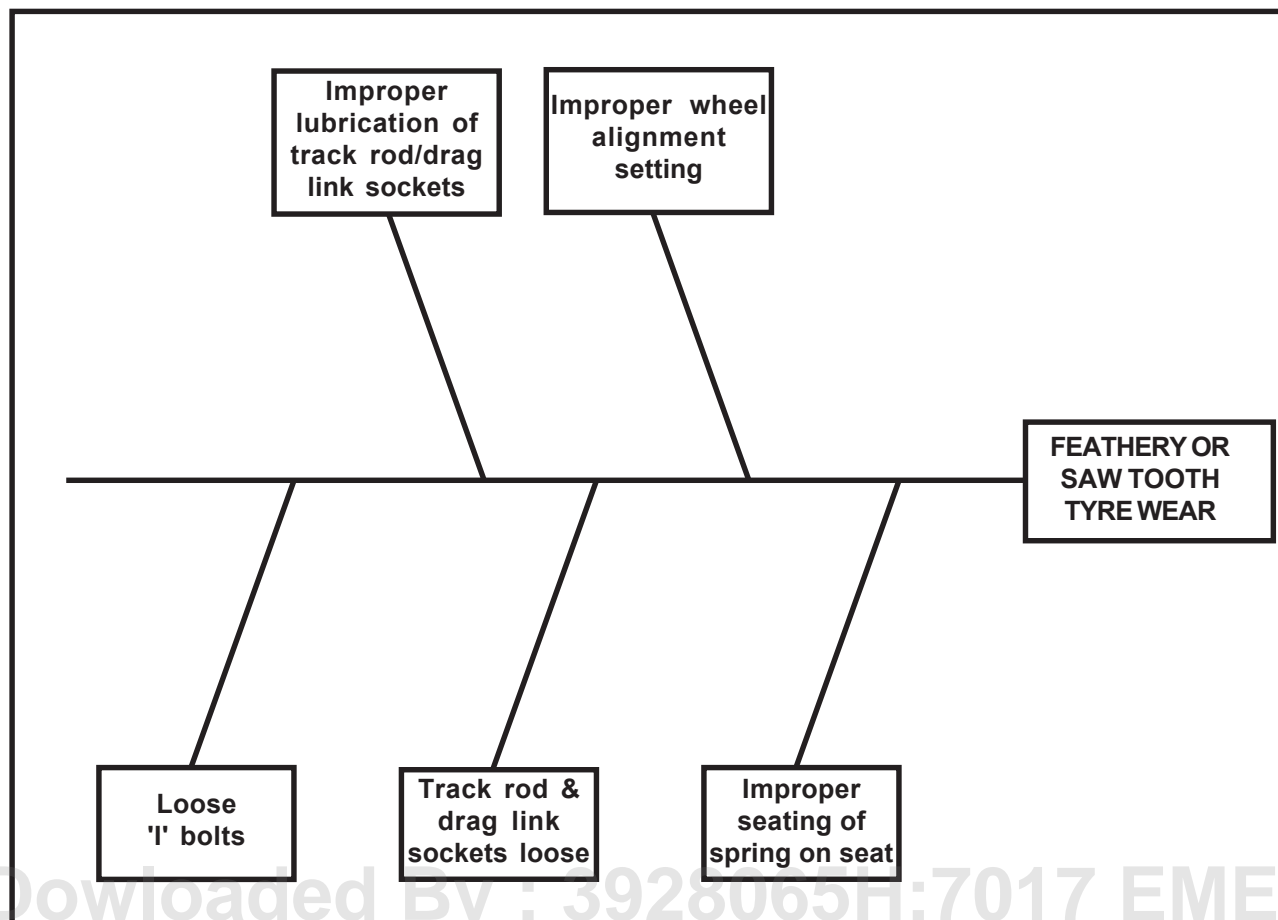


Cause and Effect Diagram - Steering Hard

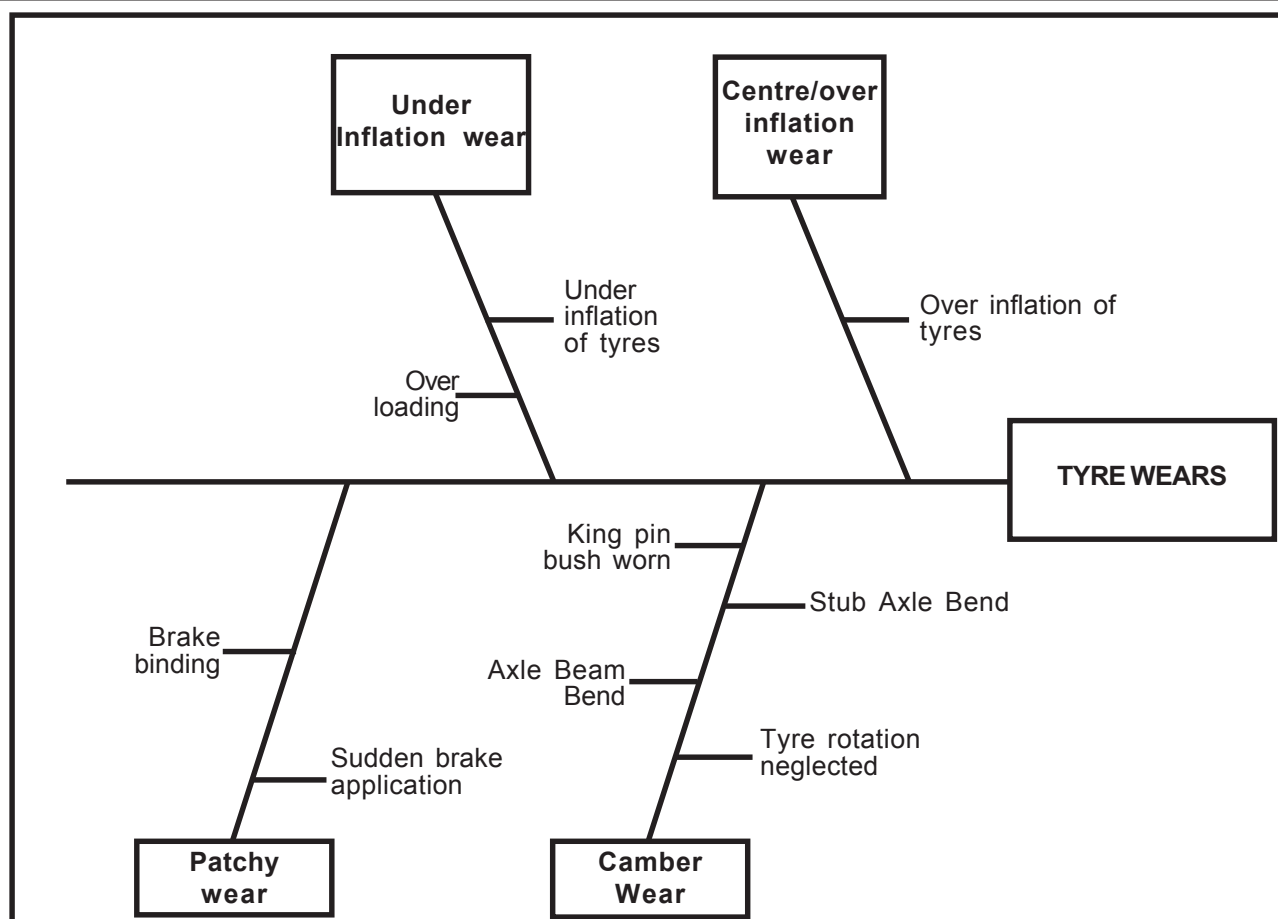


Cause and Effect Diagram - Wavy Tyre Wear





Cause and Effect Diagram - Feathery or Saw Tooth Tyre Wear



Cause and Effect Diagram - Tyre wears

**42.0.3 Steering Geometry Checking Procedure****Ensure the following before checking the Wheel Alignment**

Park the unladen vehicle on level ground.

Ensure all tyres are of same size and tread wear is uniform.

Ensure tyres are inflated to recommended pressure.

Check spring pin bush wear is within limit.

Ensure the spring cambers are equal on both sides.

Spring mounting bolts are tightened to correct torque value.

Ensure hub end play as recommended.

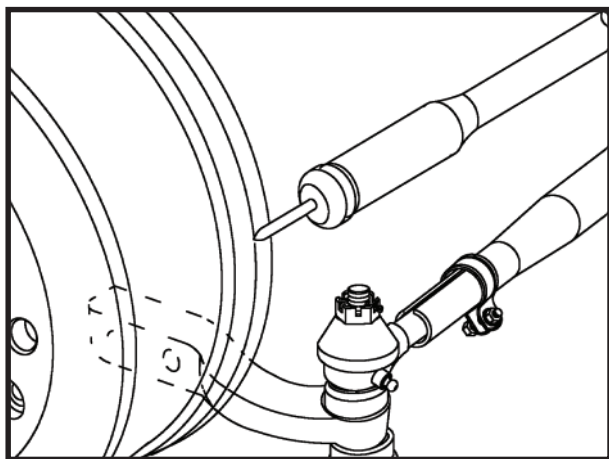
**To Set Toe-in**

Set the wheels in the straight ahead position.

Place the toe in gauge in front of the front brake drum machined area and adjust the height of the pointers of gauge to the centre of the brake drum on LH and RH sides and note the reading.

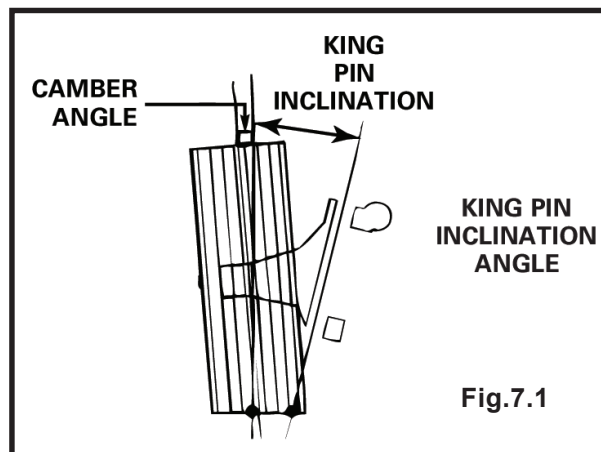
Mark both the brake drums with chalk at the points where the pointers have touched. Remove toe-in gauge.

Now roll the vehicle forward one half revolution until the chalk marks turn by 180° towards the rear, i.e., the chalk marks are at the rear.

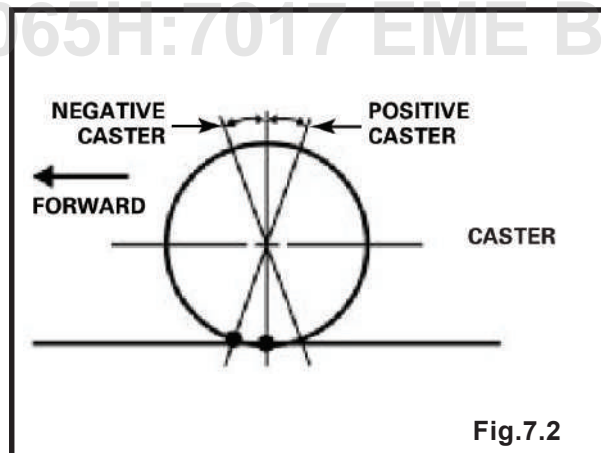
**Fig.7**

Place toe-in gauge behind the front axle and let the pointers touch the chalk mark. Note down the reading. It should be 0-1.6 mm toe in. (see fig. 7)

In case the readings do not correspond to the recommended value, adjust the length of the track rod. Repeat the checking procedure and finally tighten the clamp bolts of the track rod fully.

**Camber**

Camber is the tilt of the wheel away from a true vertical position (See fig. 7.1). A wheel tilted outwards at the top has positive camber. A wheel tilted inward at the top has negative camber. The amount of camber is controlled by machining of the axle beam and axle arm. The effect of too much positive camber is irregular tyre wear of the outside shoulders. Tyre wear on the inside shoulders, hard steering and wandering are the indications of reverse or negative camber.

**Castor**

It is in the forward or backward tilt of the axle. If the axle is tilted to the rear this is called positive castor and if it is tilted to the front it is negative castor.

**For manual steering:**

Castor plate to be fitted in such a way that the thinner section faces front for bottom castor plate and thicker section faces front for top castor plate on both RH and LH. (see fig. 8)

For power steered vehicles, the castor plate direction has to be vice-versa.

One additional packing plate is added on RH side immediately above the axle beam for RHD vehicles. For LHD vehicles the plate should be fitted on LH side.

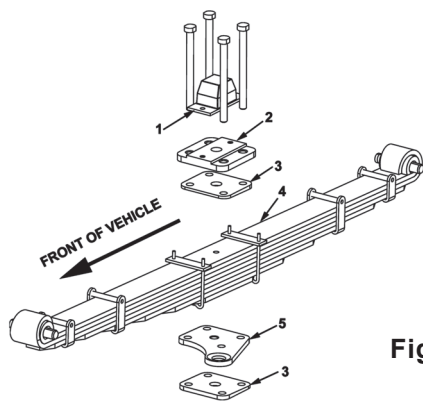


Fig.8

Description	ILL No
Bump stop	1
Bump stop mounting plate	2
Castor Plate	3
Leaf Spring	4
Shock Absorber mounting plate	5

## 42.1 TO REMOVE AND REFIT FRONT AXLE FROM VEHICLE

This operation explains the removal and installation of the front axle assembly (axle beam, axle arm, hubs drums, etc) as a complete unit.

### 42.1.0 To Remove

Park the vehicle on level ground.

Disconnect battery terminals, chock the wheels.

Unscrew ball pillar nut and using the **Special Tool 0602001 - Extractor Ball Pin** disconnect the drag link from the lower end of the drop arm. (see fig. 9)

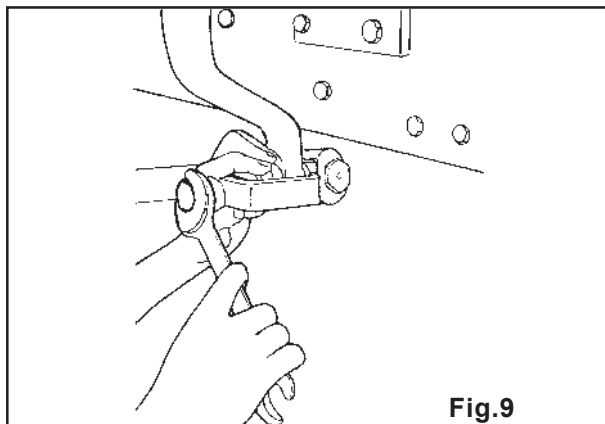


Fig.9

Loosen the leaf spring I-bolts clamp nuts using **Special Tool 0901002 - Socket Spring Clamp Nut**. (see fig.10)

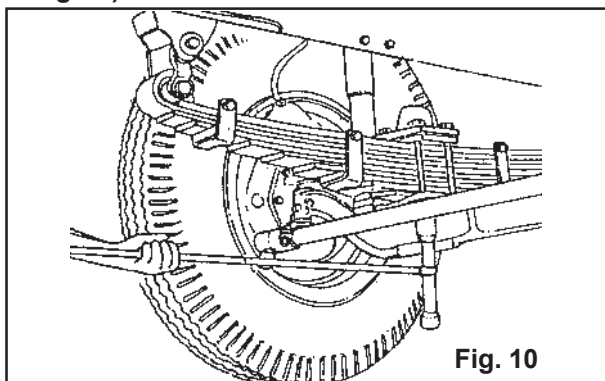


Fig. 10

Disconnect brake hoses.

Lift the front wheels off the ground by jacking the axle beam (use conventional crawler cum trolley jack below axle beam).

Unscrew shock absorber fasteners and remove shock absorber assemblies.



**Place suitable chassis support props below chassis frame.**

**Considering safety remove the tyres by ensuring that no human body parts are hurt. By slowly removing the 1 bolts/nuts remove the axle assembly along with the hub ends.**

### 42.1.1 To Refit

Support the front axle assembly on a jack.

Position the front axle assembly under the springs. Place the shock absorber plate on the axle beam and check that it registers with the location in the mounting pad of the axle beam. Fit the spacers if provided. Lift the jack and ensure that the front axle assembly, is located correctly.

Fix the clamp plate with rubber buffer over the spring, install the fixing bolts and tighten.

Ensure fitment of castor plates, shock absorber plate, clamp plate fitted as per fig. 8.

Connect the brake hoses to the brake chambers and ensure that they do not come in contact with the wheels when the wheels are turned either to left or to the right.

Connect the drag link to the steering lever, tighten the castle nut and fix the split pin.

Connect the shock absorber to the shock absorber bracket.



**Torque tighten the fasteners.**

Fix the wheels and wheel nuts.

Lower the wheels to the ground and tighten the wheel nuts uniformly to the recommended torque.

## 42.2 FRONT AXLE ASSEMBLY OVERHAUL



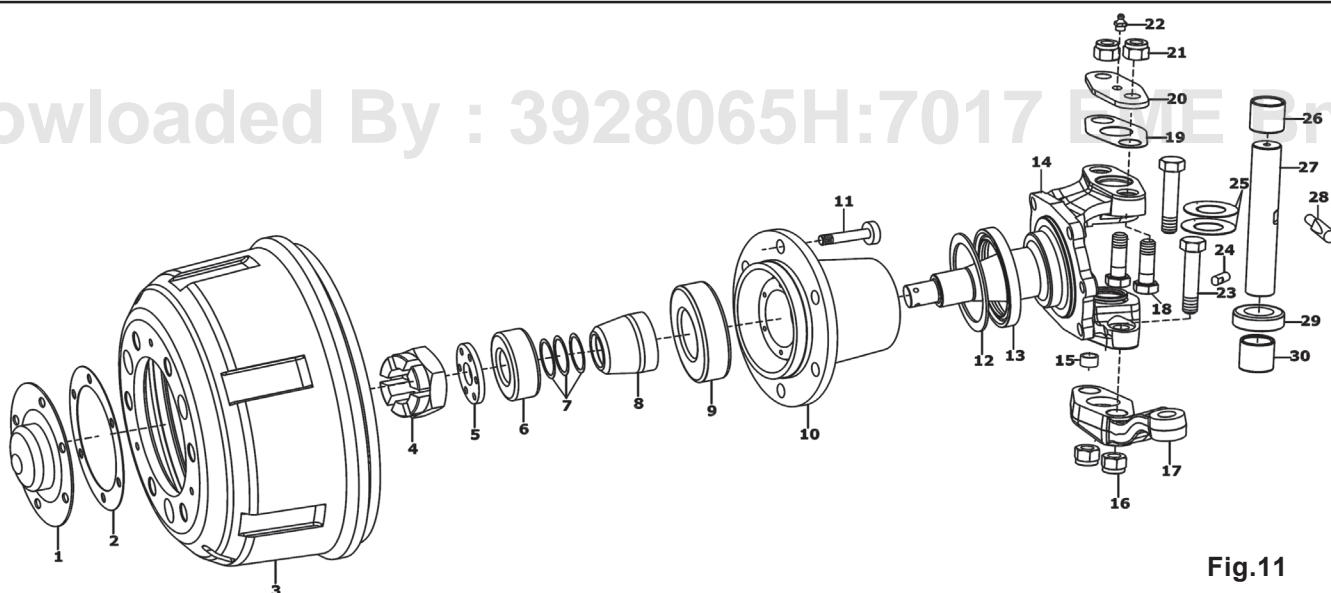
**Asbestos (Brake shoe lining material) dust is Injurious to health and must not be inhaled. Do not blow the dust with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable facemask and remove the dust carefully with a brush. Collect the dust for disposal. Do not use petrol, paraffin, trichloride ethylene or any petroleum based fluid as damage will occur to the rubber components, resulting in brake failure. Use only clear Methylated spirits Isopropyl alcohol.**

**42.2.0 Drum and hub Removal and Refitment (see fig.11)**

- \* Remove the wheel nuts previously slackened, and remove the road wheel, Position the road wheel on the ground.
- \* Remove drum mounting bolts and washers.
- \* Lift the brake drum from the hub. If necessary a mallet may be used to release the hub to drum seal.
- \* Remove bolts securing the hub grease cap and remove the cap.
- \* Remove the split pin, castle nut, thrust washer and outer bearing cone.
- \* Remove hub along with bearings from axle arm.
- \* For refitting reverse the above procedure.
- \* Remove the remaining front hub and drum assembly as previously described.

**42.2.1 Wheel Bearing Cup Removal**

- \* Carefully remove the grease seal from the inner face of the hub and withdraw the inner bearing cone. Discard the seal & bearing.
- \* Using a soft metal drift or a suitable puller, remove the inner and outer bearing cups from the hub. Ensure that the drift does not damage the bearing cup bores in the hub. Discard the bearing cups.
- \* Thoroughly wash and de-grease the hub and grease cap.

**Fig.11**

Description	ILL No.	Description	ILL No.
HUB CAP	1	NUT	16
GASKET	2	TRACK ROD LEVER	17
BRAKE DRUM	3	BOLT	18
CASTEL NUT	4	GASKET	19
WASHER	5	KING PIN COVER	20
TAPER ROLLER BRG - OUTER	6	NUT	21
SHIMS	7	GREASE NIPPLE	22
DISTANCE PIECE	8	BOLT	23
TAPER ROLLER BRG - INNER	9	MAX CUT SCREW	24
FRONT HUB	10	SHIMS FOR AXLE ARM PLAY	25
WHEEL BOLT	11	BUSH	26
PLATE OIL SEAL	12	KING PIN	27
HUB OIL SEAL	13	COTTER PIN	28
AXLE ARM	14	THRUST BEARING	29
HOLLOW DOWEL	15	BUSH	30

## 42.2.2 Wheel Bearing Cup Installation



**Bearing cone & bearing cup assemblies are supplied in matched sets and should be used as sets. It is not permissible to assemble a bearing cup & bearing cone from different manufacturer. Always ensure that match number is same.**

- \* Check the degree of fit of the new bearing cones on the appropriate axle arm. The cone should be a push fit without tight spots and without perceptible clearance. If there is excessive clearance, even with a new bearing cone fitted, the axle arm should be renewed. (see fig. 12)

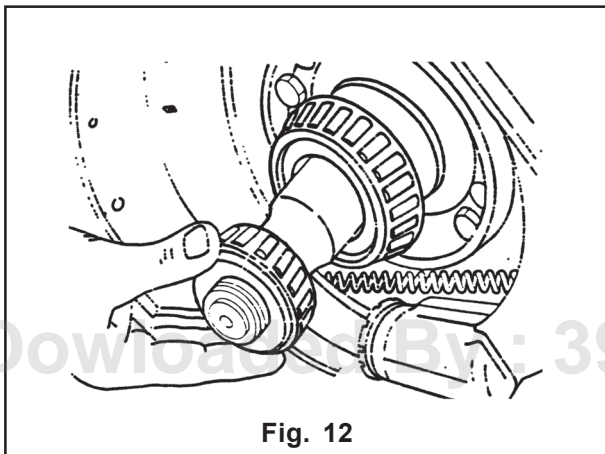


Fig. 12



**If a bearing assembly has seized and rotated on the axle arm, with subsequent damage to the axle arm, the new axle arm and bearing assembly must be fitted. On no account should a axle arm be cleaned up after bearing failure since further bearing failure with possible dangerous consequences due to wheel separation may result.**

- \* Ensure the hub bearing cones are not damaged. Install the new inner and outer bearing cups in the hub. The cups should be installed with a soft metal drift to avoid damaging the cups and hub. Lightly tap the cups at diametrically opposite points to ensure that the cups are correctly fitted when they contact the bottoms of the hub bores.
- \* Fully pack a new inner bearing cone with recommended grease to the correct specification. Fit the inner bearing cone into the hub, and carefully tap a new grease seal into place. (see fig. 13)

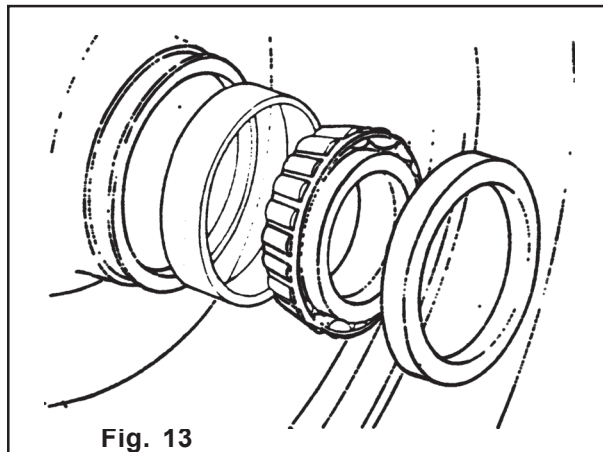


Fig. 13

- \* Renew the inner bearing, cups & grease seal, as previously described, for the other side of the vehicle.

## 42.2.3 Hub Overhaul

**To dismantle**

1. Isolate batteries.
2. Chock wheels and move hand control valve to 'PARK' position.
3. Slacken front road wheel retaining nuts.
4. Jack the front axle and remove nuts and wheel.
5. Release break shoes, then withdraw brake drum.
6. Remove hub cap.
7. Extract split pin and remove hub nut and washer.
8. Remove hub assembly.
9. Remove outer roller bearing, leaving bearing race in place in hub.
10. Remove oil seal and hub inner bearing, leave bearing inner race in place in hub.

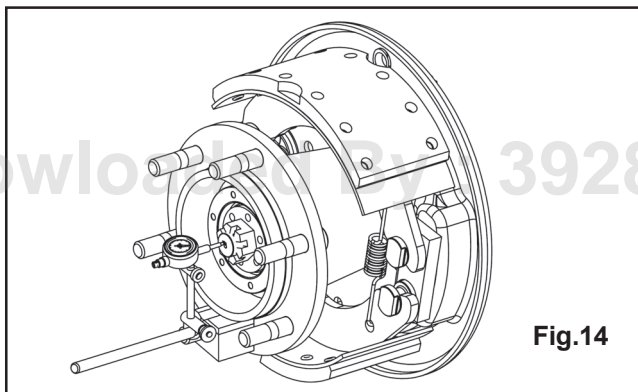
**To inspect**

1. Thoroughly clean all components.
2. Inspect bearing for evidence of pitting, wear, overheating or cage distortion.
3. Examine hub for wear or damage, renew if necessary.
4. Examine wheel bolts for worn or damage, if necessary replace.
5. When fitting new hub bearing, outer races should be press fitted in the hub, if this condition is not apparent wear of outer race location in hub will occur and hub must be renewed.



**To Reassemble and adjust end float (see fig. 14 & 15)**

1. Pack inner, outer bearing and hub cavity with grease.
2. Place inner bearing and withdrawal plate before pressing oil seal.
3. Press the oil seal with using suitable bunk and hammer.
4. Position the hub on the axle arm spindle bearing diameter.
5. Ensure no damage caused to inner bearing and oil seal of the hub. Put distance piece and shims.
6. Place the outer bearing (pre-greased) on the spindle diameter and using drift for aligning outer bearing.
7. Place the washer and hub nut.
8. Tighten the hub nut to recommended torque.
9. Check end float and bring it to recommended value by adding or removing shims. **(see fig. 14)**

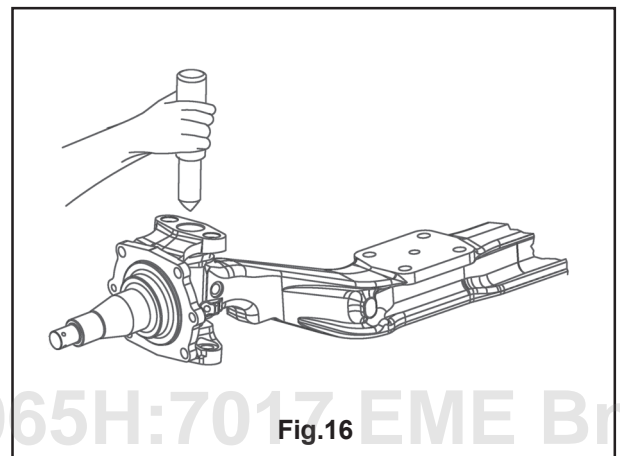


**Fig.14**

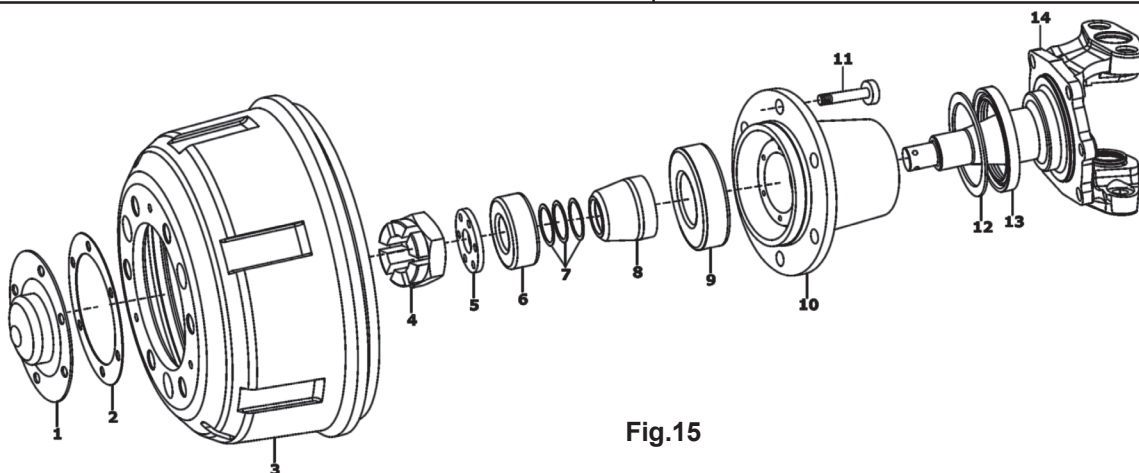
10. Insert the split pin and fold.
11. Fit the hub cap with packed grease.
12. Fit brake drum road wheel and nuts.
13. Lower the vehicle to the ground and tighten wheel nuts to recommended torque values.
14. Adjust the brakes.

**42.2.3.0 Assembly**

Mount the axle arm on the axle beam and insert a suitable drift into the king pin bore to align the axle arm. **(see fig. 16)**



**Fig.16**



**Fig.15**

Description	ILL No.	Description	ILL No.
HUB CAP	1	DISTANCE PIECE	8
GASKET	2	TAPER ROLLER BRG - INNER	9
BRAKE DRUM	3	FRONT HUB	10
CASTEL NUT	4	WHEEL BOLT	11
WASHER	5	PLATE OIL SEAL	12
TAPER ROLLER BRG - OUTER	6	HUB OIL SEAL	13
SHIMS	7	AXLE ARM	14



Fit the taper roller thrust bearing between axle beam and axle arm at lower boss. Align the thrust bearing and axle arm assembly. (see fig. 17)

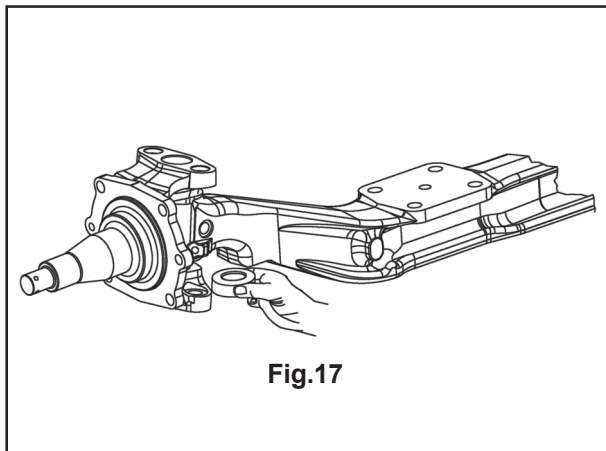


Fig.17

Ensure that the thrust bearing is fitted in such a manner that the grease enters from the bottom side of bearing for bearing lubrication.

Measure the clearance at several points between axle arm upper boss and axle beam as shown in figure by using a feeler gauge. Note the minimum clearance. (see fig. 18)

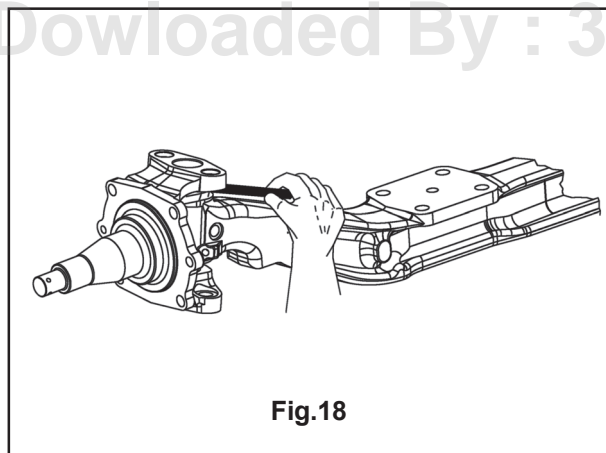


Fig.18

Select the shims and insert the shims into the position between axle arm upper boss and axle beam. (see fig. 19)

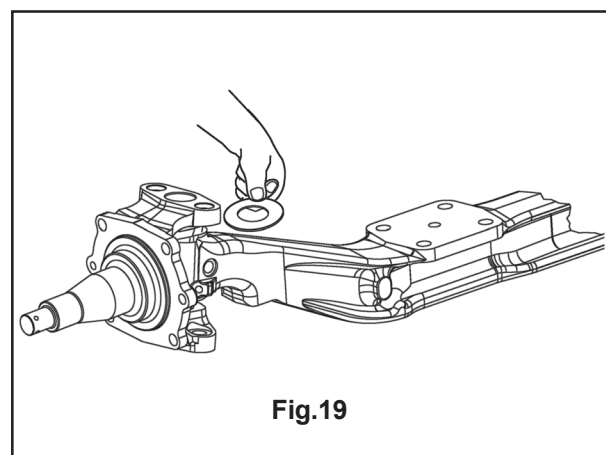


Fig.19

Insert the king pin into the king pin bore and align cotter pin slot with the holes in the axle beam. see (fig. 20)

Ensure recommended end play of the axle arm with the free movement of the axle arm from lock to lock position.



**Ensure TOP/T marked ends of the king pin is in top. Coat the king pins and shims with specified grease.**

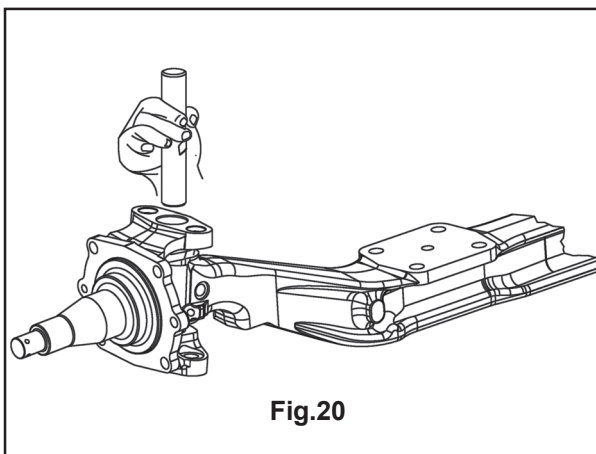


Fig.20

Fit cotter pin and lock it.

#### 42.2.4 Axle Arm End Play Checking Procedure

Hit the boss of the axle arm with brass/rubber mallet to properly seat the parts in position.

Turn the axle arm to the straight ahead position.

Attach a magnetic stand with dial gauge. Fix the tip on the centre of the king pin. Set the dial gauge indicating to zero.

Put a pry bar between axle arm and the top of the axle beam. Push the axle arm up and measure the end play, repeat the above with axle in the fully right and full left position.

Ensure the end play is set within limits. (see fig. 21)

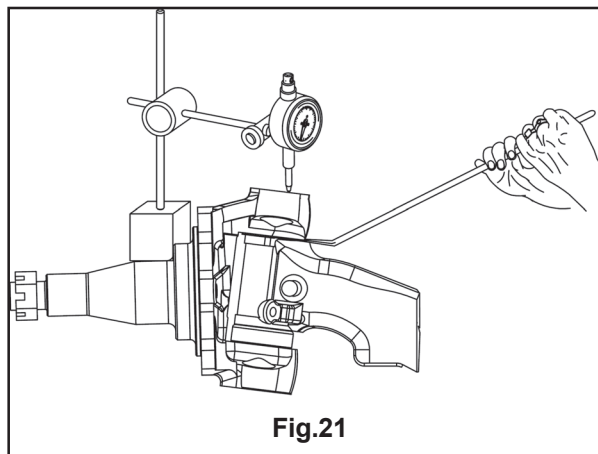


Fig.21

If the axle arm binds or zero end play measured - remove shims.

If more end play is measured, add shims.

**42.2.5 Assembling King Pin Cotter**

Drift the cotter pin in the axle beam firmly using a brass hammer. When correctly installed, the heads of the pins should be project out from the axle beam by 2 to 8 mm.



**Three sizes of cotter pins are available to achieve the correct fit.**

Fit the washer and nut in the cotter pins and torque tighten.

Fit the gasket, top & bottom cover plate and grease nipples.

Top and bottom cover bolt to be torque tightened.



**Lubricate with multipurpose grease under pressure through top and bottom grease nipples till grease is seen coming out from axle beam top and thrust bearing at bottom.**

Fix the track rod lever LH, RH, steering lever and tighten the special set screws to recommended torque.

Fit the brake shoe assembly on the axle arm and tighten the nuts.

Fit the slack adjuster on to the splined end of the 'S' camshaft.

Install the removed shims at the nose of the 'S' camshaft. Fix the circlip.

Fix the brake chamber on RH side and LH side. Connect the slack adjuster and brake chamber with the pivot pin.

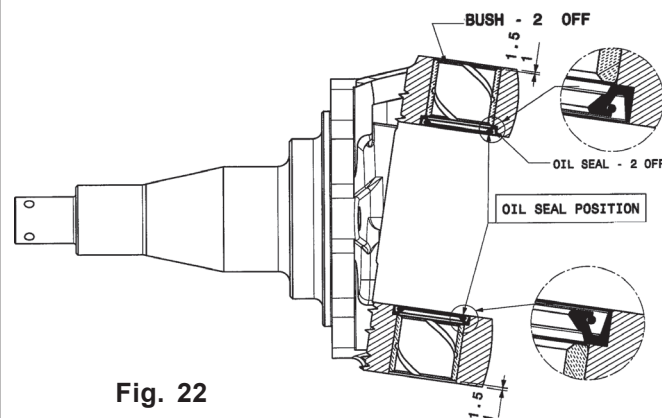
**42.3 TO PREPARE FRONT AXLE SUB-ASSEMBLIES****42.3.0 Axle Arm Sub-assembly**

Using 10 Ton hydraulic press and suitable drift, drift out king pin bushes top and bottom.

To assemble press new bushes using suitable drift.

Chill the bushes for 30 min at 0 to -5° temperature.

Press both the bushes to achieve the dimension of 1 to 1.5 mm as shown in **fig. 22**

**Fig. 22**

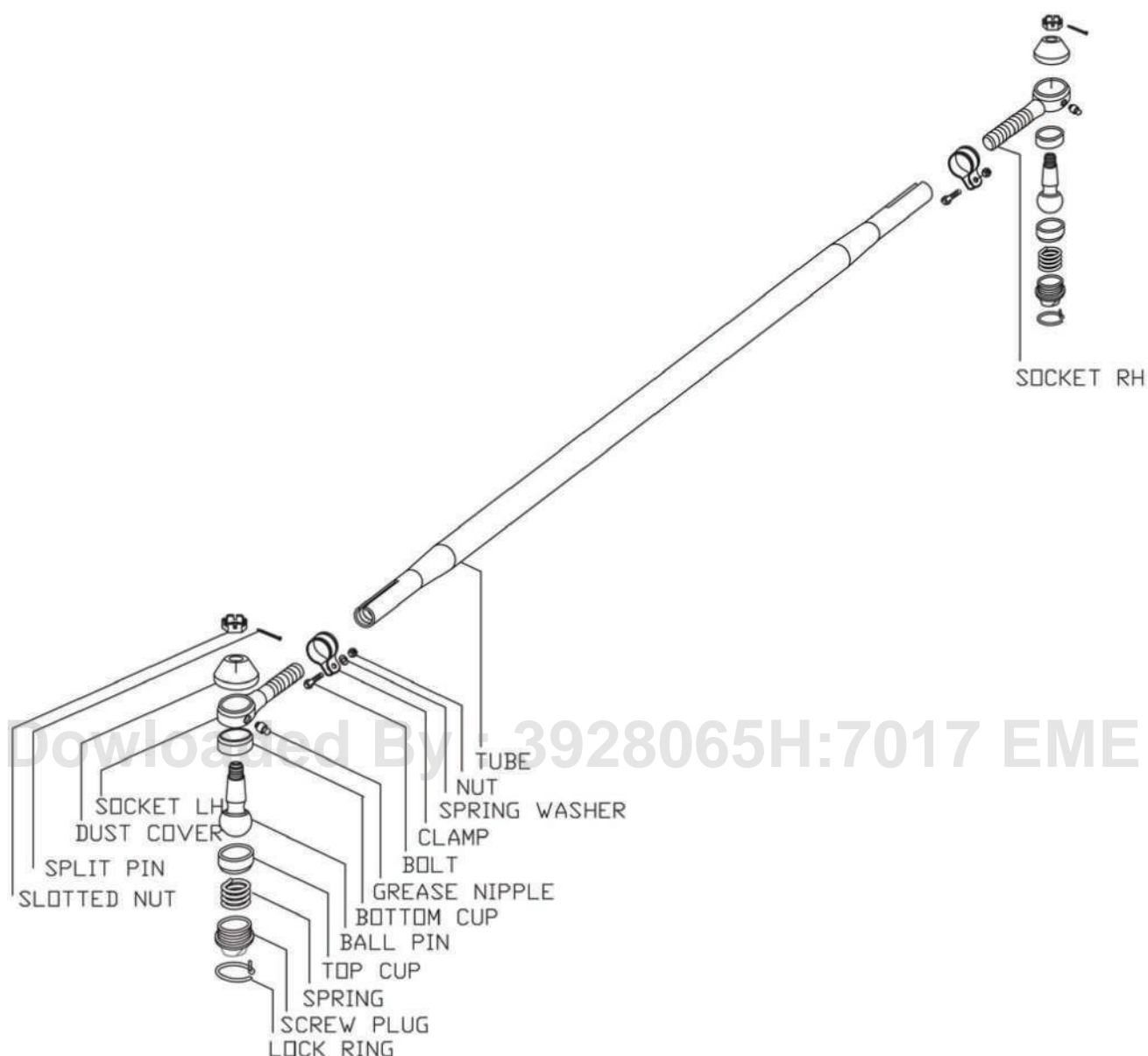
Fit the king pin oil seal as shown in **figure 22**.

Ensure free rotation of king pin on bushes.



**The king pin is available in 3 over sizes. A punch mark is provided on king pin's TOP face indicating service size i.e. OS1, OS2 and OS3.**

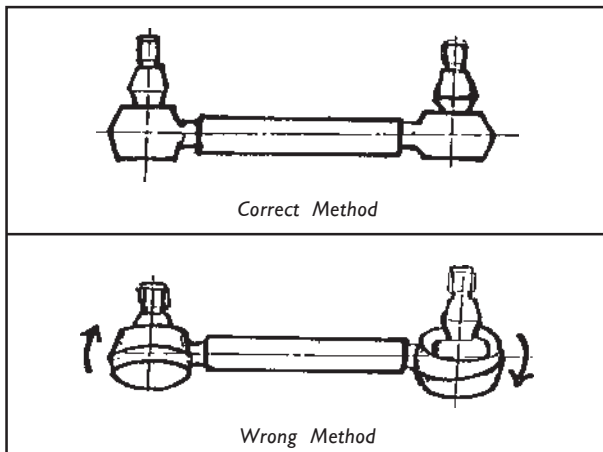
## 42.4 TRACKROD



## 42.4.0 Features and Advantages

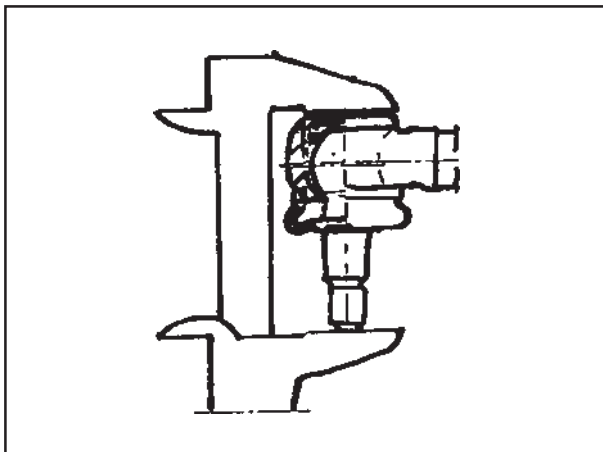
Features	Advantages
Cups and spring are axial to the ball pin	Steering freeplay will be comparatively lesser since the radial movement of cups are almost negligible.
Case Hardened material	Extended life
Ball Joint Assembly	Cup pressing and screw plug assembly is easy.
Ball Joint internals replacement	Centre distance resetting is not required as the ball joint internals can be replaced without dismantling the tube from the ball joint.
Ball joint torque adjustment after few kms run.	Ball joint torque can be increased by adjusting the screw plug without removing the tube. Hence no centre distance resetting is required.

#### 42.4.1 Fitment Procedure



- Mount the threaded part of track rod end on the track rod tube.
- Adjust the track rod end assembly roughly to the required track, then insert the tapered surface into the lever hole.
- Tighten the ball pin nut securely.
- Adjust the track correctly and lock the end with the nut/clamp provided.
- Ensure that the dis-position of ball joints are correct.
- Ensure that the pinch bolt / nut tightening torque (6 to 7 kgm).

#### 42.4.2 Check for condition of ball joints



- Turn the steering wheel alternatively to the left and to the right (with axle in loaded condition).
- The relative motion between the ball pin and the socket as shown in the figure either in Horizontal or Vertical direction should not exceed 2mm.
- This displacement can be checked by using a slide gauge.
- In case of non-conformity the joints should be recommended for replacement.

#### 42.4.3 Lubrication

Make sure the GREASE NIPPLES are intact.

- Replace immediately if they are found missing.

Make sure that always good quality & quantity of grease is used.

- Grease should be pumped through nipple and ensure that old grease from inside comes through the opening of the dust cover side.
- Grease the ball joints as recommended.

#### 42.4.4 Overhauling of Track Rod

Remove split pins and unscrew slotted nuts of ball joints on track-rod ends.

Remove ball pins from steering arms.

Remove track-rod end clamp bolt.

Unscrew ball joints from track-rod (tube).

Remove dust cap.

Remove locking ring of screw plug.

Remove screw plug from ball socket housing.

Remove spring and top cup.

Remove ball pin with bottom cup.

Clean all parts and check for wear. Replace defective parts with new one.



**If ball pin is to be replaced, also replace top and bottom cups.**

Assemble in reverse order of disassembly.



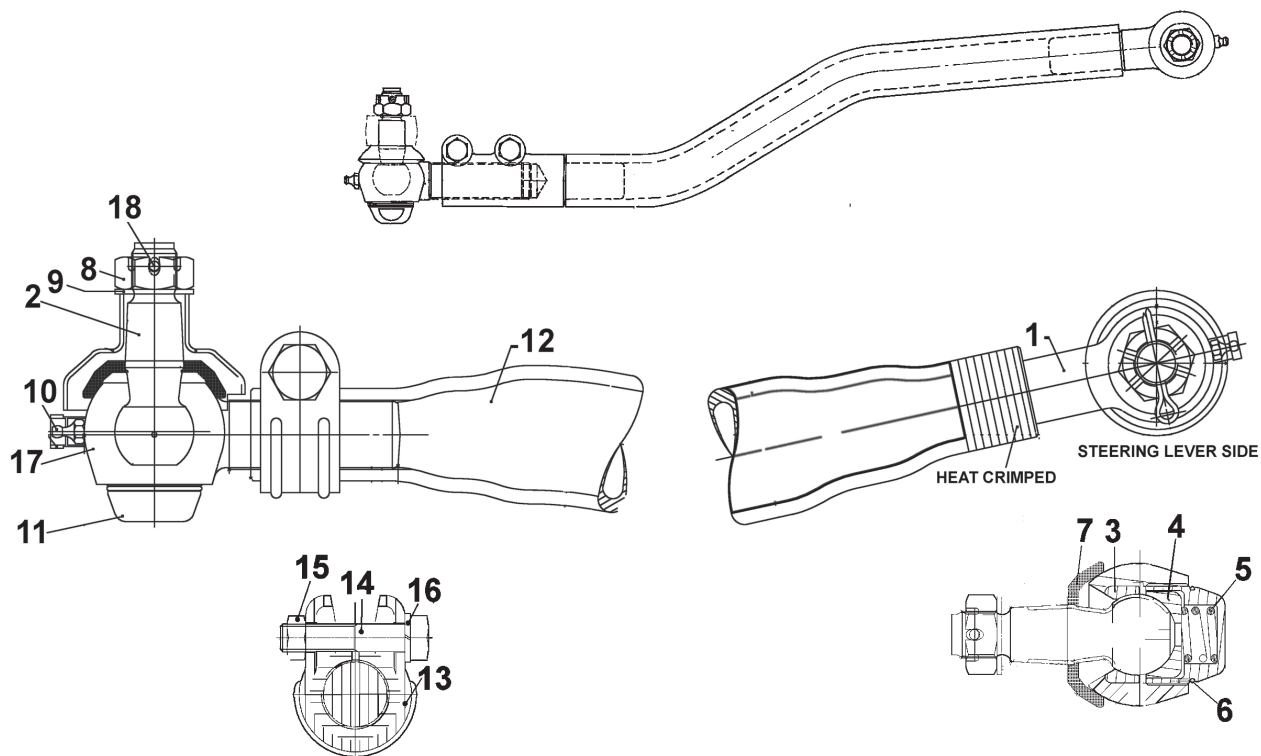
**Tighten screw plug until no play is felt between ball pin and cups at the same time there should be no binding between them in any position. Now secure screw plug with lock ring.**

**If hole for lock ring in screw plug does not align with corresponding hole in ball socket housing, drill new hole.**

After installation of track rod check and adjust toe-in.

If toe-in is within the range, tighten the pinch bolts of track-rod clamps.

## 42.5 DRAG LINK



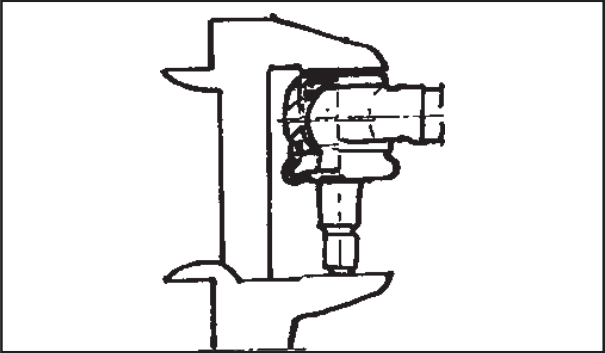
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S.NO.	DESCRIPTION	S.NO.	DESCRIPTION
1	Housing Crimp Type	11	Sealing Cap
2	Ball Pin	12	Tube
3	Bottom Cup	13	Clamp
4	Top Cup	14	Hex Bolt
5	Spring	15	Hex Nut
6	Locking Ring	16	Spring Washer
7	Dust Cover	17	Housing R.H
8	Slotted Nut	18	Split Pin
9	Punched Washer		
10	Grease Nipple		

**42.5.0 Fitment Procedure**

- Mount the threaded part of drag link end on the drag link tube.
- Adjust the drag link end assembly roughly to the required length, then insert the tapered surface into the lever hole.
- Tighten the ball pin nut securely.
- Adjust the length correctly (ensure the axle arm touches the stoppage bolt on both side by turning the steering to the extreme ends) and lock the end with the nut/clamp provided.

**42.5.1 Check for condition of ball joints**


- Turn the steering wheel alternatively to the left and to the right (with axle in loaded condition).



- The relative motion between the ball pin and the socket as shown in the figure either in Horizontal or Vertical direction should not exceed 2mm.
- This displacement can be checked by using a slide gauge.
- In case of non-conformity the joints should be recommended for replacement.

**42.5.2 Overhauling of Drag Link**

Remove split pins and un-screw slotted nuts of ball joints on drag link ends.

Remove ball pins from steering arms and steering box drop arm.

Remove drag link end clamp bolt.

Remove screw plug from ball socket housing.

Remove spring and top cup.

Remove ball pin with bottom cup.

Clean all parts and check for wear. Replace defective parts with new one.



**If ball pin is to be replaced, also replace top and bottom cups.**

Assemble in reverse order of disassembly.



**Tighten screw plug until no play is felt between ball pin and cups at the same time there should be no binding between them in any position. Now secure screw plug with lock ring.**



**Steering lever end (axle end) of the drag link is crimped.**



**If hole for lock ring in screw plug does not align with corresponding hole in ball socket housing, drill new hole.**

Unscrew ball joints from drag link(tube).

Remove dust cap.

Remove locking ring of screw plug.

After installation of drag link check and adjust wheel lock angle on both sides.

If wheel lock angle is within the range, tighten the bolts of drag link clamp.

**42.6 TIGHTENING TORQUES**

	Kgm	lb.ft	Nm
Steering arm/track lever mounting nut	26	186	252
King pin grease cap covers	13.6	98	133
Lubricator	0.86	6.3	8.5
Max. cut setting nut	9 - 12.6	65 - 91	88 - 123
Track rod mounting nut	13.8	99.6	135
Track rod pinch bolt	5	35.5	48
Brake shoe Assembly Mounting Nuts	15.3	110.7	150
Brake shoe actuator mounting bolts	5.2 - 7.3	37.7 - 52.4	51 - 71
Hub adjusting nut	9.7	70.1	95
Hub grease cup	1.8 - 2.3	13 - 16.3	17.5 - 22
Brake drum mounting bolts	5.2 - 7.3	37.7 - 52.4	51 - 71
Wheel nuts	34.5 - 40	249.2 - 290	338 - 392



## 42.7 RECOMMENDED LUBRICANTS

Aggregate	Co-branded Lubricant	Approved Lubricant
	Gulf Oil India	Indian Oil Corporation
Wheel Bearing	Crown Max RR3	Servo Gem ALT
King pin, Drag link & Track rod	MP Grease Max NLGI 2	Servo Grease ALT

## 42.8 MAINTENANCE SCHEDULE

Description	PDI	Daily	Weekly	Every Kmx1000	Remarks
<b>A Lubrication</b>					
1 Lubricate track rod / drag link ball joints					
For Tippers	✓		✓		
For all other applications	✓				Monthly
2 Repack the hubs with recommended grease. Also check the condition of hub bearings and change if necessary				48	For all applications other than Tippers.
3 Repack the hubs with recommended grease. Also check the condition of hub bearings and change if necessary				500 hrs	For Tippers
4 Lubricate king pins					
For Tippers	✓		✓		
For all other applications	✓				Monthly
<b>B Maintenance</b>					
1 Check wheel alignment and adjust if necessary	✓			8	
2 Check & adjust hub end play. Check the condition of hub bearing, change if necessary	✓			48	
3 Check and tighten thrust cover bolts				8	
4 Check king pin vertical play & adjust if necessary				16	
5 Check king pin lateral play. Replace bush if necessary				16	

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# **ZF POWER STEERING**



**ASHOK LEYLAND**

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**51.0 INTEGRAL HYDRAULIC BALL & NUT  
POWER STEERING SHORT VERSION****51.0.1 Design and function.****Design Worm:**

Both radial and axial roller bearings are mounted in the cover (128). Worm Shaft with grooved channel for ball circulation, is mounted in the cover and loaded with threaded ring (118.1).

**Piston:**

The valve bush which accommodates the valve spool is pressed into the cross bore hole. The underside of the piston is machined as a gear rack, which engages in the toothed segment of the sector shaft (30). The steering nut and finger passes into the longitudinal bore hole of the piston, thus establishing the connection with the valve spool through the worm. Depending on the version the valve is centered by means of centering springs or bending bar.

**Steering Nut :**

Longitudinal bore hole for worm engagement with grooves for ball circulation are provided. The hole on the external diameter is milled and ground for accepting the finger, which engages in the cross bore hole of the valve spool. This establishes the connection to the worm by means of the ball chain between steering nut which depends on the selection of the corresponding type of ball. The steering nut is mounted in piston, play-free, between two roller bearings. Adjustment is carried out by turning the threaded ring (118) which is secured on the open side of the piston.

**Housing (1) :**

The housing has integrated passages for the pressure and return lines and, a built-in pressure limiting valve. Oil passages which are required within the steering system are arranged as bore holes in the housing, housing cover/plate or in the piston. No external connecting lines are required due to this design. The housing has mounting holes and machined surfaces for securing the steering gear box on the mounting bracket of the vehicle.

**Sector shaft (30) :**

The sector gearing is cut with a flat angle to the shaft axis in order to facilitate, service adjustment in the axial direction. The center tooth is shaped more convex, so that the readjustment can be carried out in straight ahead position (SAP), since this is the area where the greatest amount of wear occurs, with out the following gear teeth, both the left and right, becoming jammed. The forces in the axial direction are taken up, by means of an adjustment screw (31); the screw is held in to the bore hole of the sector shaft, play-free and passes through threading in the housing cover. Adjustment in axial direction is carried out by utilizing this thread pitch and locking is done by means of a lock nut (50).

**Housing cover (40):**

It houses the adjustment screw for supporting the sector shaft & two built-in adjustable valves (55) for limiting the pressure at wheel lock. The valves are pushed open by the cam of the sector shaft in predetermined position at

left or right lock. This enables the pressurized oil to flow from the corresponding side of the cylinder chamber to a reduced required pressure of approximately 30 to 35 bar. The device is described as, "hydraulic steering limiters".

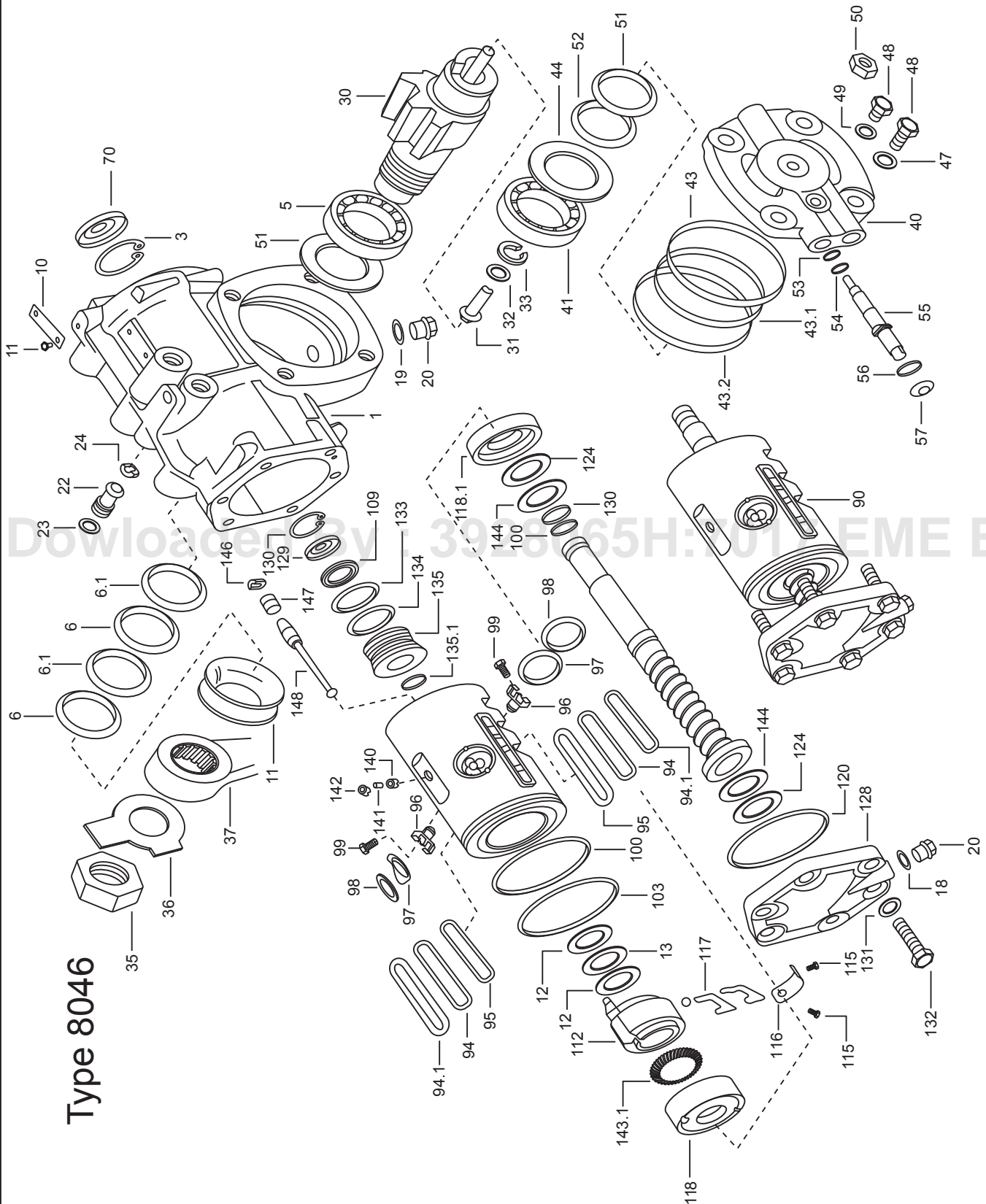
**Function:**

In order to obtain hydraulic support during steering of vehicle, the spool valve must be moved out of the neutral position. The spool valve is held in the neutral position by means of a centering spring or bending bar (148) depending on the version. Steering forces must therefore be applied in order to overcome this initial setting. The piston (90) which is positively connected with the sector shaft (30) and the steering wheels, offers resistance to rotation. The steering nut is therefore rotated by the worm and the ball chain during the steering process thus overcoming the initial setting of the center spring or bending bar. The pressurized oil flowing in to the gearbox housing from the engine driven pump is then routed in to the chamber from which the steering procedure is hydraulically supported. The oil flows in from the housing side in to a longitudinal groove of the piston and beneath the valve. It also flows in to a longitudinal groove of the same size on the opposite side in order to assist the pressure compensation and then reaches, by means of cross bore holes, at the front surfaces of the valve pistons which are separated from the chamber by means of seals. In the neutral position of the valve the oil flows to the center of the valve piston after first flowing through the forward and return edges, and from there the oil flows up through the corresponding holes in to an opening of the piston. The oil is then drained for return motion. By operating the valve, the side of the piston which is under pressure is separated from the return and the opposite side of the piston which is connected to the return flow. The spool valve is equipped with two feed-back pistons (reaction components) which have the task of making the movement of the valve, from the neutral position more difficult, depending on the oil pressure. The activating forces on the steering wheel increases proportional to the forces which are applied to the wheels. Steering units which only require a proportional increase of the steering force only up to a predetermined oil pressure are equipped with cut-off Hydraulic reaction components (feedback piston).

The spools which are inside the feedback piston ensures that after reaching the cut-off pressure the forces on the steering wheel only increase insignificantly.

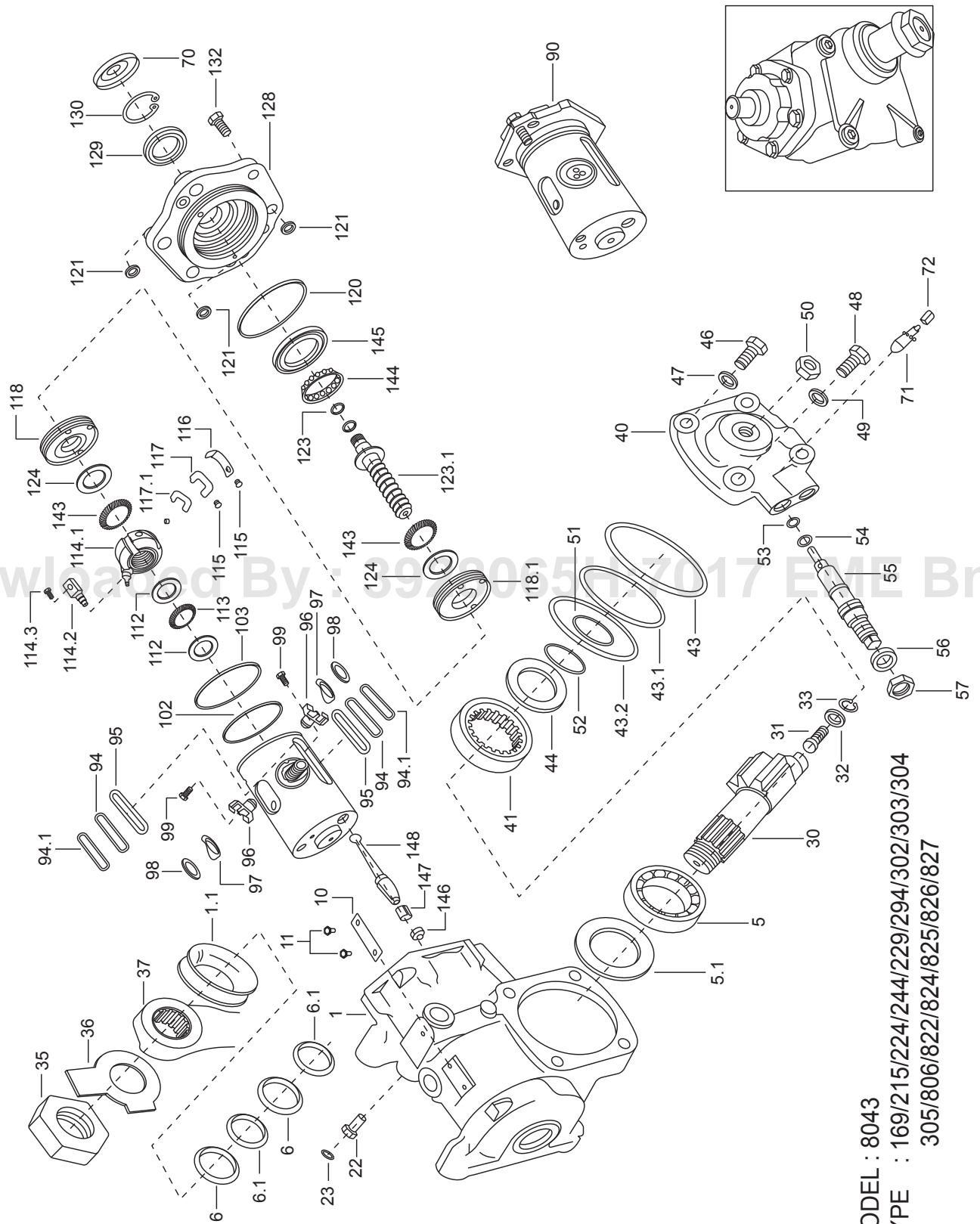
**Function of the feed back piston: (Hydraulic Reaction)**

They are floating piston mounted in the bore hole of the valve spool. They are, however, held axially and secured by connecting them with retaining plates. The outer front areas of the two pistons are continually under pressure while only one of the internal front surfaces is under pressure in the working position of the valve. The same applies for the front surface in the bore holes of the valve spool. In this way, no force occurs which tries to push the valve spool in to the neutral position. This property is described as, "hydraulic reaction".

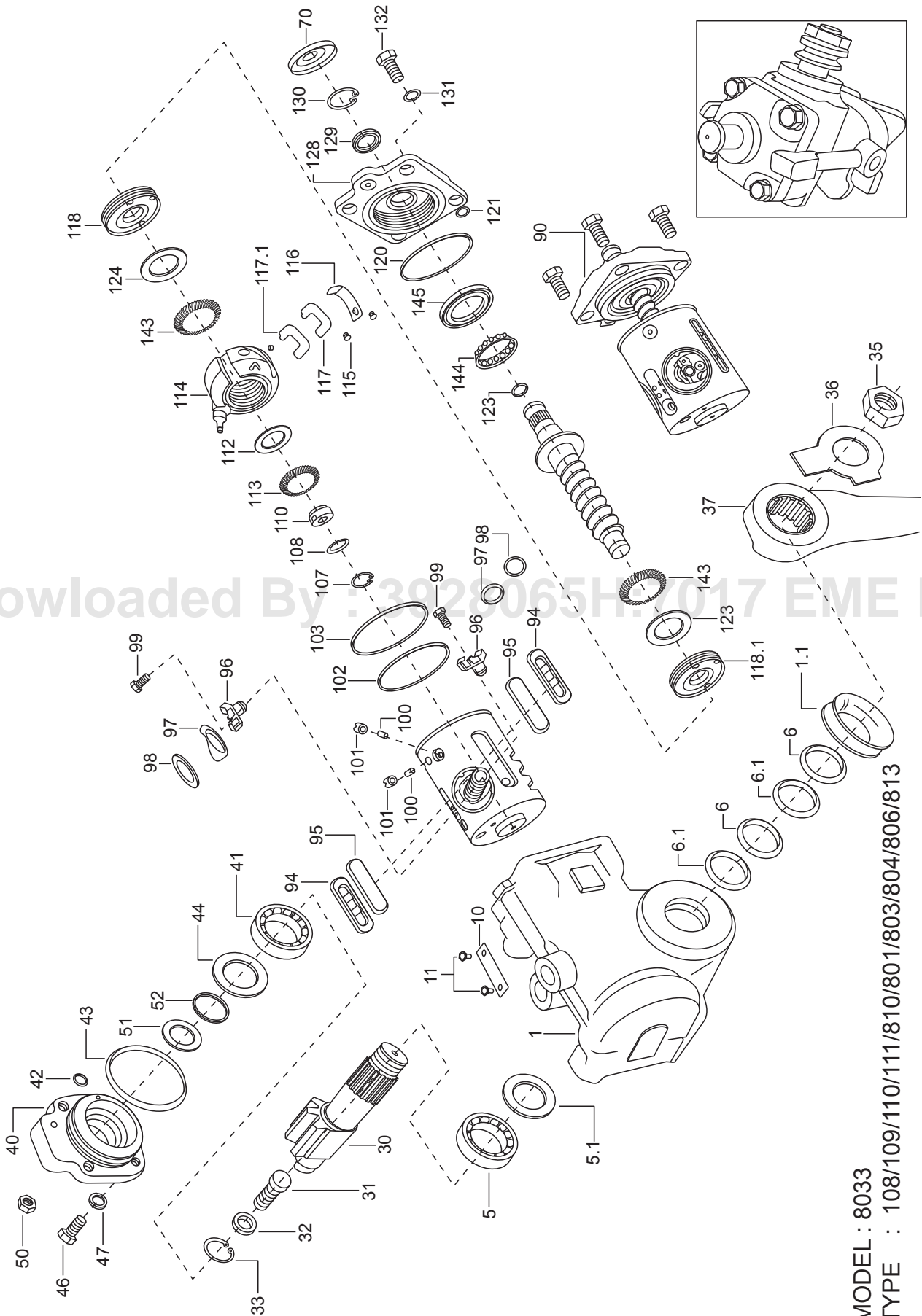


Type 8046





MODEL : 8043  
TYPE : 169/215/224/244/229/294/302/303/304  
305/806/822/824/825/826/827



MODEL : 8033

TYPE : 108/109/110/111/810/801/803/804/806/813



## Key items nos. for Exploded View

ILL NO.	DESCRIPTION	ILL NO.	DESCRIPTION
1	Housing	71	Bleeding screw
1.1.	Dust Seal	72	Cap plug
5	Needle Sleeve/Roller Brg.	90	Complete piston
5.1	Washer	94	Seal
6	Shaft seal ring/Seal supporting	95	Seal
6.1	Round seal ring/Oval seal ring	94.1	Support plate
10	Type plate	96	Feed back piston
11	Half round dowl pin	97	Round sealing ring
22	Pressure limiting valve	98	Seal
23	Round seal ring	99	Machine screw
30	Segment shaft	102	Round sealing ring
31	Adjustment screw	103	Piston ring
32	Guide washer/Wear washer	112	Bearing disk
33	Circlip/Threaded ring	113	Axial needle cage
35	Castle nut/ Hexagon nut	115	Countersunk screw
36	Securing plate/Spring ring	116	Covering plate
37	Steering drop arm	117	Half circulation tube
40	Housing cover	117.1	Ball set
41	Needle sleeve/ Roller bearing	118	Threaded ring
43	Round seal ring	120	Round sealing ring
43.1	Round seal ring	121	Round sealing ring
43.2	Seal ring	123	seal ring
44	Supporting washer/Ring	123.1	Round sealing ring
46	Hexagon bolt, Short	124	Axial disk
47	Washer	128	Cover
48	Threaded plug	129	Shaft seal ring
49	Washer	130	Circlip
50	Sealing nut	132	Hexagon bolt
53	Round sealing ring	143	Axial needle cage
54	Round sealing ring	144	Axial needle cage/Ball holder
55	Valve	145	Bearing ring outer
56	Washer	146	Clamping ring
57	Hexagon nut	147	Clamping ring
70	Protective cap	148	Bending Bar

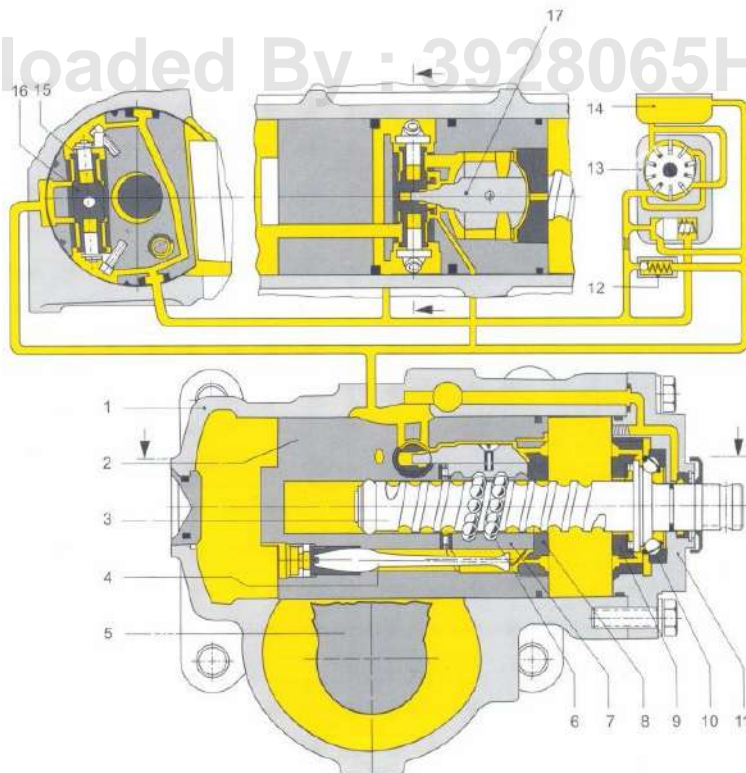
### 51.0.2 Design

The steering housing (1) contains the control valve, a complete mechanical steering gear, and it is at the same time the operating cylinder of the piston (2). The worm (3) and the steering nut (7) are connected by an endless chain of balls. The balls (6) are returned via a recirculating tube. The steering nut is maintained clearance free against axial thrust by means of two anti-friction bearings. The control valve is installed across in the piston (2). This valve is composed of a valve spool and two fixed reaction pistons. Driver (17) fitted on the steering nut fits snugly into the bore of the valve spool. The piston (2) and the sector shaft (5) are positively connected by a gearing. Due to a special tooth shape on the sector shaft, their axial adjustment is possible. This ensure clearance - free operation in the straight ahead travel range.

### 51.0.3 Operation

In neutral position of the valve, the oil pressure in the right and the left cylinder chambers is balanced. By moving the valve spool from the neutral position, a pressure difference is produced between the left and the right cylinder chambers. The piston (2) will receive

more oil pressure on one side, and the hydraulic power assistance is operative. The valve is actuated by a rotation of the steering wheel or by the force which coming from the road wheels, act through sector shaft (5) and piston (2) on steering nut (7) and worm (3). Any rotation of the worm means an axial movement of the output shaft. This operation causes the valve spools to be moved by the finger on the steering nut. Consequently the pressure oil is now supplied to only one of the two cylinder chambers. The piston assists the worm rotation. A bending bar or a pressure spring (according to steering gear version) arranged within the steering nut provides for centring of the steering nut and the valve spools. The operation is assisted by the hydraulic reaction pistons. They are floatingly mounted in bores of the valve spool, and secured against axial movement by locking plates. The outside faces of the two reaction pistons are permanently pressurized with oil. Whereas only one each of those inside is pressurized in operating position of the valve. Likewise only one of the two faces in the bores of the valve spool are pressurized with oil. This causes a force trying to return the valve spool to neutral position. This process is called hydraulic reaction.



1. Housing
2. Piston
3. Worm
4. Bending Bar
5. Sector Shaft
6. Balls
7. Steering nut
8. Threaded ring
9. Threaded ring
10. Angular contact ball bearing
11. Cover
12. Pressure relief valve
13. Vane pump with flow control valve
14. Oil Reservoir
15. Reaction Component
16. Valve spool
17. Driver

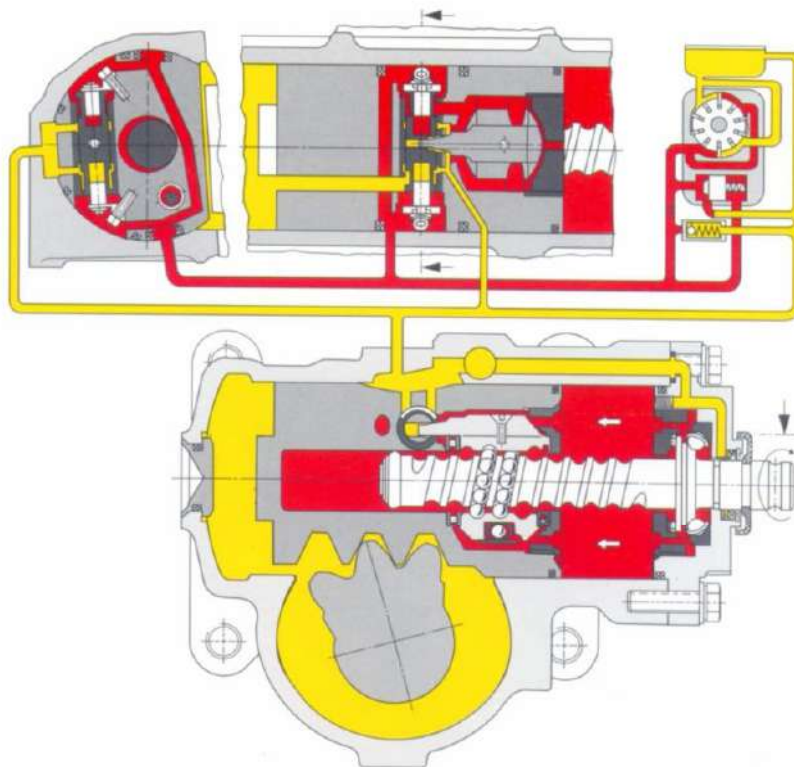
Sectional view of a ball and nut power steering gear with vane pump connected to it, steering valve in neutral position. Centring of the steering valve by bending bar.

Oil flow : after flowing through supply and return flow control edges to the middle of the valve spool and through bores to the right and left cylinder chamber.

It goes through respective bores to a recess on the piston top, from here back the oil tank.

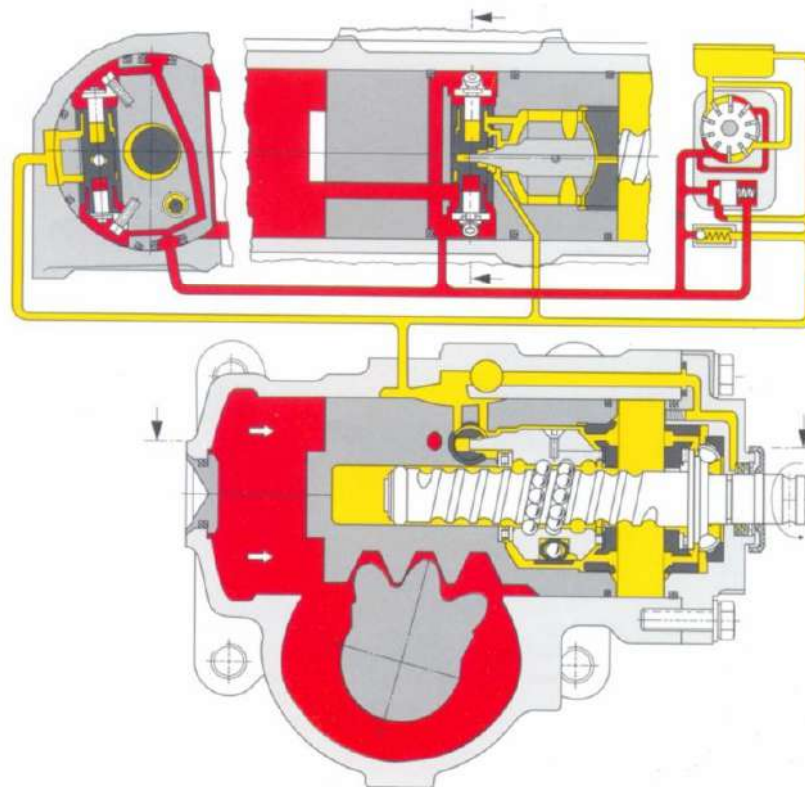


Valve in operating position



Steering wheels turned clockwise. Valve spool moved to the right, pressure oil gets into the right cylinder chamber, left cylinder chamber connected to return flow.

Valve in operating position



Steering wheel turned anti-clockwise. Valve spool moved to the left, pressure oil gets into the left cylinder chamber only, right cylinder chamber connected to return flow.

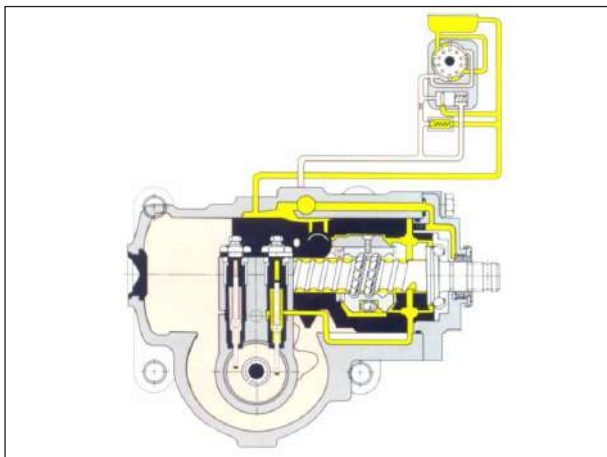


## **51.1 FUNCTION AND ADJUSTMENT OF HYDRAULIC STEERING LIMITERS.**

### **51.1.1 Function and Design.**

#### **Adjustable type Limiter Valve**

##### **Hydraulic Steering limiter**



This unit reduces the hydraulic power assistance by reducing the oil pressure. The point of response can be adjusted to any drop arm travel. The hydraulic steering limiter protects the wheel stops, steering linkage and pump from excessive and unnecessary loading at minimum turning radius, and contributes to a long service life of the entire steering system. The short version ball and nut power steering gears, model range 8033 to 8046, are therefore normally equipped with hydraulic steering limiters.

Figure shows the method of operation of the steering limiting valves. The two valves are installed in the housing cover of the steering gear. When the sector shaft is rotated, they remain shut until the cam on the face of the sector shaft hits one of the valve spools, lifts it up, thus opening the valve. This provides a connection between the highly pressurized cylinder chamber and the oil return circuit.

The pressure in this cylinder chamber drops and the hydraulic power assistance is reduced considerably. The consequence is that the steering wheel can be turned on up to the wheel stop only under increased manual effort.

Diagrammatic Representation of short version ball and nut power steering gear with adjustable steering limiter in the housing cover, movement of position to the right, left steering limiting valve opened, oil pressure heavily reduced.

### **51.1.2 Non-adjustable Limiter Valves.**

Steering Gear version M033 and 8033.

When the Piston moves to the left, the hydraulic oil can flow off into return flow duct of housing through a piston bore located at right angle in relation to piston axis before the piston arrives at the stop. When the

piston moves to the right, the piston head edge clears the return flow duct in housing.

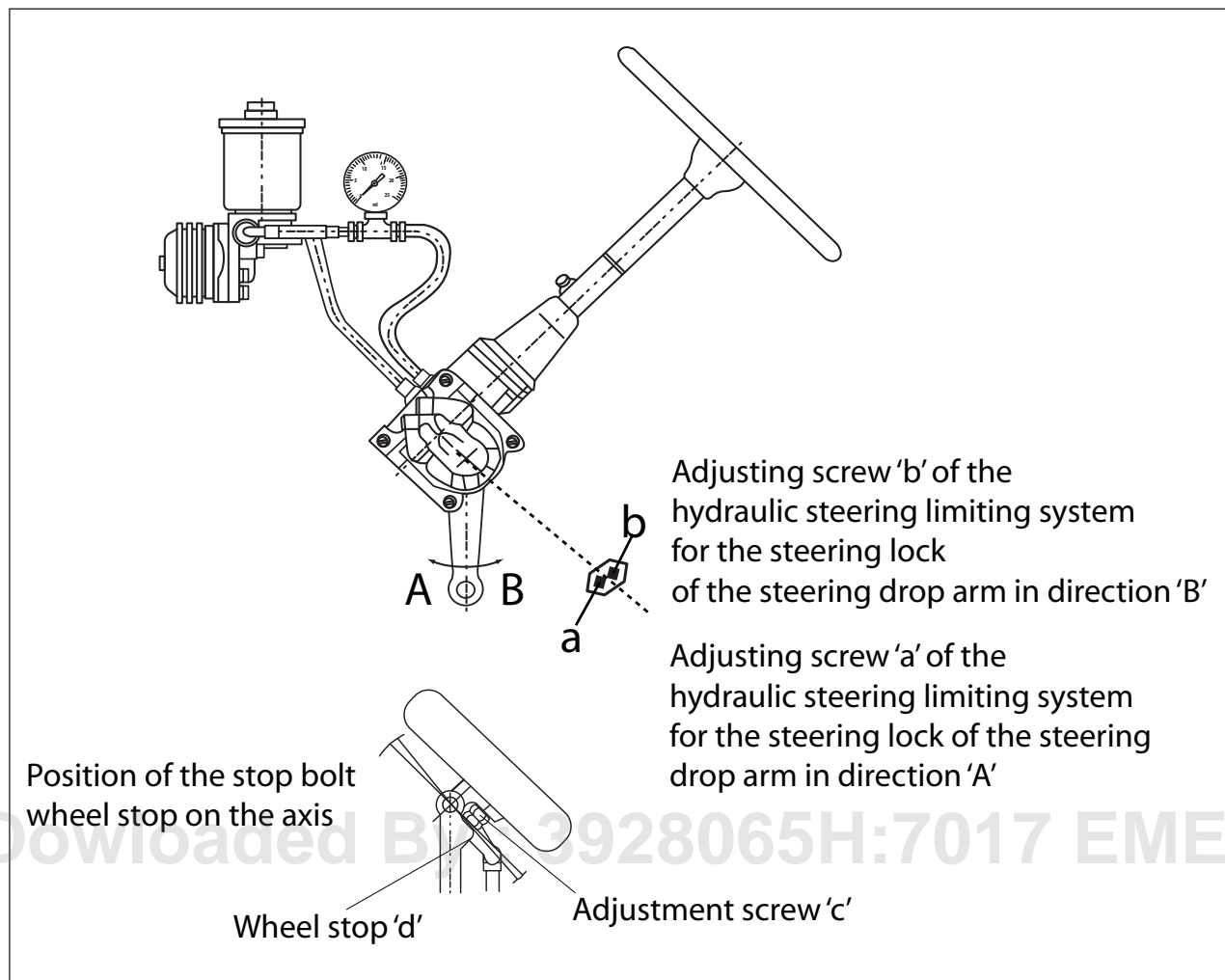
### **51.1.3 Adjustment of Hydraulic Steering Limiter.**

The first adjustment of the hydraulic steering limiters is always carried out on the Test rig stand at the Works according to the drawing and the test regulations of the vehicle manufacturers. It is necessary to carry out a further adjustment after installing the Steering system into the vehicle at the prescribed vehicle inspections with the help of a pressure gauge or without a pressure gauge.

#### **51.1.3.1 With Pressure Gauge.**

A pressure gauge (Pressure range from 0 to 250 bar) is installed in the pressure line between the Pump and the Steering Gear (see figure). and the steering axle is jacked up if rigid axle. Place the lifting Jack beneath the Axle. If the vehicle has an independent wheel suspension the steered wheels must be on 'Turn Tables' so that the Hydraulic steering limiting valves can be adjusted, the steering axle must, under all circumstances, be under load in order to approximately compensate for possibly occurring faults in the springing action during measurement. Turn the steering wheel without using much force up to the wheel stop when the engine is running. For some vehicle types it may be necessary for a second fitter to hold a distance piece with a thickness of 2-3 mm between the parts of the wheel stops so that a small reserve is maintained (follow the adjustment regulations of the vehicle manufacturer). The thickness of plate depends on the steering unit . When the wheel stop has been reached, the restoring forces of the steering valve are overcome by briefly (max. 5 secs.) If the pressure drops too early or too late when turning the steering the drop-arm in the direction "A" or "B" the limiter valves screws (a2) and (b2) must be turned as follows. If a pressure higher than 35 bar is measured, the corresponding steering limiter valve (55) must be turned further in towards the cover (In clockwise direction). If a pressure lower than 30 bar is measured, the corresponding steering limiter valve (55) must be turned further out (anti-clockwise). In figure 4.a, the distance which is represented by dimension "f" and which is the distance which should exist between the parts of the wheel stop when the hydraulic steering limiter valves are activated and should be approximately 2 mm.

## 51.1.3.2 Checking the Hydraulic setting without Pressure Gauge.



After the setting has been carried out, the hydraulic support should be in operation shortly before reaching the wheel stop. The setting should be checked on the vehicle, normally loaded and travelling slowly, steering the wheel so far until the hydraulic assistance is switched off. In this position, a gap of approximately 1-3 mm should exist between the wheel stop. (The correct thickness of the distance pieces can also be determined with this test). If the gap is too much, then insert the corresponding limiter valve inside. If the gap is too less or touches, then remove the corresponding limiter valve inside.

## 51.1.3.3 Checking of Pump Pressure.

In the event the Steering Pump needs to be checked for its function i.e. Pump pressure and flow, the same can be checked by inserting a Pressure Gauge in the Pressure line, which is between the Pump and Stg. Gear Box. The tyres should be prevented from moving in the Straight Ahead Position (SAP) and an effort applied on the Stg. Wheel. By holding the Stg. wheel in this position for not more than 30 secs. the pressure can be noted. If less pressure is recorded than the PRV setting pressure the Pump may have developed problem and needs to be investigated separately.

## 51.2 OIL FILLING AND AIR BLEEDING

There is a danger that dirt particles may enter the steering oil circuit when filling the steering unit with hydraulic oil. A high degree of cleanliness must be observed for the first filling and for all subsequent topping up operations in order to prevent failure due to foreign bodies in the system. For this reason, thoroughly clean the oil reservoir and the area around it before removing the oil reservoir cover or dip-stick so that dirt does not get into the hydraulic oil.

**Type of oil:**

For filling capacity and oil spec refer filling capacity and recommended lubricants.

**51.2.1 Oil filling**

Special care must be taken during the procedure described as follows to ensure that the oil reservoir is not allowed to run empty since this would cause air bubbles in the steering system. In addition to this, special care must also be taken during oil filling and air bleeding to ensure that the pump only turns at the lowest possible speed (idling) if the inlet flow is too small air bubbles would enter the pump and be split up in to extremely small bubbles during its passage through the pump; this situation may lead to foam formation thus greatly extending the bleeding process. Due to the various types of installation possibilities of our hydraulic steering systems (Inverted, vertical, horizontal etc.) It can occur under certain circumstances that for a short period of time, the steering system cannot be bled in certain types of vehicle and the air in the steering gear box is only removed very slowly. In such a case, we recommend that the steering drop arm should be removed so that the entire piston stroke from stop to stop can be utilized in the steering housing for the bleeding processes. In this way the air remaining in the cylinder is reduced to a minimum. This is an insignificant amount which is automatically absorbed by the oil and separated during the operation.

The steering system and pump should be filled through the opening on the oil reservoir. For the first filling and for oil changes it is recommended to remove the cover of the container and fill with hydraulic oil up to the edge of the container. The engine should then turned over briefly (cranked) a number of times with the starter in order to fill the entire hydraulic system with oil.

Since this causes the oil level in the container to fall rapidly the oil must be continually topped up during this process and under all circumstances the pump must be prevented from taking in air.

**51.2.2 Bleeding**

The engine can be started with the steering axle jacked up when the steering system is filled with oil so that the oil level no longer falls below the upper marking on the oil dipstick when the engine is briefly turned over. Allow the engine to run for some time at low speed, thus allowing most of the air to escape from the cylinder. The oil level must be observed during this process. The oil must be topped up immediately if the level still sinks. When the above instruction has been observed the oil level in the oil container must not rise higher than approximately 1 to 2 cm when the engine is switched off, according to the size of the steering system. Steering gear 8046/8043/8033/M033 is with automatic bleeders and do not have a bleeding screw. These steering systems automatically bleed the remaining air in the housing after the bleeding process has been carried out as described above. Switch off engine and remove the blocks from the steering axle. Twin Steered Vehicle: In case of Power Cylinders, ensure that the port connections are aligned in vertical position, if air is still remaining in the system, the adopters on the power Cylinders may be loosened to allow air to escape.

**51.2.3 Checking the oil level**

The oil level should be checked at operating temperature at intervals mentioned in the maintenance schedule.

**51.2.4 Oil check on stationary engine**

In order to establish that no air is sucked in when the engine is started, it must first be established whether oil loss has occurred when the engine is stationary. Therefore, the container should be filled with so much oil that the oil level is approximately 1 to 2 cm above the upper marking on the oil dipstick.

**51.2.5 Oil check on running engine**

The oil level falls slightly when the engine is running since the oil requires a pressure of approximately 2 to 4 bar to flow through the steering unit as a result of the resistance to flow. The oil should therefore once again be topped up so that the oil level lies constantly at the upper marking. The engine can then be switched off again. If this oil level is exceeded, then this is a sign that there is still air in the oil.

**51.2.6 Changing the oil and Filter:**

It is recommended to change the oil when the steering gear or pump or both the units are repaired or replaced. The filter in the oil reservoir should also be replaced and the lines cleaned at this time. When the soiled filter cartridge is removed, the bottom opening must be closed immediately while removing from the filter support to prevent dirty oil in the filter cartridge running back into the reservoir and entering the oil circuit.



**In the event of Oil losses, make sure that leaking spot is found and repaired.**

Annoying noises in the steering system.

1. Dirty or clogged filter.
2. Adopters and connectors at the Suction end of Oil Res. and Pump are not sufficiently tight. Tighten the screw connections, if required apply sealant.
3. Not enough oil in the System.

**51.3 ADJUSTMENTS OF STEERING GEAR ON THE VEHICLE.**

**The measuring and adjusting tools used must be subjected to regular accuracy check ups.**

1. Elimination of Steering gear play (Back-lash) while driving straight ahead Position (SAP).
  - a) Jack up steering axle.
  - b) Turn Steering to centre position (determined by halving total number of steering wheel turns).
  - c) Loosen sealing nut (50) on housing cover.



- d) Turn steering into one end position and measure required friction torque for turning outside the straight ahead range (appro.  $\frac{1}{2}$  turn prior to final lock). For turning steering gear, use a torque measuring tool plugged on the Steering wheel turn.
- e) Then measure friction torque of steering gear in pressure point range (Centre position). For this purpose, turn torque measuring tool approx.  $\frac{1}{2}$  turns each to the left and right beyond straight – ahead position while tightening adjusting screw (31) until an increase of friction torque of 40-50 Ncm (4-5 KgCm) as compared with value measured according to point “d” is obtained.
- f) Tighten sealing nut (50) at a torque of 90 Ncm (9KgCm) while holding adjusting screw stationary. Check adjusted torque once again. Setting friction torque in Straight ahead range (SAP) at higher than 50 Ncm (5KgCm) will by no means improve steering characteristics and contact conditions in steering gear. Actually, the contact pressure of mating parts will be too high, coupled with the resulting unnecessary wear.
- 2 For adjustment of steering limiters refer Function and adjustment of hydraulic steering limiters portion.

#### 51.4 INSTRUCTIONS FOR ELIMINATING EXTERNAL LEAKS

##### 51.4.1 Input Shaft Seal Leakage.



**In some cases it is possible to replace the Input Shaft Seal (129) on the vehicle itself. If not, it is advised to remove the Steering gear box from the vehicle.**

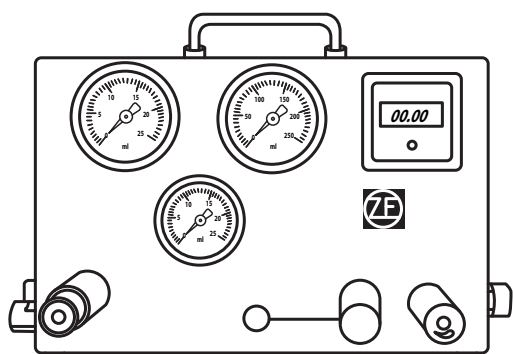
1. Remove the lower fastening screw on the universal joint and pull it out from the Input Shaft of the Steering gear. Remove protective cap (70).
2. Unsnap the locking ring (130). Remove Shaft seal (129) with a suitable pointed hook. Do not damage the Shaft Seal's seat during this procedure.
- 3) Place tool no 7 on the Input Shaft's serrations. Take the new Shaft seal duly filled with grease (ARAL HTR or the like). Slide it over the tool 7, with the Sealing lip facing inside the housing with Tool no. 6. Insert the Shaft Seal only deep enough to ensure insertion of Snap ring (130).
- 4) Remove the Tool 7 and fill the top cavity with grease and place the Dust Seal (70). Slip the Universal Joint over the Sheering's Input Shaft in such a manner that the slit of the lower fork coincides with the SAP marking of the Sheering's Input shaft. Insert the Hex. Screw and tighten the Lock nut. (Tightening torque; M8= 24 Nm: M10x1.25=48 Nm.).

#### 51.5 REMOVING THE STEERING UNIT FOR THE VEHICLE.

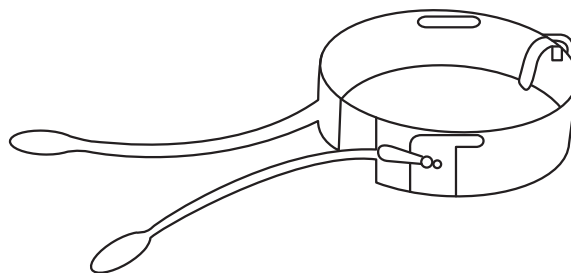
1. Thoroughly clean the steering unit and the area around it paying particular attention to the line connection.
2. Drain the oil, by opening the drain plug (48) or one of the pipe connections. Turn the steering so that the piston is shifted upwards up to the stop. Then briefly, maximum 10 seconds, crank the engine until the oil is sucked out of the pump and oil reservoir. After switching of the engine turn the steering several times both up to the left and the right stop so that the oil remaining in the cylinder chambers is pumped out.
3. Disconnect the pressure and return lines from the steering.
4. Plug all openings, to prevent dirt entering the system.
5. Remove the steering drop arm with a suitable pulling device. Under no circumstances must the steering drop arm be removed by driving a wedge between the neck of the housing and the steering drop arm or with hammer blows since this may cause serious damages within the steering gear.
6. Valid for steering units with universal joints:
  - a) Loosen the universal joint or flexible coupling between the steering gear and Steering column.
  - b) Remove the securing bolts on the housing and withdraw the steering unit.



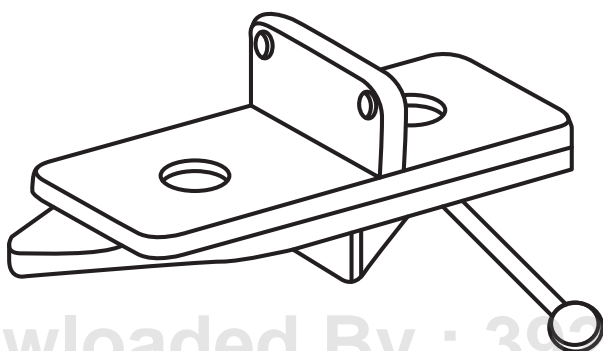
## 51.6 DISMANTLING AND ASSEMBLING TOOLS



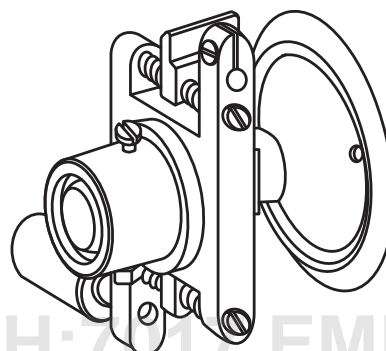
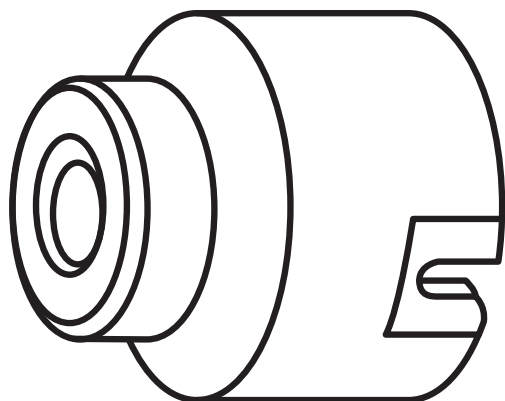
Tool No. 1-Servo Tester or Gauge: 7016 798 925



Tool No. 2-Tongue for Piston Assy. 3W06 040 004



Tool No. 3-Assembly vice for Steering Gear. 7418 798 654

Tool No. 4. Torque measuring device (without insert)  
7470 798 703Tool No. 5. Insert for torque measuring device. 1 x 79-  
7419 798 551Tool No. 6. Entry bush for Input shaft seal. (129) 7418  
798 006 1 x 79 notches.

Tool No 7 Sleeve for Shaft Seal (129). 7404 798 001



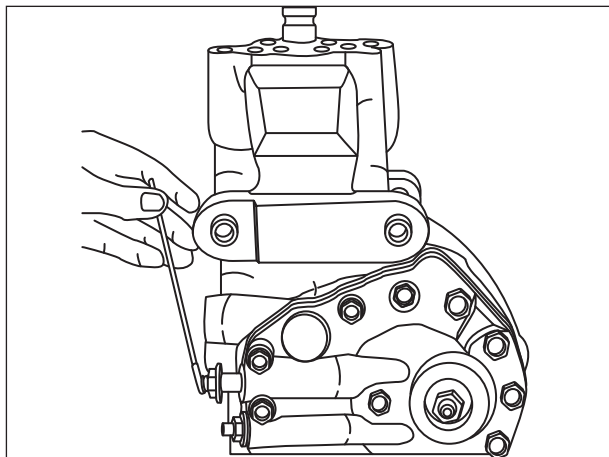
## 51.7 DISMANTLING THE STEERING UNIT.



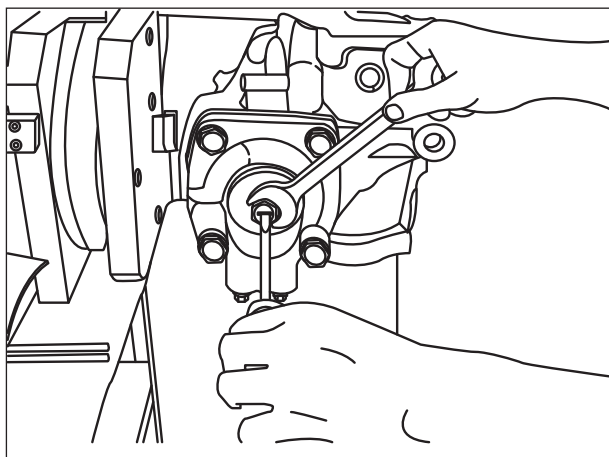
Turn the Input shaft of the Stg. Gear Box with a help of Tool 4 and 5, to achieve the SAP of the Steering Gear, before further dismantling.

## 51.7.1 Removing and dismantling the Housing Cover

1. Clamp the steering unit in the assembly vice 3, or between the soft jaws of a commercially available vice.



2. Loosen the Hex. Screw (57) and screw out the Steering Limiting Valves (55). Remove the Sealing Nut (50) from the Hsg. Cover.



3. Remove the hexagonal bolts (46) and also remove the housing cover (40) by turning the adjustment screw (31) in a clockwise direction.

- 3.1 For steering version with needle bearing - M033: Withdraw the needle sleeve (41) with a commercially available internal puller and withdraw the protective disk (44) with the seal parts (51 and 52) from the bore hole.

For steering versions with roller bearing-8033/8043/8046

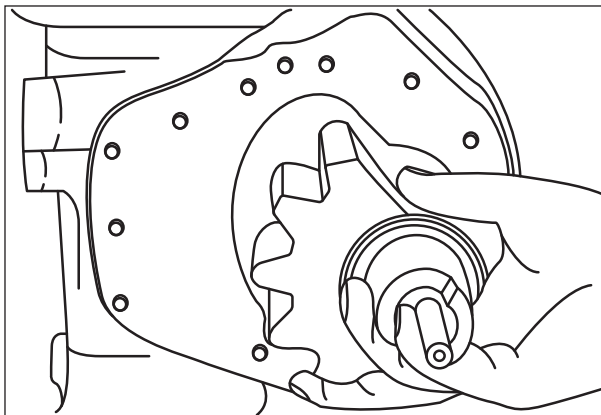


Should be dismantled only in ZF authorised dealers.



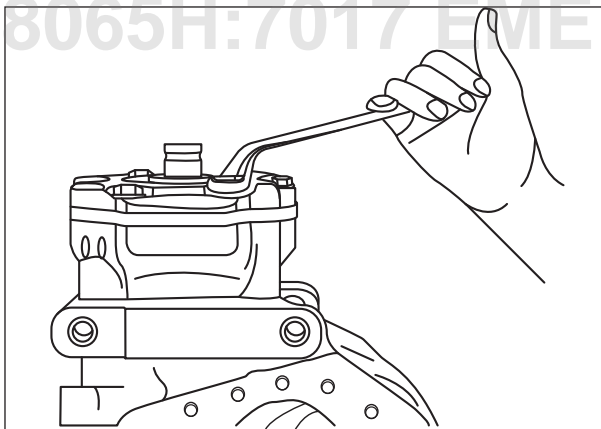
The rollers of the roller bearing (5 and 41) have been sorted into certain tolerance groups by the manufacturers. Therefore, the rollers removed from the bearing external ring on the cover side must not be interchanged with the rollers removed from the housing side,

## 51.7.2 Removing sector shaft

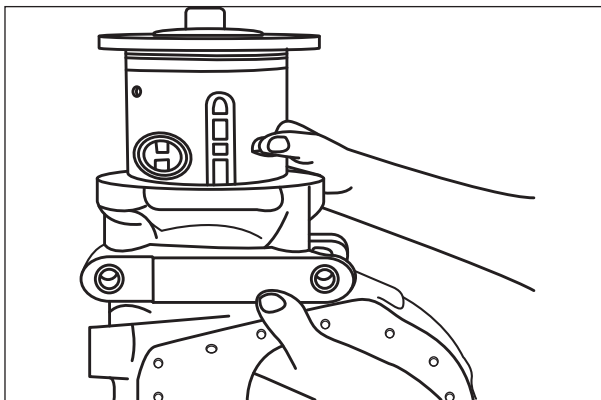


Withdraw the sector shaft (30) in the center position of the gearing (tooth), upwards out of the housing. Remove the circlip (33) from the sector shaft and withdraw the adjustment screw (31) with the guide washer (32).

## 51.7.3 Removing the piston



Remove the protective cap (70) from the worm end. Screw out the securing bolts (132).



A burr (ridge) may have formed on the side of the piston gearing depending on the service duty of the steering unit, and this will damage the piston running surface when the piston is removed from the housing. This





can be avoided if the unit is dismantled horizontally overhead (gearing (tooth) uppermost). Figure shows dismantling in an unfavorable position,

**For steering version with threaded ring (M033/8033/8043/8046).**

Withdraw the piston with worm and cover (128) from the housing.

Remove the seal parts (94, 94.1, 95, 97, 98, 102, 103, 120 and 121).

Removing and dismantling pressure limiting valve if applicable



**In some steering versions (8043/8046), the pressure limiting valve for the maximum oil pressure of the steering pump is built into the housing (1) of the steering unit. Such steering systems can be recognized by the pressure specifications stamped onto the type plate of the steering unit. This should be observed especially for fault finding.**

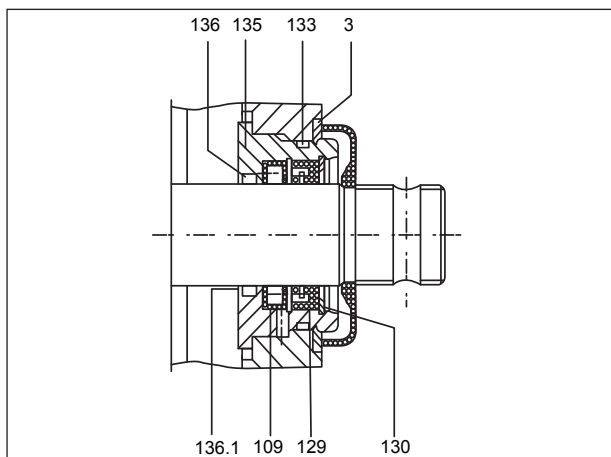
Valve inserts (22) cannot be dismantled.

#### 51.7.4 Dismantling the Housing (1).

Removal and fitment of seals is allowed.



**Should be dismantled only in ZF factory only.**



Removal of Bearing Housing for Steering version with short R dimension (without guide sleeve) (8046). Mark the position of the bearing hsg. (135) in respect of the housing (bleeding groove). Remove the circlip (130). Press out the shaft seal ring (129). Press the Brg. Hsg. (135) from inside and remove the circlip (3). Push the Hsg. Brg. out of the Hsg. Remove the bearing (109). Remove the "O" rings (133, 134) Ref. Figure

#### 51.7.5 Dismantling of piston



**Should be dismantled only in ZF factory only.**

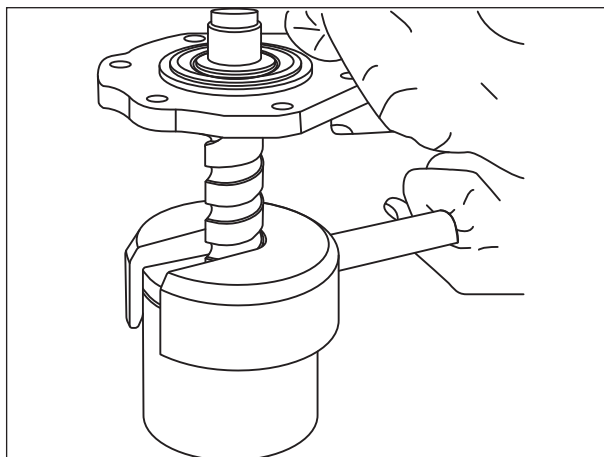
#### 51.7.6 Removing Centering Spring.

For steering version with centering spring (M033/8033) Loosen the slot nut (101) with special tool, and screw out of the Piston, the threaded stud (100) with slot nut (101).

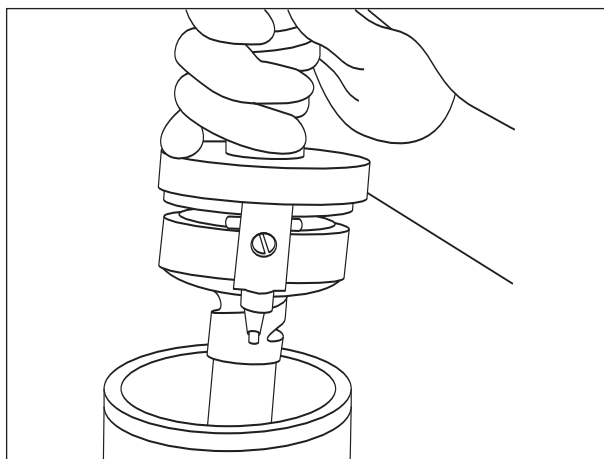
Removing the steering nut and valve piston.



**Should be dismantled only in ZF factory only.**



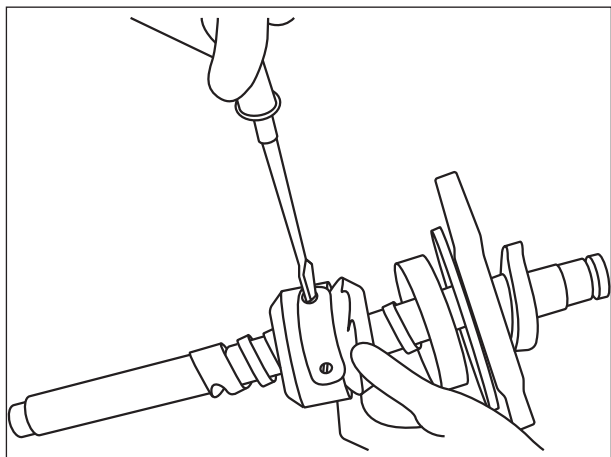
Strike open the caulking at the grooves at the threaded ring (118) and unscrew the threaded ring with special tool. The ring is sealed with Loctite; it can only be removed by heating up to a temperature of approx. 1250C Heating must carried out in a suitable oven. In this case, it is recommended to immediately loosen the two machine screw (99) and then the two countersunk screws (115) after removing the steering nuts (these are also fitted with Loctite.)



Withdraw the worm with the steering nut (114) from the piston.

Unscrew the two machine screws (99) and withdraw the feedback (96) out of the valve piston. Mark the position of the valve piston and then slide out the valve bush.

## 51.7.7 Dismantling steering nut:



Unscrew the two countersunk screws (115) on the cover plate (116). Remove the cover plate; shake the ball circulation tube (114). Remove the steering nut, needle cage (143), axial disk (124), threaded ring (118), intermediate shaft (122) axial disk (124) and the needle cage (144) from the worm.

## 51.7.8 Dismantling the Centering spring / Bending Bar



Should be dismantled only in ZF factory only.

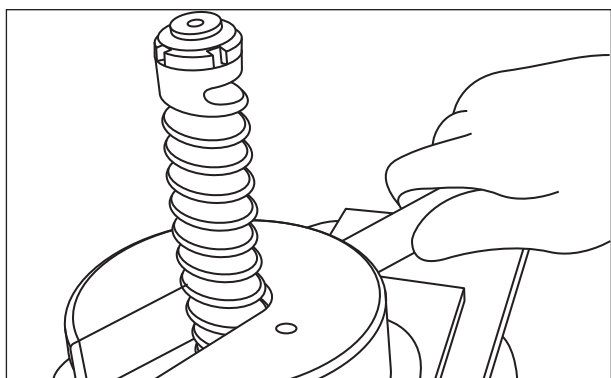
For steering version with centering spring (Model M033/8033) Unscrew the countersunk screw (114.3) and press the finger (114.2) out of the groove of the steering nut. Remove the two spring plates (114.6) and the centering spring (114.5) from the finger.

For steering version with Bending Bar. Unscrew the threaded bush (146) special tool and loosen the deflection rod (148) by lightly tapping a screwdriver or drift, made from round steel with a dia. of 8mm. with a hammer. Slide the clamping high (147) together with the deflection rod out of the piston from the upper side of the piston.

**Removing worm-bearing mounting for steering version threaded ring in the cover (M033/8033/8043/8046).**

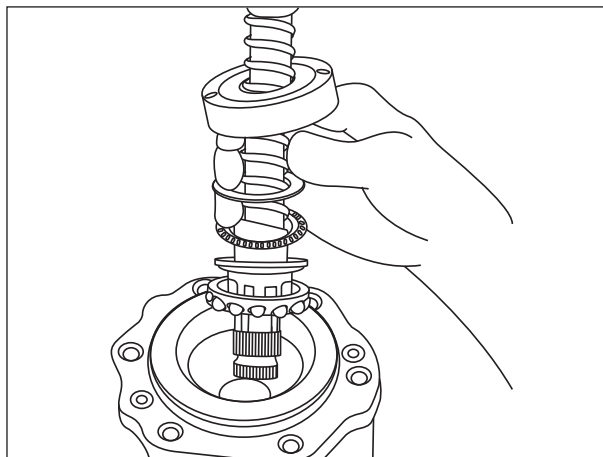


Should be dismantled only in ZF factory only.



1. Clamp the cover (128) in the vice with the worm thread pointing upwards. Knock open the caulking of the two grooves of the threaded ring with special tool. The threaded ring is sealed with Loctite.

## For steering version with angular ball bearing



Remove the axial disk (124), axial needle cage (143), worm, ball Cage (144) and bearing ring (145) one after another. Remove the circlip (130) and the shaft seal ring (129) for models M033/8033/8043/8046. Remove the Sealing rings (138/139)

## 51.8 CHECKING THE STEERING PARTS



Thoroughly wash all parts in a cleaning fluid. Clean Loctite residue from the threads. The seal rings and other rubber parts must not be cleaned in trichloroethylene but with a suitable washing liquid, such as P 3 or Pril, which is completely soluble in water.

## Checking:

Check the parts for wear, damage or other defects in order to establish whether the parts can be used again. Only new parts suitable for the type of steering and corresponding to the spare parts list should be used, see type plate. eg. 8043 955 302.



The test requires detailed specialist knowledge and conscientiousness. The fitter must be responsible for the decision as to whether the parts needed changing or not.

## 51.8.1 Housing and housing cover

- Cylinder bore. Max. wear dimensions of the bore diameters for honing:
 

8033/M033	=	78.055 mm
8036	=	83.06 mm
8038/42	=	95.06 mm
8043/45	=	101.56 mm
8046	=	110.00 mm
- Threads

**51.8.2 Piston**

The piston (90), valve piston, finger (114.2), steering nut (114.1) and worm (104) must all be changed if one of the parts is damaged since they are preselected and assembled at the factory to keep play to a minimum.

- External diameter.
- Gearing (crack testing longitudinally and laterally with a suitable testing procedure such as ferro flux). Scrap all parts with cracks. Remove any burr (ridges) on the sides of the gearing.



**Should be dismantled only in ZF factory only.**

**51.8.3 Worm and steering nut.**

**Should be carried out in ZF factory only.**

- Ball circulation channel (coefficient of friction in the center range of the channel, min.5 Ncm).
- Running surfaces of the needle cages and of the shaft seal ring.
- Cylindrical parts of the steering finger.
- Serrated gearing of the worm.
- Crack testing. Longitudinal and lateral (with suitable testing procedure, ferro flux). Scrap all parts with cracks
- Play between the bending bar and the longitudinal groove of the steering, maximum 0.2 mm.

**51.8.4 Sector shaft**

- Teeth (crack testing, longitudinally and laterally, with suitable testing procedure, e.g. ferro flux.) Scrap all parts with cracks.
- Running surfaces of the needle sleeves and the shaft seal ring.

**51.8.5 Needle bearing and ball bearing.**

The relevant bearing should be changed in the case of indentation or wear on the running surfaces of the steering parts.

**51.8.6 Technical Data**

- Centre Torque between Sector Shaft and Piston:
- Centre Torque; 40 to 60 Ncm above the Out of Centre Torque, for all the models.
- Out of Centre Torque:  
For 8033-37 -70 to 150 Ncm.  
For 8038-44 -100 to 200 Ncm.  
For 8045-46 -120 to 220 Ncm.

**51.9 ASSEMBLY OF THE STEERING UNIT AND FUNCTIONAL TESTING**

Before assembly, all traces of paint and damages must be removed from the face surfaces of the housing and cover. In addition, all parts must be thoroughly cleaned; lightly oiled and all sealing parts must be renewed. The measuring and adjusting tools used must be regularly checked for accuracy.



**Should be carried out in ZF factory only.**

Apply Loctite to the threaded rings (118 and 118.1), machine screws (99) and countersunk screws (115). This requires that the parts are dry, oil and grease free. That the oil Loctite deposits are removed and that the sprayed activator is ventilated. Pretreating the contact surfaces with activator T Accelerates the initial hardening time. The Loctite should be applied so that no excess loctite drips onto the parts after they have been joint together. Hardened Loctite drops may lead to functional disturbances. Loctite joints should only be separated after the Loctite has fully hardened and then refitted together. The use of Loctite is not dealt with in any further detail in the repair instructions, expect for the fact that care should be taken to select the correct identification number of the type of the Loctite to be used.

Hardening times for loctite identification No. 222 and 270 at room temperature.

After two hours, it can be transported, Adjustment of the hydraulic medium possible with air.

After six to eight hours, completely hardened, adjustment of the hydraulic medium possible with oil or final testing on the testing rig.

**51.9.1 Preassembly of housing**

For model M033. Clamp the housing in the assembly vice 1, and press in the inner needle sleeve (5) with the same drift .Place the protective disk (8) in the opening above bearing. Press in the profile seal ring (9) with the drift 6 until it lies on the protective ring. The sealing lip of the protective seal must face the inside of the housing.

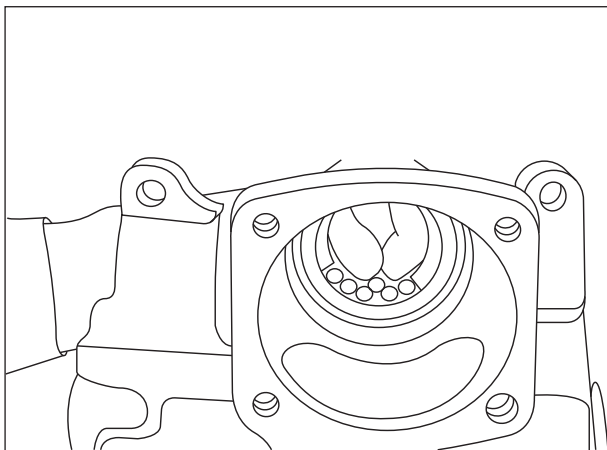
For steering version with roller bearing.



**The rollers of the roller bearings (5 and 41) have been sorted out in certain tolerance groups by the manufacturer. Therefore, the rollers removed from the bearing outer ring on the cover side must be interchanged with the rollers from the housing side.**



**Should be carried out in ZF factory only.**



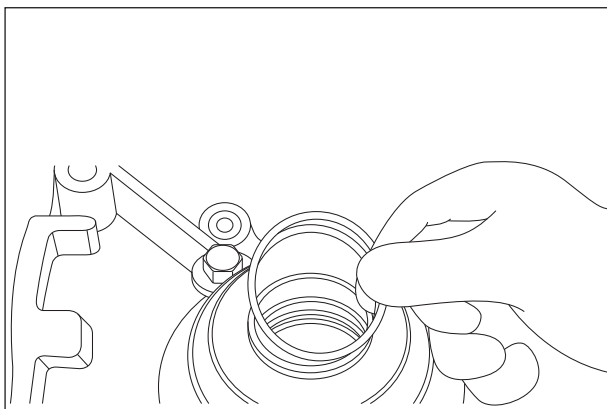
Place the housing on the workbench with the housing neck facing downwards. Place the supporting disk (5.1) in the bearing neck bore hole

For roller bearings without roller cage. M033/8033/8043/8046

Press the outer ring of the roller bearing (5), without the roller, into the housing until it reaches the collar using tool 18, and lock in position by making 10 notches around the circumference. Fit the rollers with grease and place the polyamide filler piece in a roller gap; this provides protection which the parts are stored and remains in the steering unit. Remove the segment shaft.

Press the roller bearing into the housing until it reaches the collar with the open cage side first, and lock in position by making 6 notches around the circumference.

Mount the additionally fitted needle sleeve (5) 1 for the steering unit version with long bearing neck. Fill the spaces between the needles with hot bearing grease.



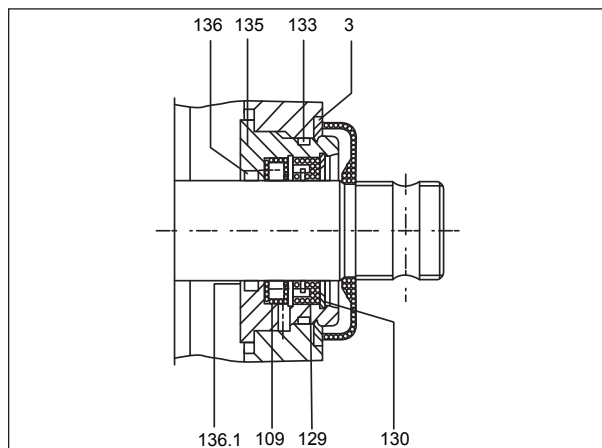
Place one round seal ring (6.1) and one seal ring (6) in each of the two radial grooves of the housing neck. Special care must be taken to ensure that the polyamide rings with the beveled surface lie on the same inclined surface of the groove.

For 8046 model. Fitting Bearing Hsg. or Bearing Plug.

Place the "O" rings (133, and 134) in the radial grooves of the bearing plug (135).

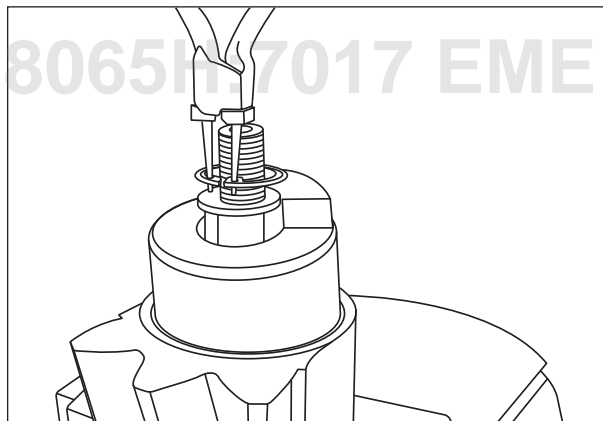
Insert the needle cage (109) in the bore hole.

Press in the shaft seal ring (129) with drift 7. Fill in the space between the sealing lip and the dust lip with hot bearing grease. Fit the circlip (130).



With a special tool insert the Bearing Hsg. in the Housing (1), taking care to align it with the bleeding hole groove. The Circlip (3) secures the Bearing Hsg. On the Housing (1).

### 51.9.2 Preassembling the segment shaft



Fit the adjustment screw (31), guide washer (32) and circlip (33) in the segment shaft with punched curve outwards. The adjustment screw should be fitted play – free but must not jam. (Refer to technical data)

### 51.9.3 Preassembling the piston and adjusting the hydraulic reaction.

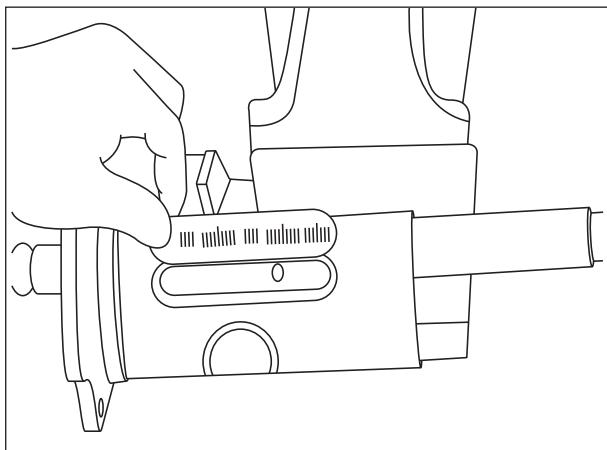


Should be carried out in ZF factory only.

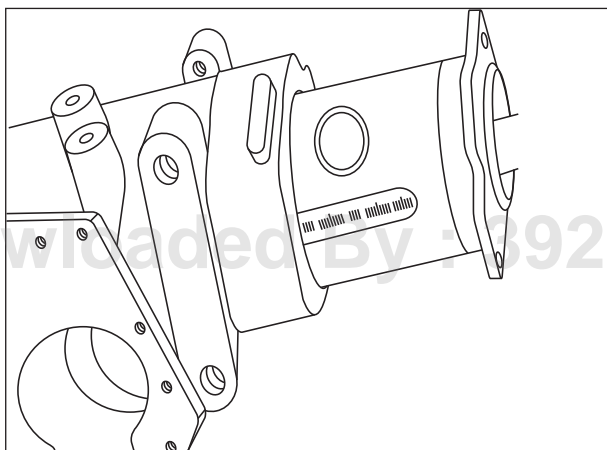
Complete Piston Assy. 90 needs to be replaced, hence assembly instructions of Piston are not given. The following are the nominal size of Balls for the Steering models. M033/8033-7 mm. Total 23 nos. 8046/8043-8 mm. Total 26 nos.



#### 51.9.4 Fitting the Completely assembled Piston



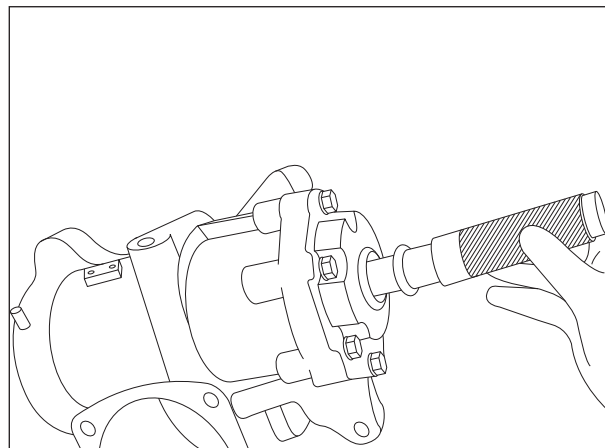
Fit seals (95) in the longitudinal grooves of the piston and then fit the seals (94). A support plate (94.1) is also provided in some cases and must also be fitted in the longitudinal recesses.



The pair of seals (97 and 98) are also fitted with the inner seal (97) first and then the outer seal (98). Place the round seal ring (102) in the recess of the piston and then fit the piston ring (103). Special care must be taken when passing the seal over the piston to ensure that no damage is caused by the edges of the piston. In case of the Longer R dimension Stg. Gear M033/8033/8043, the small round seal rings (121) must be adhered to the recess of the 122) or the cover (128) by means of grease. Lubricate the cylinder path well with oil. Slide in the preassembled piston up to the shoulder of the intermediate cover. In order that the seal parts are not damaged the piston should be fitted in its final position, i.e. gearing parallel to housing neck. In case of Short R dimn. Stg. Gear assembly 8046, the Sealing rings (138,139) must be inserted in the worm groove. Insert the worm in the Bearing Hsg. by applying grease.

For steering version with threaded ring in the cover: screw in and tighten the hexagon bolts (132) with the washers (131).

Use the washers (131) in conjunction with the bolt lengths given in the parts list. Tighten the End Cover.

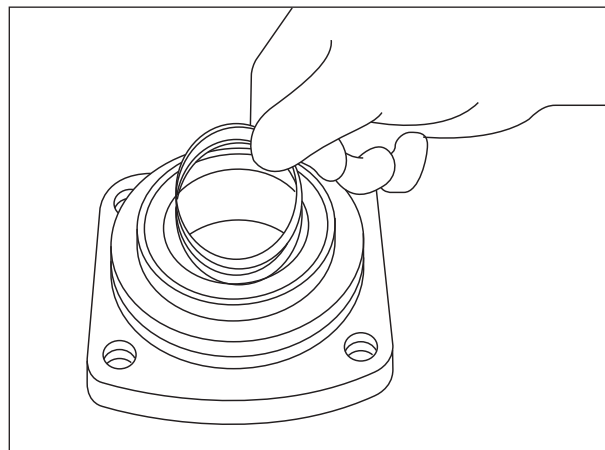


For M033/8033/8043, Slide the entry bush over the serrated gearing of the steering spindle, press the shaft seal ring (129) with the sleeve so deep that the circlip (130) can just be fitted in its groove (sealing lip pointing towards the inside of the housing. Fill the space between the sealing lip and the dust lip with hot bearing grease) fit the circlip (130).

Refer to the technical data for tightening torques.

#### 51.9.5 Fitment of Housing Cover.

- 1 Clean the parts thoroughly whereby the rubber or plastic parts must not come in contact with trichloroethylene. Clean the bore holes with compressed air.



- 2 Fit the round seal ring (52) and the seal ring (51) in the radial groove. Special care must be taken to ensure that chamfered area of the polyamide ring lies in the same chamfered surface of the groove.

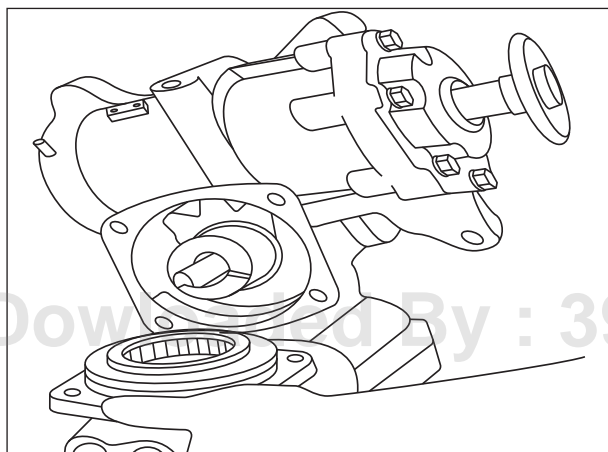
#### 51.9.6 Fitting the segment shaft

1. Bring the piston to the center position by turning the end of the steering shaft. This center point is found by first determining the total number of turns of the worm then turning back the piston from one stop by half the total number of turns.
2. For steering version with roller bearing slide the entry bush over the tapered serrated gearing of the segment shaft (30). Insert the segment shaft into the housing, taking care not to damage the

sealing parts. The Sector Shaft Centre marking must lie at right angle to the piston axis in the mid position of the piston. Push the dust seal (1.1) onto the segment shaft up to the shoulder and apply HTR2 grease or similar between the dust seal and housing.

#### 51.9.7 Fitting the housing cover

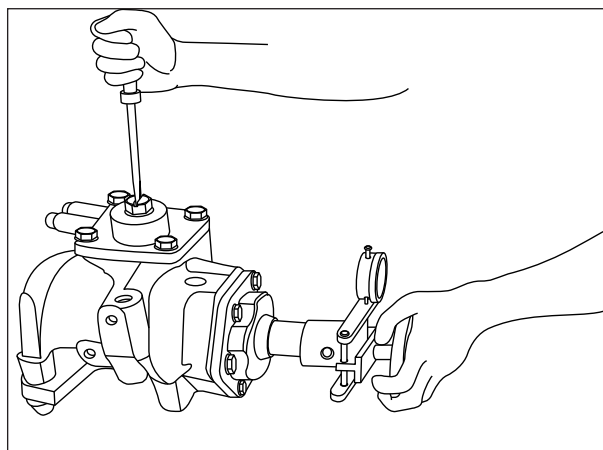
- For steering version with needle bearing Fit the two round seal rings (42 and 43) in the axial groove of the housing cover (40).
- For steering version with roller bearing Fit the round seal ring (43) and the round seal ring (43.1) together with seal ring (43.2) in the two radial grooves. The round seal ring (43.1) is fitted together with the seal ring (43.2) in the radial recess on the inside of the housing.



- Fit the housing cover. Position the housing cover by turning the adjusting screw (31) on the front surface of the housing in a counter – clockwise direction and screw on the sealing nut (50) temporarily. Screw in and tighten the hexagon bolts (46) with washers (47). Screw in the threaded plug (48) and tighten (refer to the technical data for the tightening torque).

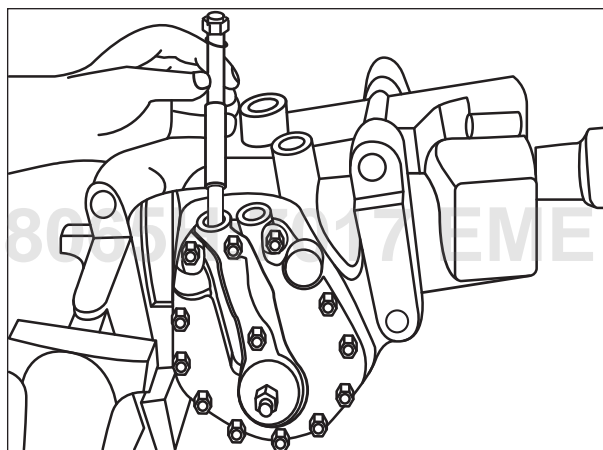
#### 51.9.8 Setting the pressure Point

- Place the torque measuring unit 8 and insert 9 on the worm.
- Turn the steering from the one end position to the other. Measure the frictional force outside the pressure point and determine the total turn of the steering wheel. Then set the frictional force in the area of the pressure point (mid position; half of the total turn of the steering wheel). The torque measuring device is turned both to the left and right of the center position and the adjusting screw should be screwed out so far until an increase in the friction torque of 40-60 Ncm compared to the value measured in point 2 is set.



- Tighten the sealing nut (50) (refer to the technical data of the tightening torque), while holding the adjusting screw in a fixed position. Check the set torque once again. Fit the protective cap (70).

#### 51.9.9 Fitting the steering limiting valve



Fit the "O" rings (53 and 54) in the radial groove of the two valves. Turn the valves into the housing cover 9. Turn the hexagon nuts (57) with the washers (56) onto the threads and tighten slightly.

#### 51.10 CHECKING THE FRICTIONAL TORQUE OF THE COMPLETELY ASSEMBLED STEERING UNIT

Place the torque measuring device 8 and insert 9 on the worm. Turn the steering unit from one end position to the other. Measure that frictional torque outside the pressure point in a horizontal position (refer to the technical data.) If the frictional torque is above this value, this may be due to excessive initial tension of the seal (94) in the piston.

##### 51.10.1 Functional test:

Clamp the completely assembled steering unit on the steering test rig after Final hardening time for loctite. Bleed the steering unit and increase the oil temperature to approximately 50°C.

The adjustment values given are valid for the setting pressure point of the steering system after completion of the repairs on the workbench. There is no oil in the steering unit.



**51.10.2 Testing the maximum pressure:**

Block the steering unit in the mid position (steering units without hydraulic steering limiting system can be turned to the extreme stop). Turn the steering wheel until the maximum pressure has built up on one side of the cylinder. For this purpose it is necessary to apply a force of 100-200N (10-20 kg) to the periphery of the steering wheel so that the maximum path of the valve is utilized.

If the steering unit is fitted with a pressure limiting valve a maximum pressure must be built up which corresponds to the specifications given on the type plate (tolerance + 10%). If the steering unit has no pressure limiting valve then the pressure limiting valve built into the testing rig must be set to the rated pressure which is predetermined for the steering unit (this would correspond to the rated pressure which is given on the type plate of the pump).

The same measurements are now carried out in the opposite direction of the steering wheel. If the maximum pressure is not reached within the specified tolerance, the oil leakage in the steering system is either too great or the pressure limiting valve, if applicable, is incorrectly adjusted. The latter can also be the reason for too high maximum pressure.

**51.10.3 Checking for oil leaks:**

The control valve must be fully activated in order to be able to determine the leakage oil in the steering system. For this reason a minimum of approx. 200 N (20 kg) must be applied to the steering wheel. The test is carried out with the pump running and a pressure is set on the steering testing rig which lays approximately 20 bars below the maximum pressure given on the type plate.

The maximum permissible leakage oil under these conditions is:

1.8 LPM for type 8033-8037

2.0 LPM for type 8038-8043

2.2 LPM for type 8045-8046

The test can be carried out with blocked steering drop arm for Steering Gear with non-adjustable Limiter and in the end positions of the Steering Gear in Adjustable Limiter type. Repeat the leakage oil check at a pressure of 20 – 30 bar.

**51.10.4 Checking the valve setting:**

The pump is running and the oil circulates through the hydraulic system of the steering unit. No counter force is set on the steering shaft in the steering test rig. The hydraulic steering is turned slowly to both sides up to the stops in each case and the torque measuring device is released several times during this process. The steering must not move in any direction on its own. The difference in the torques when steering to left and right must not exceed 30% in respect of the low value up to a pressure of 3 bar compared with the flow pressure when the steering drop arm is blocked.

**51.10.5 Checking control valve:**

Close the control valve by turning the steering wheel then build up the maximum pump pressure. The steering wheel should then be slowly released. The valve should then return to the 0 position, i.e. the oil pressure must fall to the flow pressure.

**51.10.6 Setting the hydraulic steering limiter:**

Turn the steering wheel in one direction until the deflection of the steering drop arm as given in the parts list for the switch –off point of the hydraulic steering limiting system is reached. Then adjust the steering turning the valve (55) in or until the oil pressure drops. This can be felt immediately in that the steering wheel can be turned only with increasing force. The adjustment should also be carried out in the opposite direction of the steering drop arm. Finally lock the hexagon nut (57) with a torque of 25 to 35 Nm.

**51.10.7 Checking the seals:**

No leaks should be visible on the hydraulic steering unit after running for 10 minutes in the neutral position of the steering valve. Tightness at high pressure must be determined during the test in accordance with the above points. Place the dust seal (1.1) on the segment shaft up to the shoulder, applying HTR2 grease or equivalent between the dust seal and housing, and place the protective cap (70) on the steering spindle end, applying HTR2 grease or equivalent between the protective cap and valve housing.

**51.11 FITTING THE STEERING UNIT IN THE VEHICLE**

**In order to ensure perfect functioning of the ZF hydraulic ball & nut steering, special emphasis must be paid to cleanliness when fitting all the relevant units of the system and when laying the oil lines. In order that faults can be avoided due to foreign bodies or dirt in the oil steering circuit the cap plugs on the line connections of the steering unit, oil pump, working cylinder, valves etc. should only be removed when connecting on the lines. Connection lines and securing elements must be carefully cleaned and deburred.**

- 1 Clean any paint or dirt from the contact faces of the mounting brackets.
- 2 Insert the steering gear in the mounting bkts and tighten the bolts with the corresponding torque.
- 3 Stresses which may occur during the assembly of the steering gear/bearing block due to the position of the dash board or on the circumstances when securing the steering column tube and steering spindle. Stresses can cause bending forces especially in the steering spindle which, depending on size and frequency, may lead to fractures or

impair the easy movement of the steering gear. The check whether the steering unit has been installed correctly should be carried out as follows:

- Check the movement of the steering gear at the mounting bracket, steering drop arm and drag links (s). Fit the universal joint or the flexible coupling between the steering column and the steering gear. The UJ's Slit must match the SAP mark of the Steering Gear's Input Shaft Mark. The angle should be the same if two universal Joints are used and the joint forks must be arranged in one plane. If it is not possible to fit them in this way, synchronization can be achieved by positioning the forks on the serrated gearing in respect of each other.

Hammer blows on the joints must be avoided in the case of aluminum universal joints because this might lead to destruction or stiffness. Connect them by inserting the fit bolts and tightening the nuts. (Refer to the technical data for the tightening torques).

6. Bring the steered wheels of the vehicle to the straight ahead position. This position is reached when the steered wheels are flush or parallel to the second pair of rear wheels or when placed on turn tables (Or place the measuring bar on the wheels and the chassis frame).
7. Slide the steering drop arm on the sector shaft (30), whereby the markings of the steering drop arm and the sector shaft must coincide. Tighten the hexagon nut (35) temporarily and turn the steering clockwise until the wheel stop. Remove the steering drop arm and establish whether there is steering reserve in the steering unit by continuing to turn the steering wheel. Repeat the measurement in clockwise direction. Tighten the hexagon nut (35) with torque given below and secure with split pin (34) or the securing plate (36). Hook on and tighten the drag link.
8. Secure the hydraulic pump on the bearing block and adjust the necessary tension of the V – belt. Thumb test.
9. Connect the pressure and return lines between the pump, steering and working cylinders. If the lines have to be bent then this must be carried out in a cold condition so that the risk of combustion is eliminated.
10. Commissioning the steering unit In order to prevent dirt particles which still could be in the oil line system, from entering the pressure limiting valve during first commissioning, we recommend that the oil is allowed to flow through the system for several minutes, with changing engine speed and without turning the steering wheel. The steering should then be turned several times in both directions without completely reaching the stops of the steering system at a medium engine speed (until the operating temperature is reached).

It is advantageous for steering units with a built in pressure limiting. Finally bleed the steering unit.

11. For adjustment of the hydraulic steering limiting refer Function and adjustment of hydraulic steering limiters.

## 51.12 FAULTS AND REMEDIES

The ZF hydraulic ball nut steering system in short form is designed to meet exacting requirements. The unit is designed in such a way that no faults can occur in the case of correct maintenance and normal operation.

However, if a fault should occur the following information should contribute to establishing and rectifying the fault. Before the steering unit is checked for the individual faults, the oil level must first be checked with the engine running. We would also like to draw your attention to the fact that the use of heavily foaming oil may lead to faults, since such oil release air with great difficulty or not at all, once it has entered the steering system.

**51.13 POWER STEERING TROUBLE SHOOTING**

The ZF ball and nut-type power steering gear, short version, is designed to meet exacting requirements. The unit is designed in such a way that no faults can occur in the case of correct maintenance and normal operation.

However, if a fault should occur the following information should contribute to establishing and rectifying the fault.

Before the steering unit is checked for individual faults, oil level must first be checked with the engine running. We would also like to draw your attention to the fact that the use of heavily foaming oils may lead to faults since oils only release air with great difficulty or not at all once it has entered the steering system.

Fault	Cause	Remedy
1 Noise	Low oil level Air in system Drop in pressure	Top up oil level Bleed the system. Contact Authorised Service Centre.
2 No Pressure/Flow too low	Pump flow control valve sticky	Dismantle clean ensure easy movement.
3 Low Pressure	Wrong flow control valve setting	Clean or Replace flow control valve.
4 Both side steering is hard	Low oil level Air in system Filter choked Hard Steering Column Defective Steering Box Defective Pump	Top up oil level. Bleed the system Renew filler element Replace Replace Replace
5 Hard to move in one direction	Hose leak Wrong hose size Defective Steering Box	Arrest leakage Change hose Replace
6 Hard to move for fast steering	Air in system Flow too low Defective pump	Bleed the system Dismantle clean reset flow control valve. Replace
7 Return line obstruction	Sticky steering linkages Misaligned linkages Steering column defective Tight universal joints Rocker shaft to piston teeth jam	Lubricate Reset Replace Lubricate or replace Adjust section
8 Inaccurate steering	Low oil level Loose linkages Loose suspension Loose Universal joints Hard linkage joints Loose steering mounting Air suction in pump Improper preload Defective steering box	Top up oil level Tighten Tighten Tighten Lubricate Tighten Renew sealing ring and bleed the system. Adjust backlash between rocker & piston. Replace
9 Steering wheel knocking	Low oil level UJ play Air suction in pump Improper preload Defective steering box	Repair leaks Renew Renew sealing ring and bleed the system. Adjust backlash between rocker & piston. Replace
10 Torsional vibrations	Unbalanced wheels Defective steering geometry Air suction in pump	Balance Correct Renew sealing rings bleed.
11 Steering wheel play	Loose linkages, UJ mounting & suspension Improper preload defective steering	Tighten / Replace Replace.
12 Steering wheel excessive centre play	Defective steering box	Replace
13 Oil Loss	Reservoir cap loose Wornout sealing rings Hose Leakages Defective steering box	Tighten Replace Arrest Replace

Use only recommended grade of oil.

Don't use contaminated/reconditioned oil. Avoid mixing of water, any other oil, Kerosene etc.

Don't allow the oil level to drop below minimum level while engine is running.

Attend to leakage complaints immediately.

**51.14 ZF VANE PUMPS****51.14.1 Functional description**

ZF vane pumps have been specifically designed to supply pressure oil to hydraulic assisted steering systems the low number of moving parts (drive shaft rotor and vanes) and the minimum possible face end play of these elements with respect to the drive side and cover side faceplate ensure high efficiency and consequently the best possible utilization of power this efficiency is also partially the result of the pairs of two opposite suction and pressure zones, a design whereby the ten pump cells each convey twice their own cell volume per revolution. The double arrangement of the suction and pressure zones results in mutual cancellation of the hydraulic radial forces acting upon the rotor.

When turning the drive shaft and the rotor connected to it the vanes guided therein are also driven. Centrifugal force and pressure oil which can pass via bores and grooves from the pressure chamber onto the inside faces of the vanes force the wings against the track of the cam ring. The pump cells are thus separated from each other causing intake as the volume rises and discharge as the volume decreases the oil passes from the two pressure chambers into the space between the cover and the cover side faceplate which is thus forced against the cam ring at operating pressure and also to the flow limiting valve and via a throttle to the discharge line.

An increasing speed and/or increasing conveying flow results in an increasing pressure drop downstream of the chock and consequently on the spring side of the valve piston as soon as the hydraulic force (pressure difference x piston area) exceeds the spring force the piston move against the spring with the result that the superfluous conveyed oil can pass into the inlet channel of the pump via the bypass bore which is then opened consequently, an almost constant oil flow is delivered for the steering unit over the entire speed range. The maximum pressure in the pump is controlled by a spring loaded valve in the flow limiting piston.

Pumps with descending characteristic are designed in such a way that the conveying flow drops as the speed increases. This improves the steering feeling and, therefore the contact with the road. However the reduced conveying flow is great enough at all times to permit build up of the maximum hydraulic assistance. This effect is achieved either by a special purpose arrangement of the throttle in the pump pressure channel, or by a tapered control pin which varies the annular gap in the throttle. In both cases the pressure down stream of the throttle or on the spring side of the valve piston is continuously reduced as the speed increases.

Second generation ZF vane pump without control pin constant conveying flow over the entire speed range.

**51.14.2 Overhauling**

After removing the power steering pump from the engine follow the steps mentioned below for dismantling, inspection and assembling.

**51.14.3 Dismantling**

Clean the rear cover properly.

Remove the hook spring ring.

Mount steering pump in the fixture then lightly press the rear cover by hydraulic press. By spring tension the backcover will come out automatically.

Remove rotor set and pressure plate.

Remove the oil seal from the front end.

Remove the snap ring and then remove shaft with bearing.

Remove the flow control valve unit.

**51.14.4 Inspection**

Check the pressure plate, front plate and rotor sets for any damage, scores and pits. If found defective replace the same.

Check the roller and needle bearing for any damage and replace if found defective.

Clean and check the shaft for any scores, pits and damage, replace if found defective.

Check the flow control valve for proper functioning and replace piston, springs if found defective.

**51.14.5 Assembly**

Hold the pump housing in the fixture.

Insert the shaft with bearing then fix the retaining ring.

Mount the front oil seal.

Fix the body inside O ring and support ring.

Fix the dowel pin inside the body.

Fix the rear plate properly on the dowel pin.

Fix the rotor set and pressure plate.

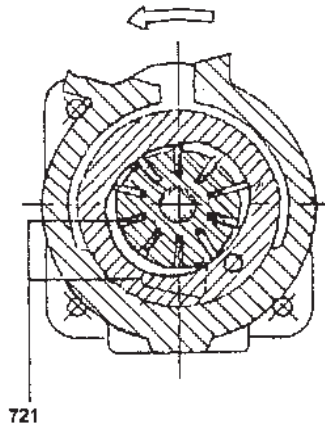
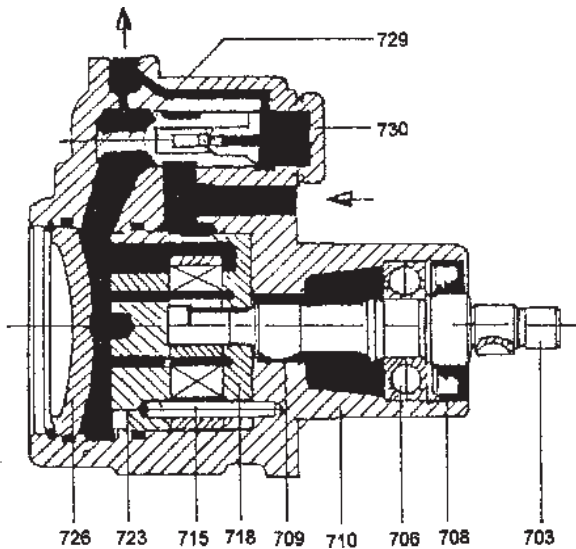
Place the spring, sealing ring and then fix the rear cover.

Finally press the rear cover and fix hook spring ring properly.

Assembly the flow control valve components (piston, spring, washer and screw plug) in sequence and torque tighten to 90 Nm.

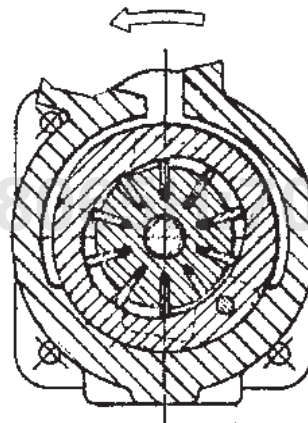
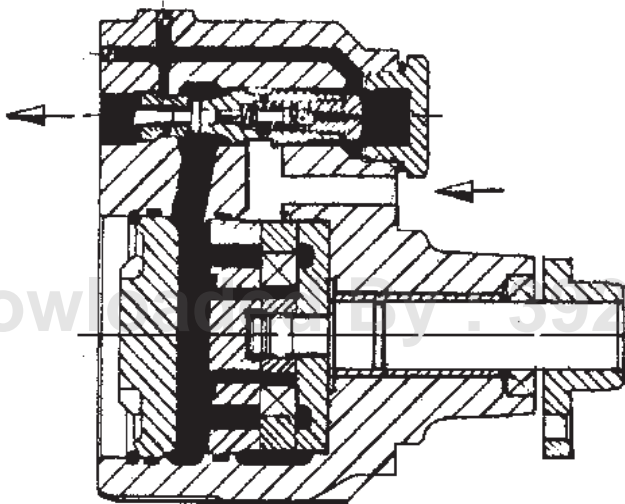
After assembly of the pump mount it in a test bench and check it for proper functioning and performance.



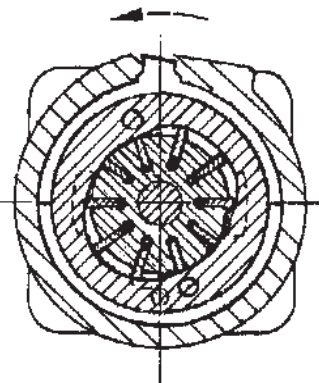
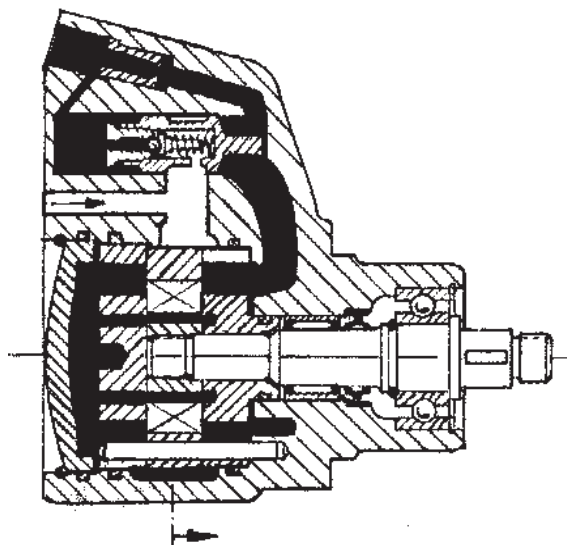


- 703 Drive shaft
- 706 Deep groove ball bearing
- 708 Shaft seal ring
- 709 Needle bearing
- 710 Housing
- 715 Dowel pin
- 718 Drive-side faceplate
- 721 Rotor Assembly
- 723 Cover-side face plate
- 726 Cover
- 729 Valve piston assembly
- 730 Compression spring

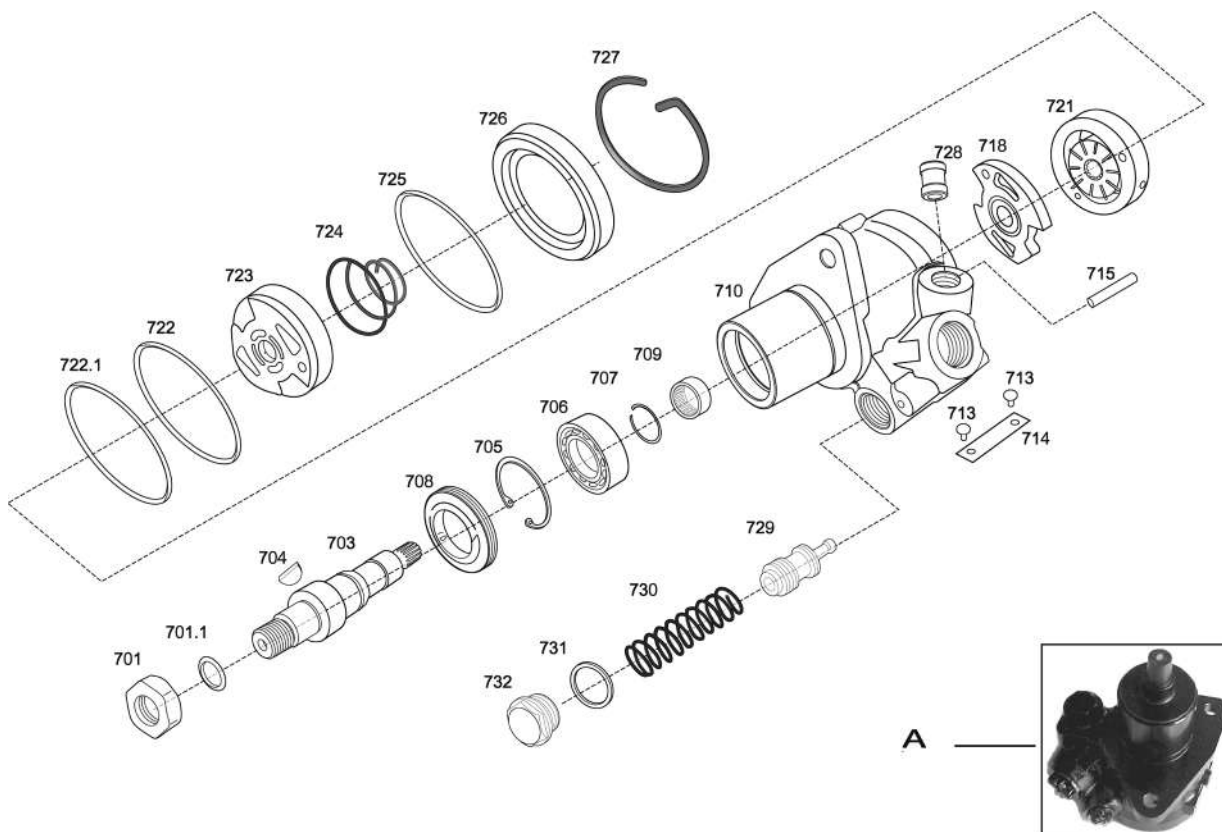
Second generation ZF Vane pump **without control pin**. Constant conveying flow over the entire speed range.



Second generation ZF Vane pump **with control pin**. Conveying flow drops as speed increases.

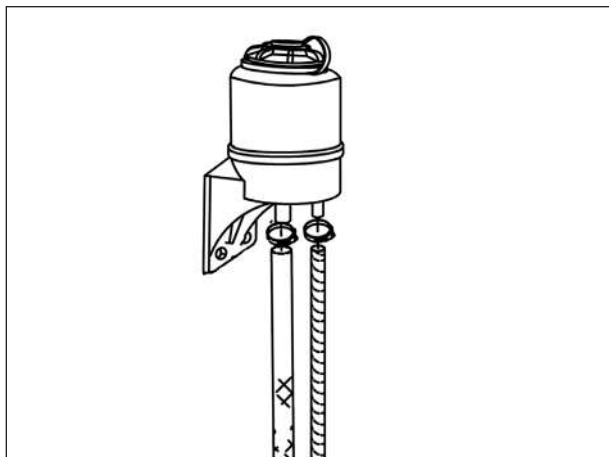


First generation ZF Vane pump **without control pin**. Constant conveying flow over the entire speed range.



Representative Diagram - ZF Vane Pump

ILL. NO.	Description	Qty	ILL. NO.	Description	Qty
A	vane pump	1	722	O ring	1
703	Shaft	1	722.1	Supporting ring	1
706	Ball bearing	1	718	Pressure plate	1
707	Snap ring	1	724	Compression spring	1
704	Woodruff key	1	726	Cover	1
705	Retaining ring	1	725	Profile sealing ring	1
708	Shaft seal	1	727	Hook spring	1
710	Housing	1	731	Sealing ring	1
709	Needle sleeve	1	732	Screw plug	1
715	Dowel pin	1	729	Flow limiting piston	1
723	Pressure plate	1	730	Compression spring	1
721	Rotor set	1	721,718,723	Rotor kit with front plate & pressure plate- rh	1

**51.15 OIL RESERVOIR**

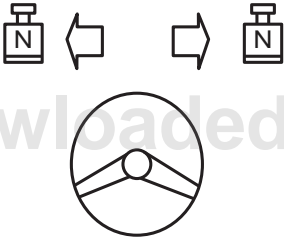
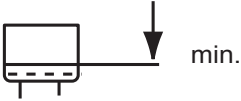
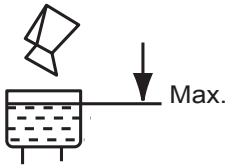
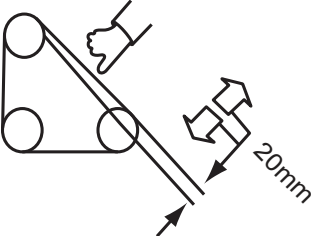
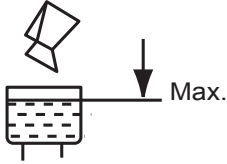
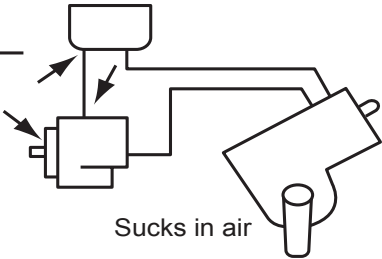
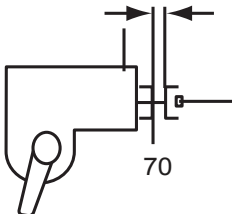
In general, the oil tank is installed separately from the pump. This arrangements is favourable for oil cooling

purposes. Three lines are required for this type of installation:

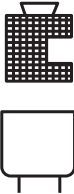
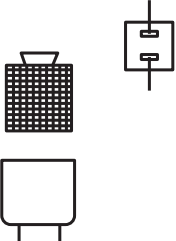
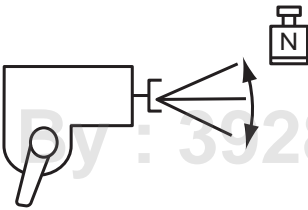
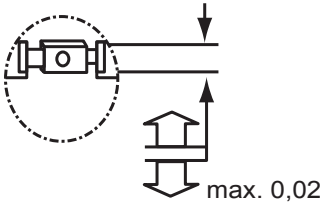
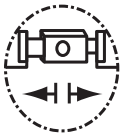
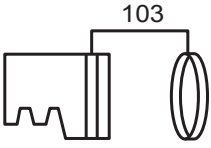

1. Pressure line between pump and steering system,
2. Return line between steering system and oil tank,
3. Suction line between oil reservoir and pump.

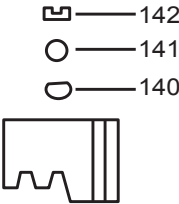
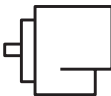
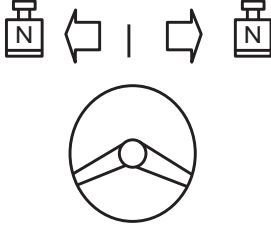
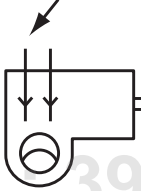
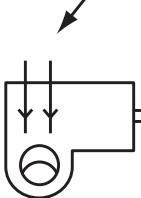
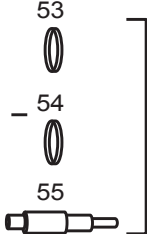
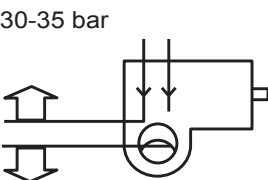
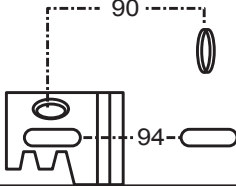


**Trouble Shooting**

Fault	Cause	Remedy
<p>Difficult on both sides</p> 	<p><b>A</b> External faults - maintenance work</p>	
		<p>Repair leak</p> 
		<p>Renew Seal ring</p>  <p>Bleed</p>
		<p>Bleed</p>
		<p>Bleed</p>

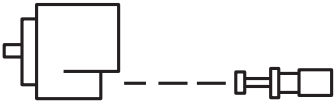
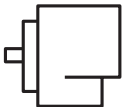
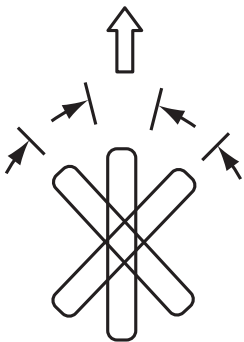
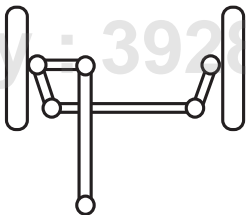
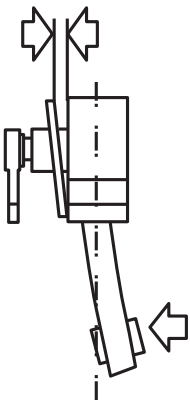
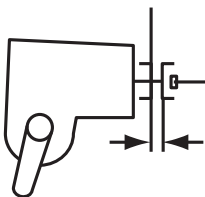
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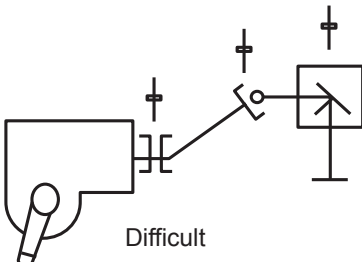
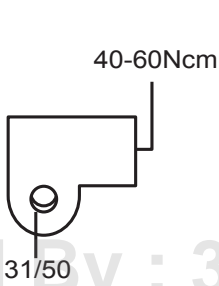

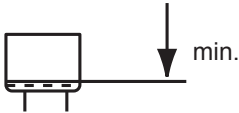
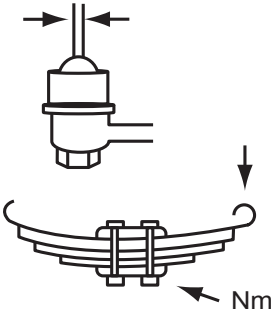
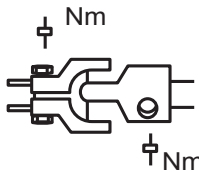
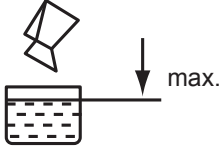
Fault	Cause	Remedy
	  	<p>— Renew, regulating valve clean inlet line.</p> <p>— Renew</p> <p>— Ensure easy movement or replace</p>
<b>B</b>	Internal faults - ZF service division	
	   	<p>— Check or exchange</p> <p>Jamming — Remove foreign bodies</p> <p>Leaking — Renew</p>

Fault	Cause	Remedy
	 <p>Looking</p>	Renew
	 <p>Conveying flow too low</p>	Exchange
	<b>A</b>	External faults - maintenance work
	 <p>Locking</p>	Renew
	 <p>Leaking</p>	 <p>Check or exchange</p>
	 <p>30-35 bar Section II</p>	
	<b>B</b>	Internal faults - ZF service division
	 <p>Leaking</p>	Renew



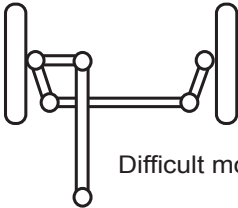
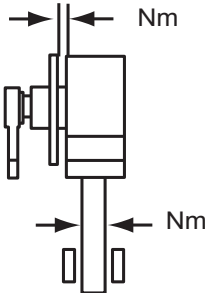
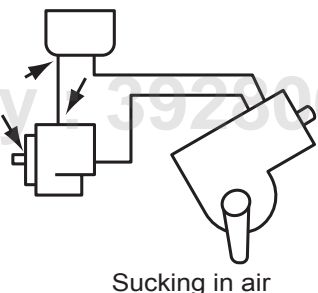
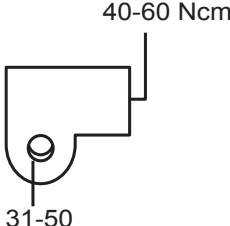

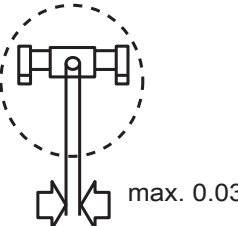


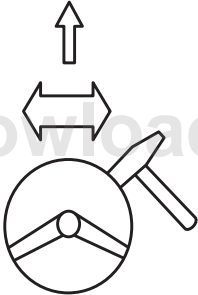
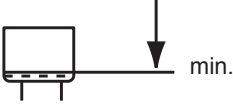
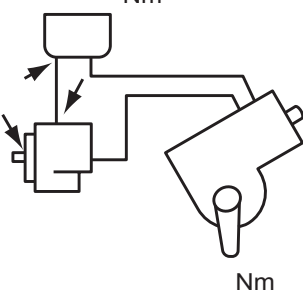
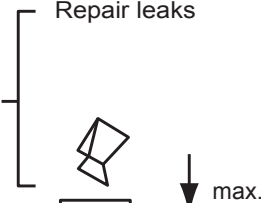
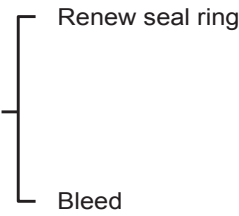
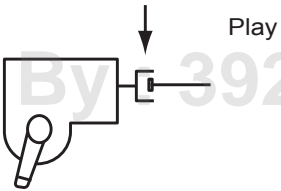

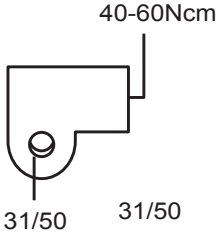

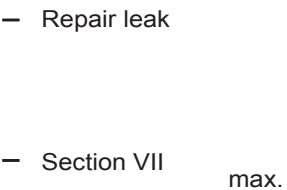
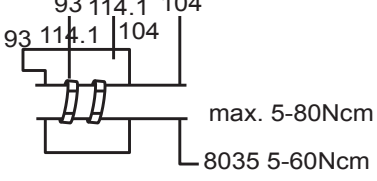

Fault	Cause	Remedy
	Conveying flow too low 	— Renew
	<b>B</b> Internal faults - ZF service division	
	Conveying flow too low 	— Exchange
	<b>A</b> External faults - maintenance work	
Return line obstruction V(km/hr) 		— Lubricate
		— Release tension
		— Regrind/Renew

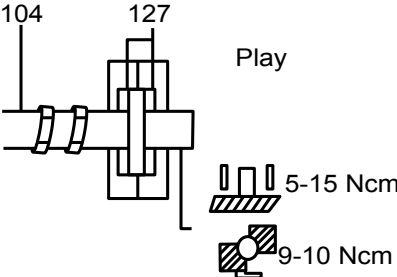
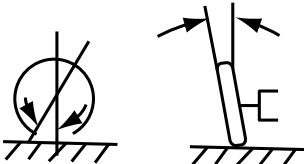
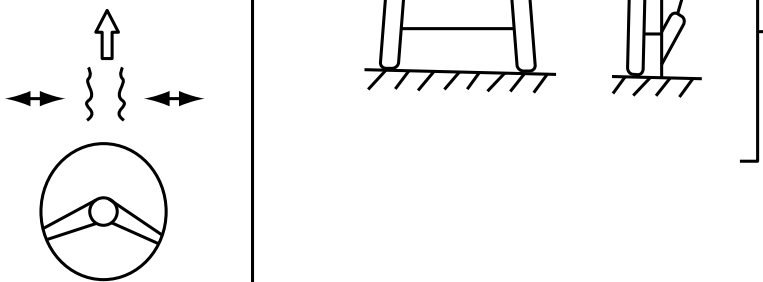
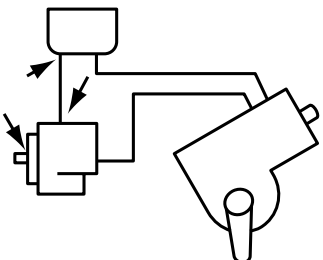
Fault	Cause	Remedy
	<div></div>	<div>— Lubricate</div>
	<div><div></div><div></div></div>	<div>— Section VII</div>
Not exact V (km/h)	A External faults - maintenance work	
	<div><div></div><div></div><div></div></div>	<div><div>Repair leak</div><div></div><div>Bleed</div><div>Tighten replace</div></div>



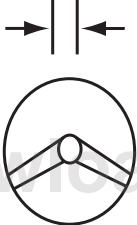
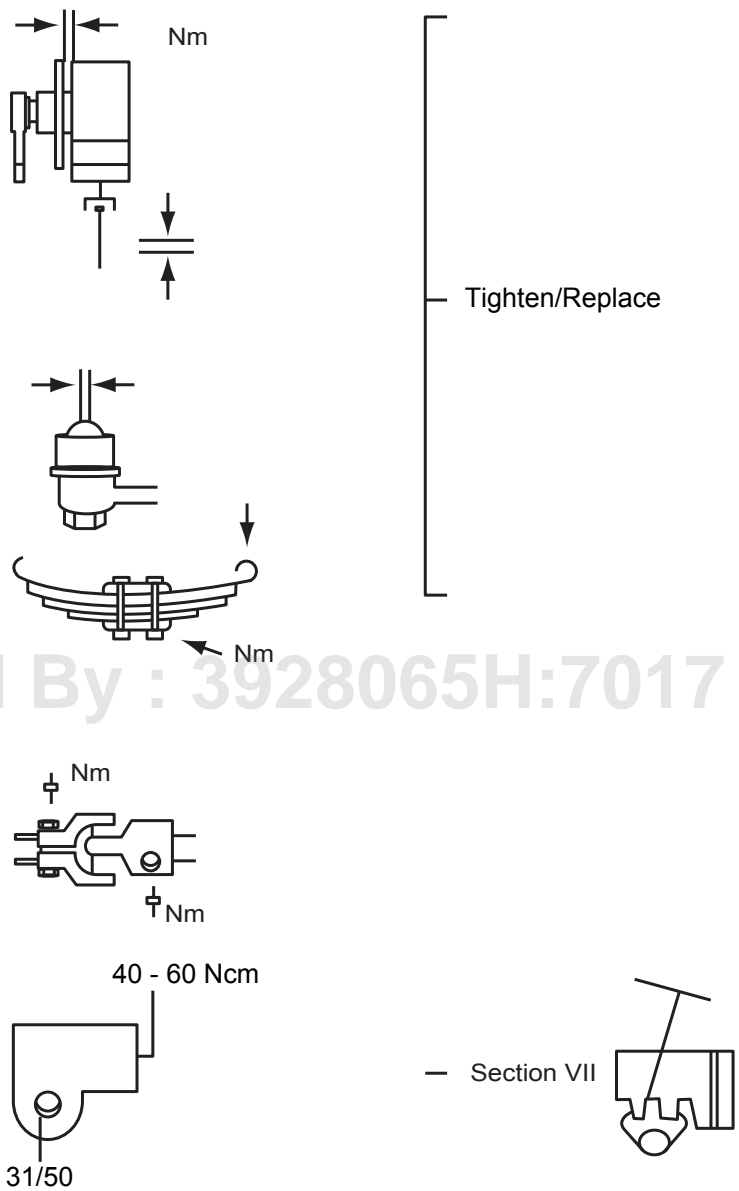
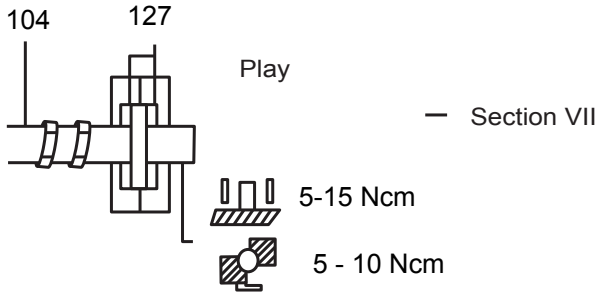


Fault	Cause	Remedy
	    	<p>— Lubricate</p> <p>— Tighten</p> <p>— Renew Seal rings</p> <p>— Bleed</p> <p>— Repair leak</p> <p>— Section VII max.</p>
	<p><b>B</b></p> <p>Internal faults - ZF service division</p> 	<p>— Test or replace</p>

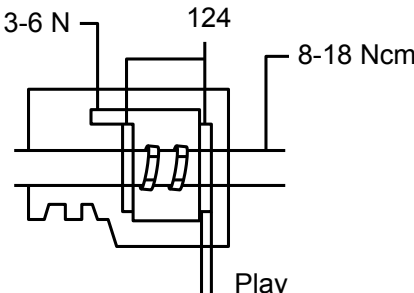
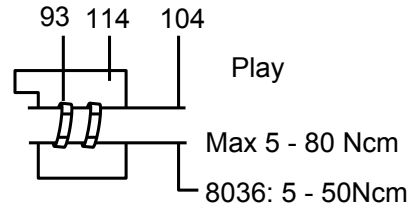
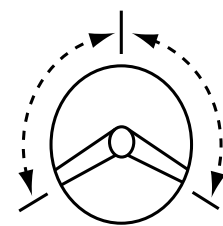


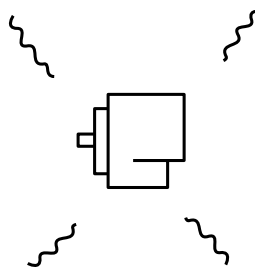
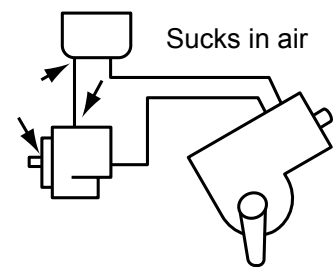
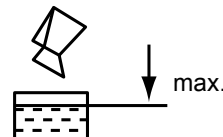
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	<b>A</b> External faults - maintenance work	<div>  </div> <div>  </div> <div>  </div> <div>  </div> <div>  </div> <div>  </div> <div>  </div> <div>  </div> <div>  </div>
	<b>B</b> Internal faults - ZF service division	<div>  </div> <div>  </div>

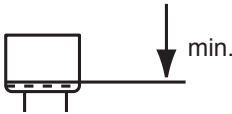
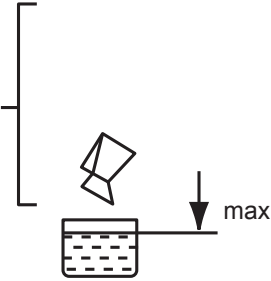
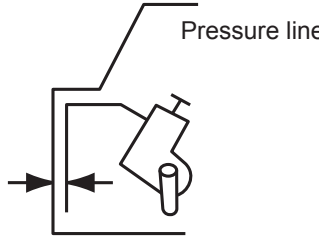
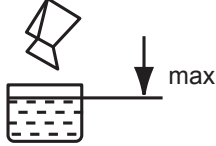
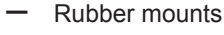
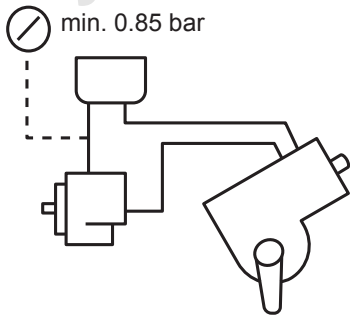
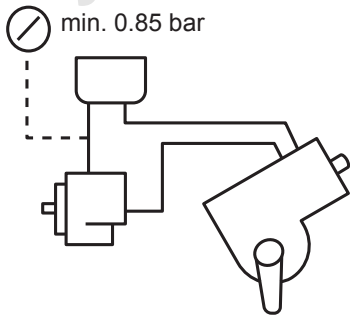
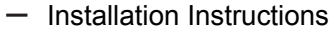
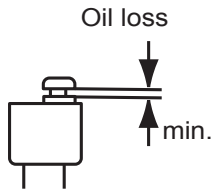
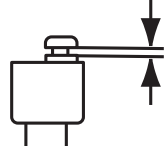
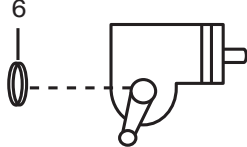
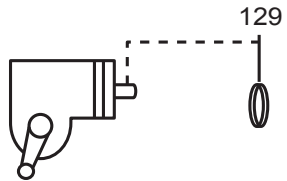


Fault	Cause	Remedy
		<p>— Section VIII</p>
	<p><b>A</b> External faults - maintenance work</p>	
	<div> <p>Out of balance</p>  <p>— Balance</p> </div> <div> <p>Turning vibrations V (km/hr)</p>  <p>Adjust</p> </div> <div>  <p>Renew seal ring</p> <p>Bleed</p> </div>	

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Fault	Cause	Remedy
<p>Steering wheel play</p> 	<b>A</b> External faults - maintenance work	
	 <p>Tighten/Replace</p> <p>Section VII</p>	
	<b>B</b> Internal faults - ZF service division	
	 <p>Play</p> <p>Section VII</p> <p>5-15 Ncm</p> <p>5 - 10 Ncm</p>	

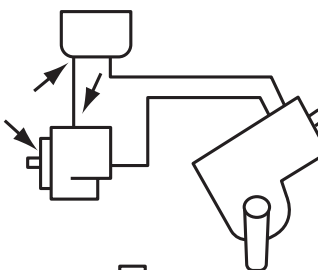
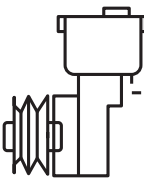
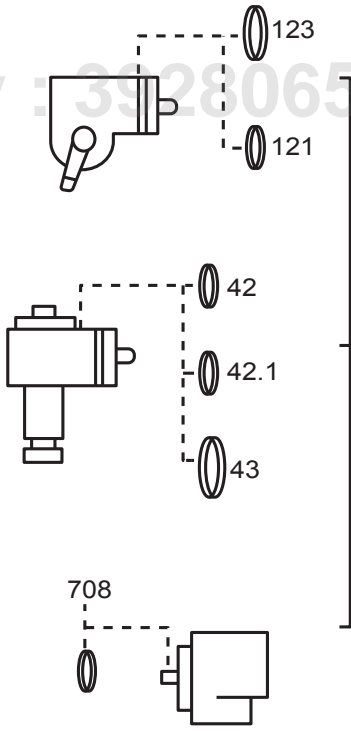
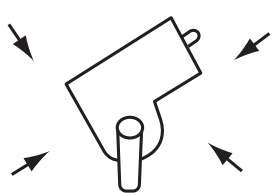
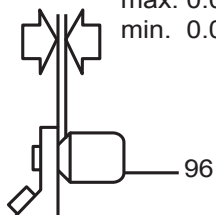


Fault	Cause	Remedy
	 	
<b>Wear</b> 	<b>B</b> Internal faults - ZF service division 	 — Section VII
<b>Noises</b> 	<b>A</b> External faults - maintenance work   Bleed	 Renew seal ring max. Bleed

Fault	Cause	Remedy
	  	 
Wear	<b>B</b> Internal faults - ZF service division 	 
	<b>A</b> External faults - maintenance work   	 





Fault	Cause	Remedy	
	 <p>Tighben Lines</p>  <p>616 — Renew</p> <p>617</p>		
	<b>B</b>	Internal faults - ZF service division	
		 <p>123</p> <p>121</p> <p>42</p> <p>42.1</p> <p>43</p> <p>708</p> <p>Renew</p>	
 <p>Noises</p>	<b>B</b>	Internal faults - ZF service division	
	 <p>max. 0.04 min. 0.02</p> <p>96</p> <p>— Renew</p>		



51.16	TIGHTENING TORQUE	Kgm	lb.ft	Nm
<b>Steering Box</b>				
Bottom cover Hex.Bolt				
M10		6.2	45.73	62
M12 x 1.5		11.5	84.82	115
M14 x 1.5		1.9	140.14	190
Housing cover Hex. Bolt				
M10		6.2	45.73	62
M12 x 1.5		11.5	84.82	115
M14 x 1.5		1.9	140.14	190
M16x1.5		28.5	210.21	285
Adjusting screw sealing Nut		9	66.38	90
Pressure Relief Valve Insert		3	22.13	30
Steering Limiting valve Hex. Nut		2.5 - 3.5	18.44 - 25.81	25 - 35
<b>Steering pump</b>				
Flow control valve screw plug		9	66.38	90

**52.17 RECOMMENDED LUBRICANTS**

Aggregate	Minimum Ambient Temp. °C	Co-branded Lubricant	Approved Lubricant
		Gulf Oil India Gulf Power Steering Dura Max	Indian Oil Corporation Servo Transdex II
Power Steering	-40		

NOTE : Do not mix lubricants of different brands/grades.

**52.18 FILLING CAPACITY**

Aggregates	Filling Capacity (ℓ)
ZF - Power Steering	4.0

**52.19 MAINTENANCE SCHEDULE**

MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks
1	Check steering gear box for oil leaks and level, top up if necessary			✓	8	
2	Check for wear and tighten steering drop arm, drag link and track rod ends				8	
3	Check tightness of steering box mounting fasteners				8	
4	Lubricate drag link and trackrod ends			✓		Weekly for Tippers and Monthly for all other applications.
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# Brakes



**ASHOK LEYLAND**

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**55.0 GENERAL****55.0.0 Specifications****System Data**

Service brake	Dual line full air S-cam brakes with ABS
Parking Brake	By spring brake chamber at rear.
Drum dia (Front & Rear)	393.7
Lining Width	Front - 5"/6"/7" Rear - 6"/7"/8"
Lining Thickness	16 mm
Wearable lining thickness	Upto wear limit identification step
Lining Material	Moulded Asbestos free based - RAF Grade 7
Brake Actuators	Front - Type 20/24 & Type 24/24 Rear - Type 24/24
Air Compressor Piston (Bore x Stroke)	66.7 x 46 mm / 80 x 46 mm
Air Delivery per stroke	160cc / 230 cc
System pressure	Cut out - 8.1 ± 0.2 bar Cut in - 7.1 bar
Low air pressure (Service and Parking Brake) warning signal operation below	4.9 bar
Parking brake hold off pressure	4.5 bar

**Maintenance Data**

Clearance between drum and lining	0.25 mm			
Brake pedal free play at roller	0.25 mm			
Pump up time from zero to cut out pressure at full engine rpm to fill 45 Litres of air	140 sec			
System protection valve opening pressure	Ports (21,22) - 7.35 bar Ports (23,24) - 7.0 bar			
Minimum port closing pressure when pressure in one of the circuit is zero (in bar)	<b>Port 21</b>	<b>Port 22</b>	<b>Port 23</b>	<b>Port 24</b>
	0	>6.8	>6.6	>6.6
	>6.8	0	>6.6	>6.6
	>4.7	>4.7	0	>6.6
	>4.7	>4.7	>6.6	0
Maximum brake chamber stroke in brakes applied condition (front & rear).	10 mm - 20 mm			
Stand out of push-rod fork eye centre to mounting face of brake chamber front / rear	72 mm			

**Repair Data**

Brake drum dia for front and rear	Standard - 393.7 mm (15.5") Oversize 1 - 395.29 mm Oversize 2 - 396.88 mm
-----------------------------------	---



**Brake drums should not be used beyond 396.88 mm dia. After that, there will not be any service braking or parking brake left, due to cam roll over. Drums should be discarded.**



### 55.0.1 Design & operation of dual line full air braking system with S cam brakes

#### Dual Brake System

Ashok Leyland vehicles are fitted with dual line full air braking system with S cam brakes. The Dual Brake System is a split system of air brakes to actuate front and rear foundation brakes separately / independently, thereby ensuring partial braking of the vehicle, in case of failure in air system in any one front and rear brake circuits.

The engine driven compressor draws air from the inlet manifold/Air intake pipe of the engine through air cleaner. The compressed air is pumped into the air tank through the DDU / Air Dryer / Unloader Valve.

The Unloader valve in the Air dryer ensures the unidirectional flow of air into the system apart from regulating the system pressure.

Air dryer has one inlet and two outlet ports, one is connected to Purge tank and the other is connected to Quadruple system protection valve port 1. Quadruple system protection has four independent delivery lines, two of which are charged for both front and rear service braking, while the third line is utilised for parking brakes and the fourth for auxiliaries like Pneumatic doors, Exhaust brakes & Air horn.

The Service Reservoirs are connected to the Primary and Secondary inlets of the Dual brake valve. The Primary delivery of the Dual brake valve is connected to the Service port of the spring brake actuator. The secondary delivery of the dual brake valve is connected to the service port of the front brake chamber.

Parking port of the spring brake actuator is charged with air from third port (23) of Quadruple system protection valve through graduated hand control valve.

The Slack Adjusters convert the longitudinal movement of Spring brake actuator/Front brake chamber push rod into rotational movement of the 'S' cam shaft of the foundation brakes and applies brakes.

Low pressure warning switches are connected in front, rear and parking brake circuits to provide warning when pressure drops below minimum working level.

The Stop light switches are fitted one in each of the delivery lines of dual brake valve to give warning in the rear as and when the service brakes are applied.

#### Service Brake:

The Service Reservoirs are connected to the Primary and Secondary inlets of the Dual brake valve. The Primary delivery of the Dual brake valve is connected to the Service port of the spring brake actuator. The secondary delivery of the dual brake valve is connected to the service port of the front brake chamber. Brake chambers are connected to slack adjusters which actuate the foundation brakes.

Two independent pressure gauges are provided in circuits to indicate prevailing system pressures. Low pressure warning switches & stop light switches are connected in both the brake circuits.

When brake pedal is pressed, air pressure from service reservoirs flows through dual brake valve to front and rear brake chambers, which in turn actuate foundation brakes and during release of pedal, air from actuators are exhausted to atmosphere. In case of failure of one circuit, the other circuit will apply partial brake.

#### Spring Brakes

One of the secondary outlets of system protection valve is connected to spring brake ports of spring brake actuator through graduated hand control valve.

During normal running of vehicle air pressure from system protection valve through hand control valve flows to spring brake portion of spring brake chamber and keeps the spring brakes released. During parking/emergency braking, hand control valve is operated for releasing air from spring brake chamber thereby applying spring brakes.

Advantages of Dual line brake system.

The following are the advantages of dual line brake system.

- \* Better safety & reliability.
  - \* Less response time (i.e., Reduced stopping distance & reduced stopping time)
  - \* Increased Reservoir capacity.
    - More number of safe brake applications.
    - Better condensation of water and oil.
    - Ensures supply of clean dry air to Brake Valve and Brake Chambers
    - Hence, increased life of brake system components
  - \* The Pneumatic brake system is split into independent subsystems as given below.
    - Front brake system
    - Rear brake system
    - Spring actuated mechanical hand brake system
    - Auxiliary system
- In each subsystem, the number of units are less. Hence, each subsystem is more reliable & the overall reliability of the brake system is doubled.
- \* Provides a third braking system available to the driver even in the unlikely event of failure of both the Primary and Secondary brakes.
  - \* Auxiliary equipments like, Air Horns, Pneumatic Doors, Exhaust brake & etc are isolated from the main brake system, which ensures better safety. And failure in auxiliary system cannot affect main system.
  - \* Low pressure warning switches are provided in each circuit, which indicates to the driver the failure in any of the subsystem.

#### Port identification

All ports of pneumatic valves are generally, designated by numbers for easy identification while connecting pipelines. The numbers consists of 2 digits. It can be decoded as follows.

X X

The first digit indicates the following.

1. denotes inlet (supply) port
2. denotes delivery port
3. denotes exhaust port
4. denotes Control port

If more than one inlet or delivery port exist, the second digit indicates serial number.

- |    |                                  |
|----|----------------------------------|
| 11 | denotes primary inlet (supply)   |
| 12 | denotes secondary inlet (supply) |
| 21 | denotes primary delivery         |
| 22 | denotes secondary delivery       |

**55.0.2 Trouble Shooting - Brake System****Air is not building up in both the gauges**

Location of Check	Cause	Remedial Action
Compressor	Cylinder head gasket failure	Overhaul cylinder head. Also check for any block in pipe lines, hose and unloader valve with tyre inflator filter. Remove blockage, clean filter and refit.
Hose, pipes and fittings	Heavy leak in circuit between compressor delivery and system protection valve inlet.	Check lines and all joints. Rectify Replace hose assembly if damaged.
Air Dryer	Heavy leak through top cover and exhaust spout.	Overhaul assembly.
System Protection Valve	Heavy external leak from the valve assembly	Overhaul assembly.

**Delay in building up system pressure**

Compressor	Defect in cylinder head inlet / delivery valve	Overhaul cylinder head.
	Damaged piston / rings	Carry out major overhaul.
Hose, pipes and fittings	Leak in circuit between compressor delivery and system protection valve inlet.	Check lines and all joints. Rectify / Replace hose assembly if damaged.
Air Dryer	Leak through top cover & exhaust spout.	Overhaul assembly
System protection valve	External leak from the valve assembly	Overhaul assembly.

**Air is building up in one gauge only**

System protection valve	Leak through element 21 or 22. Valve not functioning.	Overhaul assembly.
Dual brake valve, Relay valve	Leak through exhaust or unused ports not plugged.	Overhaul assembly. Plug unused ports left open.
Air gauge	Defective Air gauge	Replace defective air gauge.

**Air is not building up more than 6.0 bar while running or air drops down to 4.5 bar when vehicle is parked**

Graduated hand brake valve Relay valve	Leak through exhaust.	Overhaul assembly.
System Protection Valve (SPV)	Leak through SPV element 23 or 24.	Overhaul assembly.
Spring brake actuators(SBA)	Leak through L tube indicates main seal / ram defect Leak through SBA service port (with pipelines disconnected and Hand brake released condition) indicates O ring / ram stem defect	Identify the defective assembly and overhaul.
Hose, pipes & fittings	Leak in 23 and 24 circuit lines. Rectify/Replace hose assembly if damaged	Check pipe lines and all joints.
Other auxiliary assemblies.	Leakage through auxiliary assemblies, such as Air horn, Air suspension etc.	Identify defective assemblies and overhaul.

**Pressure Drops Down to Zero When Vehicle is Parked**

Dual brake valve, Relay valve	Leak through exhaust	Overhaul assembly.
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Location of Check	Cause	Remedial Action
Hose, pipes & fittings	Leakage from SPV delivery line circuits with internal in System Protection Valve assembly.	Identify and rectify the leaky joints. Replace hose assembly. If damaged. Check SPV for internal leak and overhaul assembly, if defective. (If no internal leak check delivery line circuits of 21 & 22 only).
System protection valve (SPV)	External leak from the SPV assembly.	Overhaul assembly.
Service reservoirs	Leakage through weld joints and Drain valve.	Rectify weld joint. Replace defective drain valve.
<b>Brake Binding (Rear brakes only)</b>		
Graduated Hand Control Valve (GHCV)	Leak through exhaust or less delivery pressure	Overhaul assembly. Ensure shimming / setting to get correct pressure
Spring Brake Actuators (SBA)	Leak through L tube - indicates main seal / ram defect. Leak through SBA Service Port (with pipeline disconnected and Hand brake released condition) indicates O ring / ram stem defect	Identify defective assembly and overhaul.
System protection valve (SPV)	Hand brake element in SPV not functioning.	Overhaul assembly.
Hose, pipes & fittings	Leakage between GHCV delivery & SBA port circuit.	Check pipe lines and all joints. Rectify / Replace hose assembly if damaged.
<b>Brake Binding - Any Wheel in Front or Rear Brakes</b>		
Slack adjusters.	Misalignment between Spring Brake Actuator / Brake Chamber and slack adjusters.	Reset if required.
Foundation brakes	S Cam sticky. Excess clearance between Drum and Brake lining. Defective shoe return spring.	Rectify to ensure free rotation of Cam Adjust the brakes. Replace the shoe return spring
Hose, pipes & fittings	Choked or kinked in pipe lines / hose. Blockage in pipes / fittings at Dual brake valve delivery lines.	Replace defective pipes and hose assembly. Clean pipe / fittings.
<b>Brake Binding - Both Front and Rear brakes</b>		
Dual Brake Valve (DBV)	No free play between brake pedal and the valve. Sticky movement of DBV piston. Sticky movement of Brake Pedal	Set correct free play. Overhaul assembly. Identify the defect and rectify
<b>Poor Brake / Wheel Rolling</b>		
Foundation brakes	Excess clearance between Drum and Brake lining. Glazed lining / brake drum. Excess drum ovality.	Adjust the brakes. Rectify or replace as per recommendation. Rectify or replace as per recommendation.
Brake chambers and Spring brake actuators	Leakage through diaphragm. Leakage through clamp ring joint. Wrong setting of push rod fork stand out.	Replace diaphragm. Tighten clamp ring bolt. Set to correct dimension.
Dual brake valve	Sticky operation of valve. Dual brake valve not operated to full travel	Overhaul the relay valve assembly. Check and rectify pedal travel.
System pressure	System pressure not maintained.	Adjust / rectify to correct system pressure



Location of Check	Cause	Remedial Action
<b>Vehicle Pulling to One Side While Applying Brakes.</b>		
Slack adjuster	Worm shaft slipping in Slack adjuster.  In correct position between slack adjuster and actuator push rod.	Overhaul the defective assembly.  Angle between actuator push rod and Slack adjuster should not be less than 90 degree at brake applied condition. Reset push rod adjustment evenly and adjust brakes.
Brake chambers and Spring brake actuators diaphragm leak.	Push rod sticky operation Difference in type (Size) of actuators between RH and LH Brakes.	Overhaul defective assembly. Replace diaphragm / push rod seal Ensure fitment of correct size in all brakes.
Foundation brakes and Vehicle condition.	Defect in foundation brakes. Uneven loading or defect in steering linkages & other alignments.	Rectify as per recommendation. Rectify as per recommendation.
<b>Warning Buzzer Continuously Working</b>		
Graduated hand brake valve (GHCv)	Leak through exhaust or less delivery pressure	Overhaul assembly. Ensure shimming to correct dimension.
System pressure	System pressure less.	Adjust / rectify to correct system pressure.
Low Pressure indicator switch	Defective switch.	Identify defective switch(s) by disconnecting the wire from one by one. Replace defective assembly.
<b>Low Pressure Warning System Not Working</b>		
Low Pressure indicator switch	Defective switch.	Identify defective switch(s) by disconnecting the wire from one by one. Replace defective assembly.
Wiring and Buzzer	Defective circuit / buzzer.	Identify the defect and rectify / replace.
<b>Stop Light Not Working</b>		
Stop light switch	Defective switch.	Identify defective switch and replace.
Wiring and Bulb	Defective circuit / bulb.	Identify defective circuit / bulb and replace.



**55.0.3 Easy Method to Identify leakage Complaints**

**Delay in charging the system due to leakage between Compressor and Air dryer. Method to identify the leakage.**

- \* Deplete the pressure to 5.0 Bar pressure.
- \* Build up air pressure up to 6.0 bar and stop the engine.
- \* Apply soap solution at all joints / Hose and pipes to identify the leakage point.
- \* If no leakage is noticed, depress the plunger of tyre inflator connection.
- \* Air should leak through the tyre inflator plunger, otherwise Compressor Inlet or delivery valve/gasket/ defective.

**Air pressure is not building up more than 6.0 bar pressure due to heavy leakage in System protection valve. Method to identify the leakage.**

- \* Ensure that system protection valve of Air dryer assembly is free from external leak.
- \* Remove pipe connection from port 22, 23 & 24 and plug the ports using suitable plugs.
- \* Build up air pressure and check proper charging of air in circuit 21. Identify the defect and rectify if the system is not charging.
- \* Similarly connect other circuits one by one after ensuring / correcting the defective circuit.
- \* With this procedure, it will be easy to check each circuit for any defect and rectify.

Always check Dual brake valve off leak with the Hand brake applied condition.

Humming noise from System protection valve (Engine off condition) indicates leakage in down stream line. Identify and rectify defective assembly / circuit as the System protection valve of Air dryer assembly is free from any defect.

**IMPORTANT PLEASE READ**

When working on or around brake systems and components, the following precautions, should be observed:

Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjuster; they may apply as system pressure drops.

Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.

Never exceed recommended pressure and always wear safety glasses when working.

Never attempt to disassemble a component until you have read and understand recommended procedures. Some injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

Use only genuine replacement parts and components.

Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

**55.1 AIR COMPRESSOR****55.1.0 SC-160 Air Compressor****Function**

To produce compressed air for brake application.

**Description**

This is a Single Cylinder reciprocating type compressor suitable for flange mounting. SC160 is run at 2/3rd of engine rpm.

**SERVICE CHECK****Inspection**

Check for the tightness of compressor mounting bolts.

Ensure that the air line from air cleaner is in good condition.

**Operating Tests**

Check for noisy operation and oil leakage when compressor is running.

If air leakage in the remaining parts/pipe joints of the system is not excessive, failure of compressor to maintain the required pressure in the system usually denotes loss of efficiency due to wear. Another sign of wear is excessive oil passing through the reservoir to other equipments of brake system. If either condition develops and inspection shows the remainder of the system is in good condition the compressor must be overhauled.

**Removing**

Block the wheels to prevent movement of the vehicle during working.

Disconnect air and oil pipes and seal the open ends to prevent dirt entry.

Remove the mounting bolts and detach the compressor from its mounting.

Unscrew the cleve lock type nut from compressor gear and extract the compressor gear using suitable extractor.

**To Refit Air Compressor**

The above mentioned procedure to be followed in reverse order.

**Dismantling**

Clean the external portion of the assembly remove the drive gear and rear coupling.

Mark the position of cylinder head and crankshaft in relation to cylinder block before dismantling.

Unscrew the four screws (13 Across Flat (A/F) hex) and remove the cylinder head with reed valve assembly and gaskets from the cylinder block.

Loosen the hex socket head cap screw using 4 A/F Allen key and remove the reed valve assembly and gaskets from cylinder head.

Provide Identification marks on the inlet and delivery side of the valve plate.

Using suitable punch, push and remove the rivets from the valve plate remove the inlet and delivery reed valves.

Loosen the four screws (10 A/F hex) and remove the base cover plate from the cylinder block.

Turn the crankshaft to Bottom Dead Centre and unfold the locking straps.

Loosen the connecting rod bolts (11 A/F) and remove the cap. Withdraw the piston assembly through the top of the cylinder bore.

Remove the piston rings from the piston if the piston assembly is to be completely dismantled remove one of the circlips retaining the gudgeon pin and press the gudgeon pin until it comes out of the piston and connecting rod.

Loosen the end cover screws (13 A/F) and remove the end cover crankshaft and thrust washer.

Remove the oil seal from the end cover.

Scrap all the old parts which are serviced in the minor repair kit.

**Cleaning**

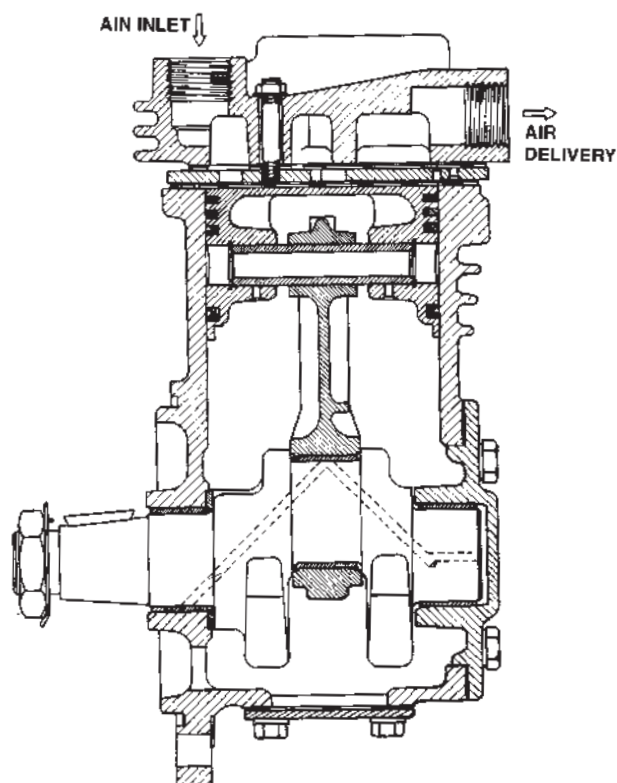
Clean all components in cleaning solvent and blow dry with compressed air. Ensure that no tract of solvent is present during reassembly.

Thoroughly clean cylinder head, scrape carbon, dirt and particles of old joints from all surfaces.

Clean the air holes in the crankshaft using a piece of wire if necessary, and flush with cleaning solvent. Ensure that the oil hole is free from blockage.

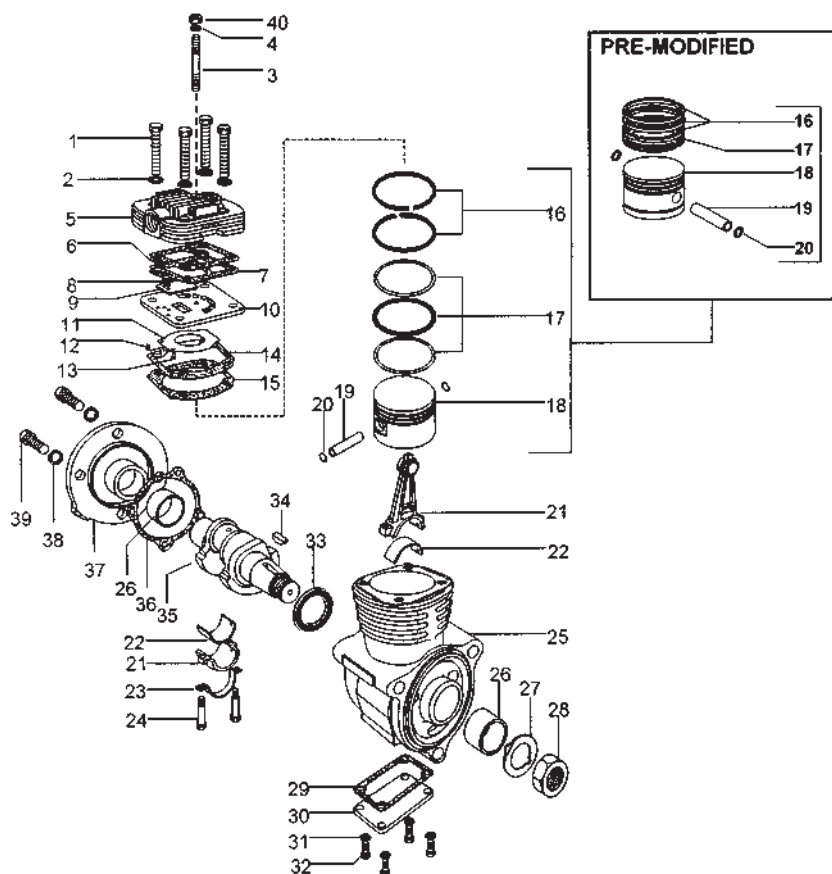
Clean the inlet and delivery reed valves if they are not worn excessively.

Clean the oil inlet passage in the end groove and blow with compressed air. Ensure that the oil hole is free from blockage.



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Single Cylinder Air Compressor (SC160) Cut Section



Single Cylinder Air Compressor (SC160) Exploded View



## SC 160 SINGLE CYLINDER COMPRESSOR

Item	Description	Qty.
1	Set Screw	4
2	Steel Washer	4
3	M6 Stud	1
4	Steel Washer	1
5	Cylinder Head	1
6	+ # * Joint (thick)	1
7	+ # * Joint (thin)	1
	Reed Valve Assembly Comprising:	
8	+ # * Locating Pin (3 mm)	2
9	Delivery Reed	1
10	Valve Plate	1
11	Inlet Reed	1
12	+ # * Locating Pin (2 mm)	1
13	+ # * Locating Pin (2.5 mm)	1
14	+ # * Joint (thin)	1
15	+ # * Joint (thick)	1
	Piston Assembly Comprising:	
16	Externally Stepped Ring	2
17	Oil Control Ring	1
18	Piston	1
19	Gudgeon Pin	1
20	Internal Circlip	2
	Connecting Rod Assembly Comprising:	
21	Connecting Rod (Including Item 24)	1
22	* Thin Walled Bearing	2
23	# * Locking Strap	1
24	Connecting Rod Bolt	2
25	Cylinder Block (With Item No. 26)	1
26	* Bush	2
27	* Lock Washer	1
28	* Nut	1
29	# * Joint	1
30	Cover	1
31	Spring Washer	4
32	Hexagon Screw	4
33	* Thrust Washer	1
34	* Woodruff Key	1
35	Crankshaft	1
36	# * Joint	1
37	End Cover	1
38	Washer	4
39	Set Screw	4
40	M6 Nut	1

Cylinder Head gasket kit consists of items marked (+).

Minor Repair kits consists of items marked (#) available as standard, Under size 1 & II.

Major Repair kit consists of items marked (\*) available as standard, Under size 1 & II.

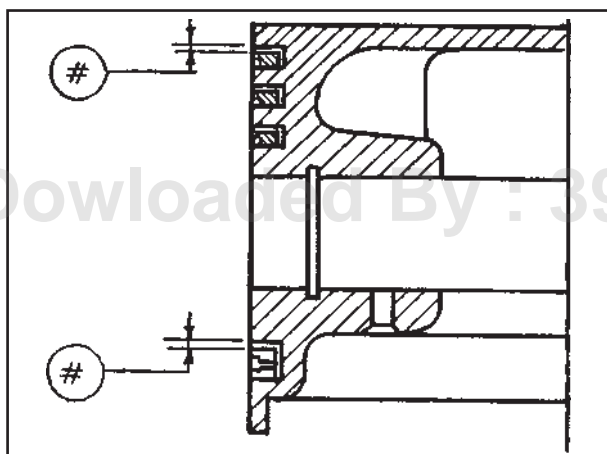


## Inspection

**Cylinder Bore:** Check cylinder bore for any deep score marks and also whether the honing pattern is visible all over the bore. If the honing pattern is visible all over the bore without score marks, then the cylinder and same size piston/rings can be used by renewing the same size rings. Otherwise, the cylinder is to be rebored and rehone to the finished bore size as given below and fitted with oversize piston and rings:

Finished bore size after honing	(mm)
Standard bore	80.18 80.000
First Oversize bore	80.268 80.250
Second Oversize bore	80.518 80.500

## Piston and connecting rod:



Check the fit of the piston rings in the ring grooves.

The clearance should be within 0.052/0.020 mm.

Install the rings in the cylinder and ensure that the gaps are within -

- 0.45/0.20 mm for Compression rings
- 0.50/0.20 mm for Oil ring

(Ensure correct bore size and proper size of rings prior to end gap check.)

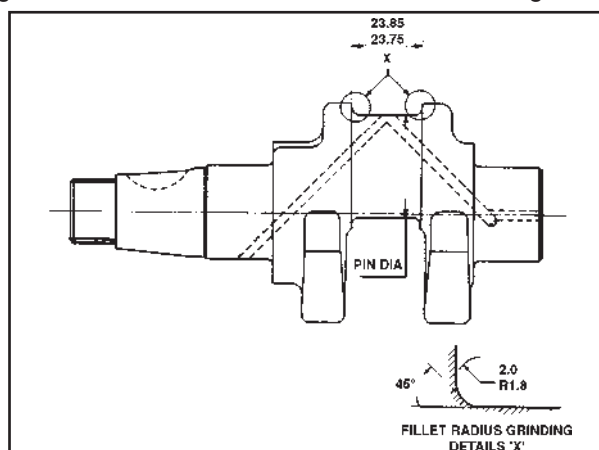
Inspect the piston and renew if scored/ cracked / damaged. Check fit of gudgeon pin in piston and connecting rod. The pin should be a light press fit in the piston and the clearance between the connecting rod and the gudgeon pin should be within 0.011/0.003 mm.

Inspect the connecting rod for cracks and damage and the bearings for correct fit on the crankshaft.

Clearance between crankshaft pin and bearing must not be less than 0.013 mm and not more than 0.051 mm.

Inspect crankshaft journal and pin dia for wear, score marks, finish and whether the ovality is within 0.04 mm. When crankshaft pin does not meet the above

requirement regrind the crankshaft pin dia to the size given below to use suitable under size bearing.



Bearing size	Pin dia
Standard	34.912 mm 34.899 mm
First Undersize (0.245 u/s)	34.658 mm 34.645 mm
Second Undersize (0.508 u/s)	34.404 mm 34.391 mm

The crankshaft should be a neat sliding fit in the bush bearing fitted on end cover and the mounting flange side of cylinder block. If worn excessively, renew the bearings and rebore to suit crankshaft.

## Cylinder head

Inspect the cylinder head for cracks and damage inspect inlet and delivery reed valves and valve plate for any wear/ distortion score marks. Replace the reed valve assembly, if excessive wear / distortion is observed.

## Oil seals and Joints

Renew all joints and oil seal by using recommended repair kits.

## To Reassemble Air Compressor

Use recommended repair kit to replace the parts scrapped during dismantling and in addition, renew all parts which were found to be defective during inspection. Lubricate all moving parts with clean engine oil to prevent possible damage when the engine is started and oil supply is established.

## To Assemble Crankshaft end cover

Locate the non metallic thrust washer in the cylinder block.

Insert the crankshaft in the cylinder block after smearing little engine oil on bush and crankshaft journals.

Press a new oil Seal in the end cover. Assemble the end cover with joint on cylinder block using a seal feed tool (**Special Tool SCT 2023**) on the crankshaft to prevent damage to oil seal lip while inserting on crankshaft.



Insert screws with spring washers and check for free rotation of the crankshaft and then tighten the end cover screws to a torque of 22 Nm.

#### **Piston assembly:**

Locate the connecting rod small end in the piston and insert gudgeon pin. Fit the circlip and ensure that the circlip is located in the piston groove properly.

Fit new rings on the piston and ensure that the sides marked 'Top' are upper most and rings gaps set at 120° (approx) to each other.

Assemble thin wall bearings on the connecting rod big end bearing cap and ensure that bearing lugs are correctly located in the corresponding notches of connecting rod and cap.

Place the cap with a new locking strap on connecting rod and ensure that the thin wall bearings are located on the crankshaft properly.

Tighten the connecting rod bolts to a torque of 15 Nm and fold the tabs of locking strap.

Again check for free rotation of crankshaft.

Apply new engine oil over the crankshaft and cylinder walls. Place and position the joint and base cover on the sump and secure by screws and spring washers. Tighten the screws to a torque of 9 Nm.

#### **Cylinder head and reed valves**

Fix delivery reed valve on to the valve plate using 2 locating pins of 3 mm dia. Locating pins can be pressed in by hand. Ensure that the reed is located on same side following the identification marks provided during dismantling.

Reverse the valve plate and fix the inlet reed valve on it using two locating pins one in each of diameter 2 mm and 2.5 mm.

Apply a drop of loctite 242 or its equivalent on the shorter threaded portion of the stud. Avoid over application.

Secure the stud with the shorter threaded portion on the delivery reed side (Top) of valve plate and tighten to a torque of 2 Nm. Avoid overtightening as it will result in protrusion of stud on the other side of the valve plate.

Place the delivery reed thinner joint (0.4 mm) on the top side of the valve plate locating the joint hole through the stud and ensure that it does not overlap with the delivery reed. Then, place the delivery reed thicker joint (0.8 mm).

Locate the cylinder head on the valve plate guiding the stud through the center hole of the cylinder head.

Insert 4 nos. of set screws with washers in the cylinder head.

Insert the inlet reed thinner joint (0.4 mm) through the 4 nos. of set screws and align it ensuring that it does not overlap with reed valve.

Insert thicker joint (0.8 mm) on the screws and position over the thinner joint.

Place and position the cylinder head on the cylinder block and tighten the 4 set screws to a torque of 22 Nm.

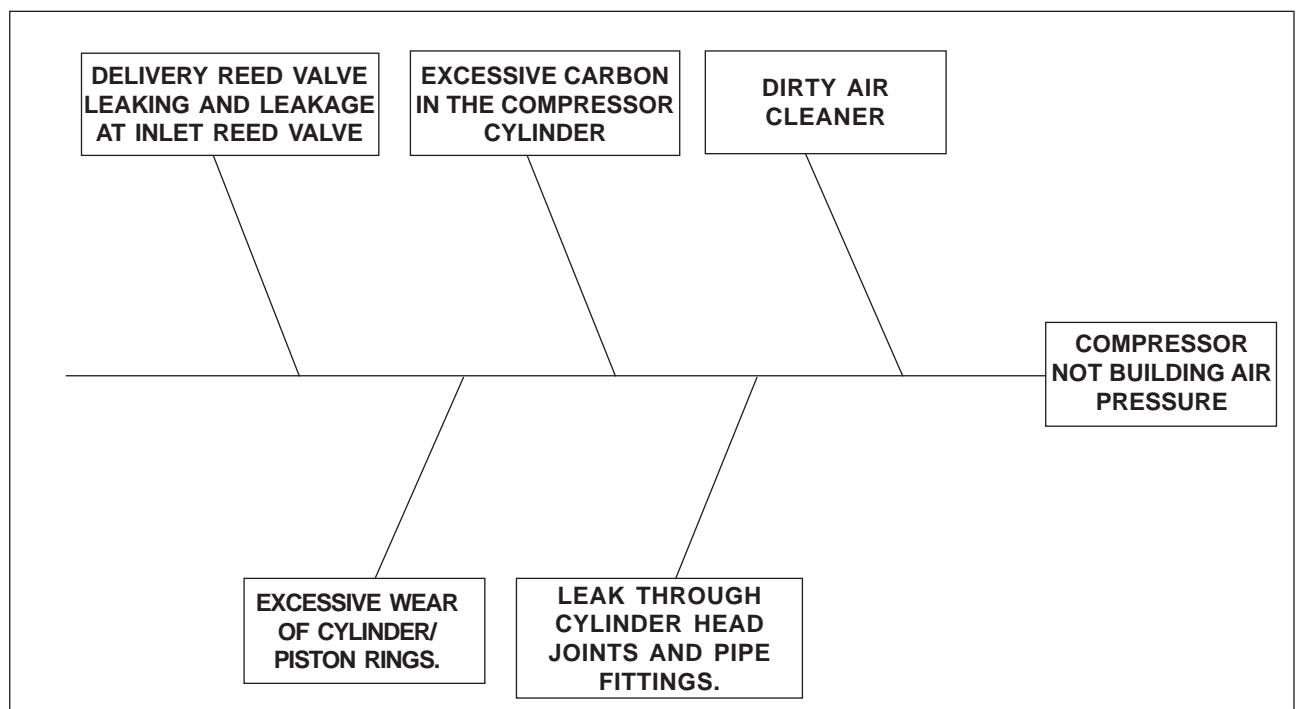
Finally tighten the cylinder head stud nut with washer to a torque of 7 Nm.



**Do not apply oil / Grease / Sealing compound like shellac on the joints.**

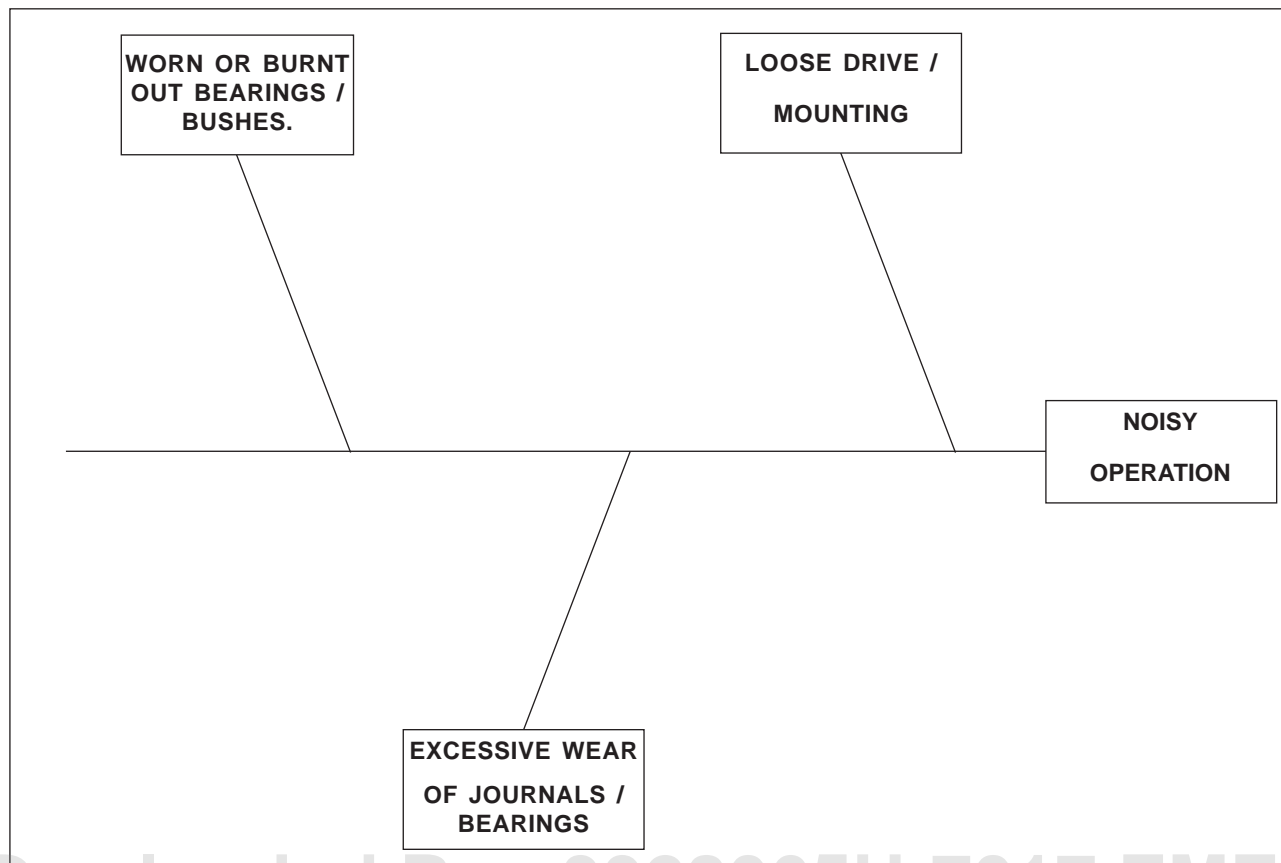
**The cylinder head joints should be used as raw in as is condition and also avoid reuse of joints once removed.**

#### **Trouble Shooting - Air compressor**

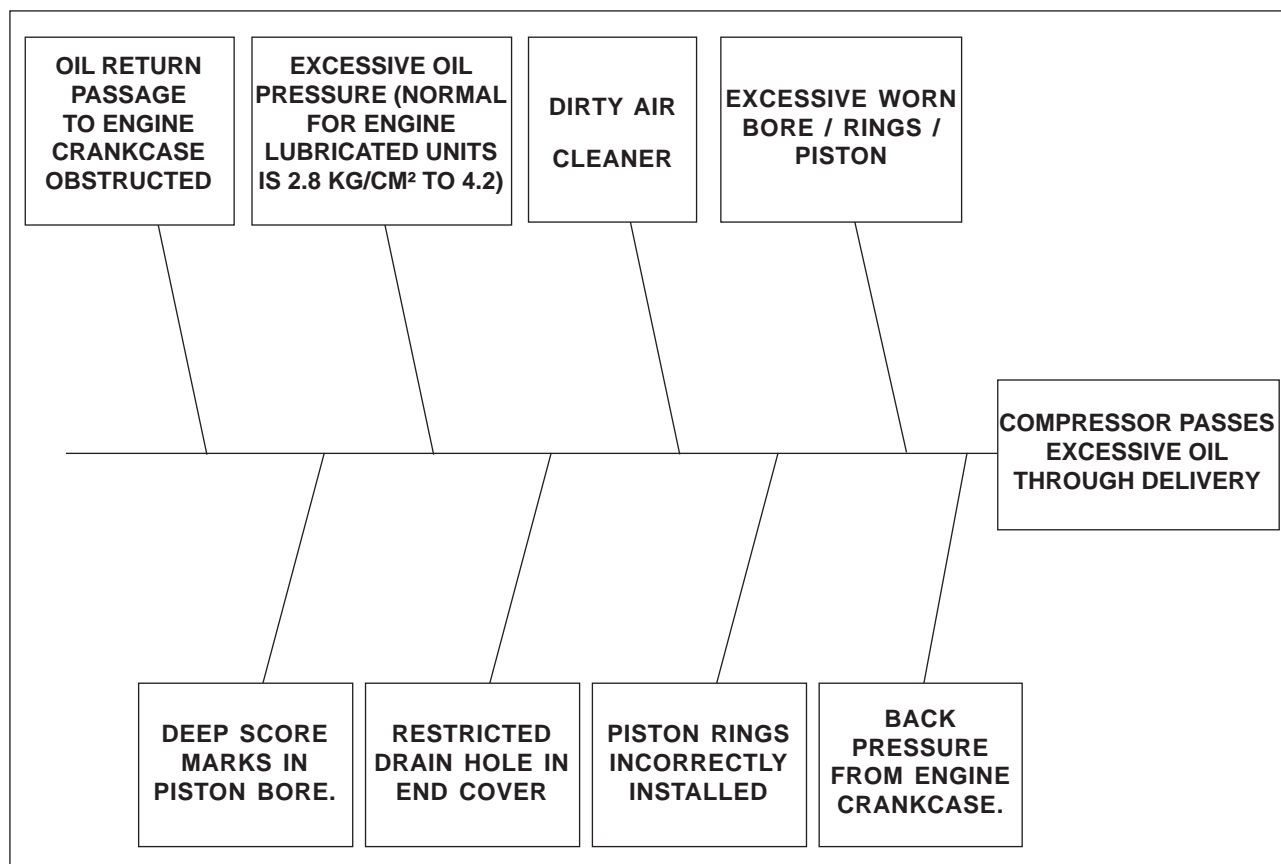


Cause and Effect Diagram - Compressor not building Air Pressure

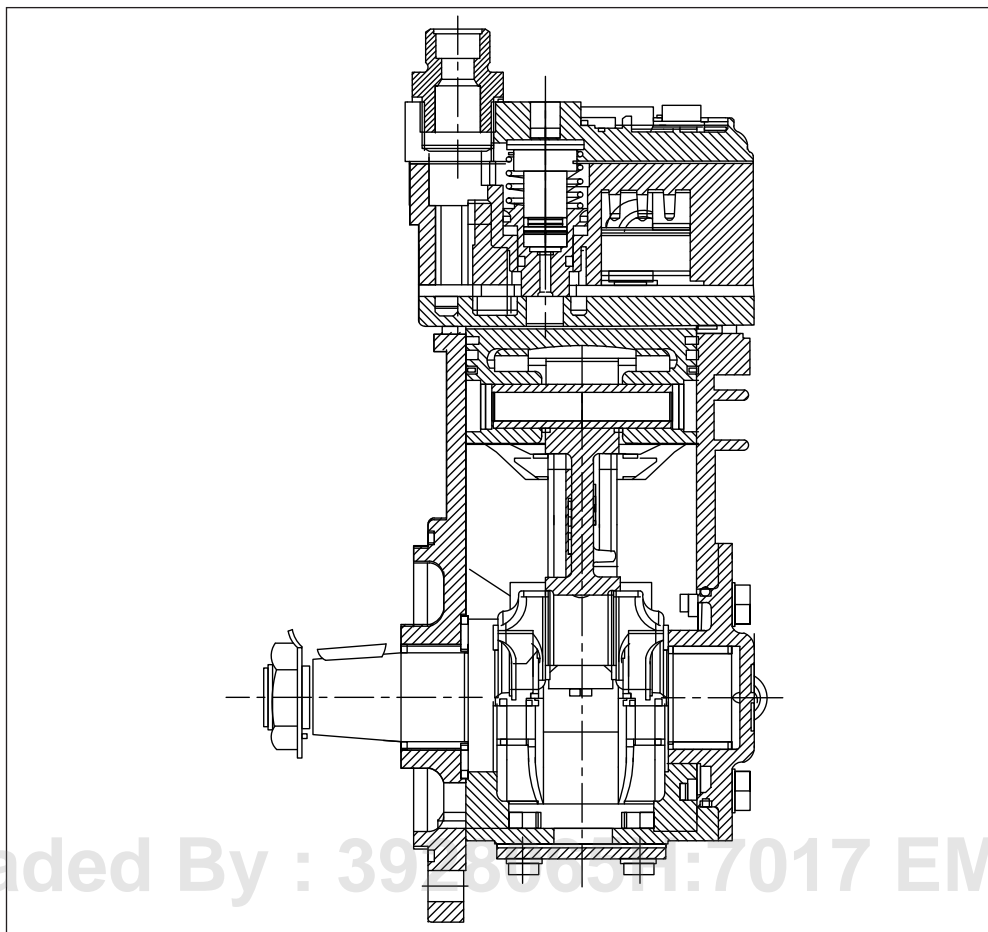




Cause and effect diagram - Noisy Operation



Cause and Effect Diagram - Compressor passes excessive oil thru delivery

**55.1.1 SC230 Air Compressor****Function**

The purpose of the compressor is to produce compressed air for road vehicles and static systems.

**Description**

This is a single cylinder, reciprocating type compressor suitable for flange mounting. The compressor has a bore of 80 mm dia, stroke of 46 mm and the displacement is 230 cc.

**Service check****a) Inspection**

Check for tightness of compressor mounting bolts.

Ensure that the air line from air cleaner is in good condition.

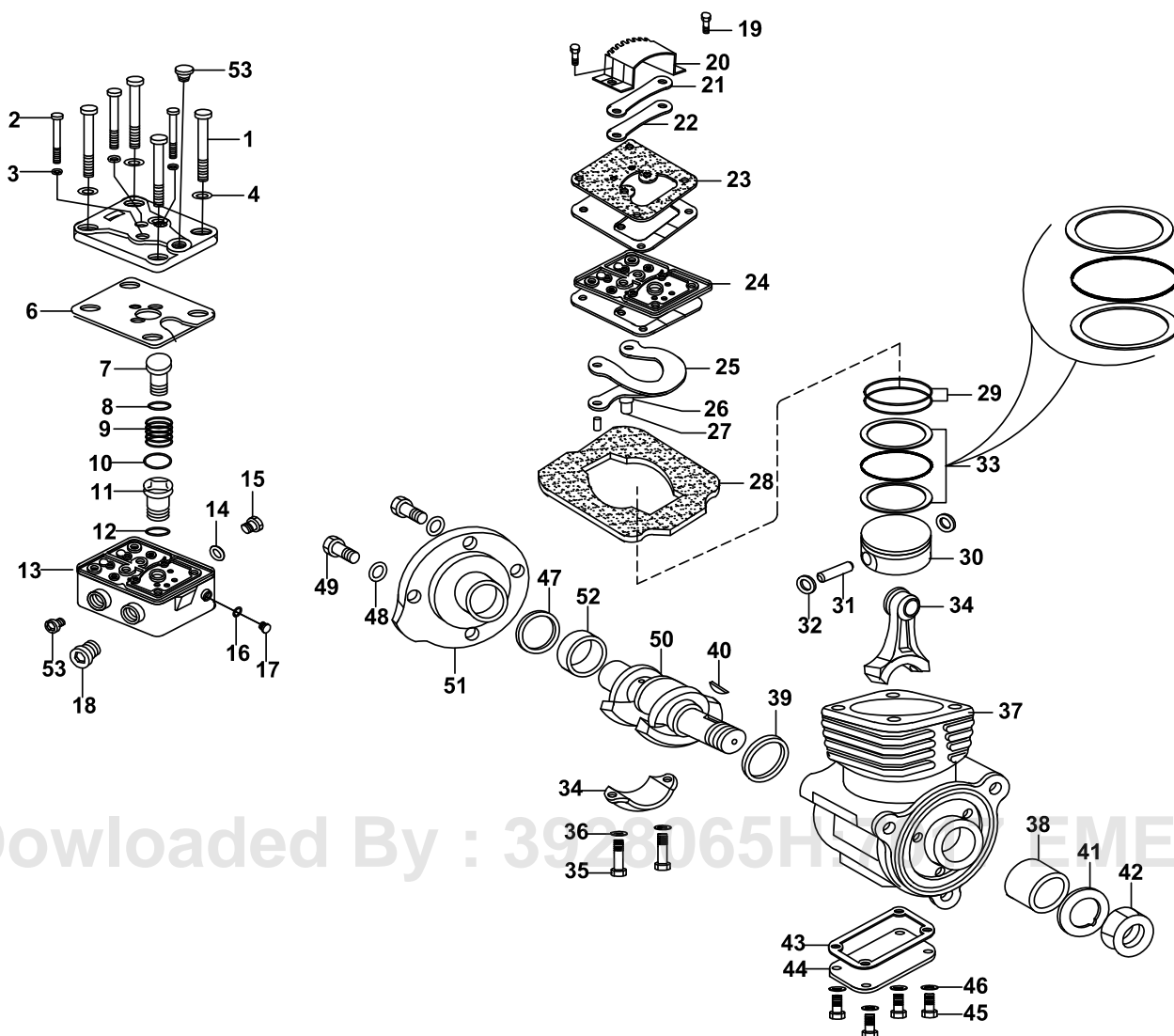
**b) Operating Tests**

Check for noisy operation and oil leakage when compressor is running.

If air leakage in the remaining parts/pipe joints of the system usually denotes loss of efficiency due to wear. Another sign of wear is excessive oil passing through the Reservoir to other equipment of brake system. If either condition develops and inspection shows the remainder of the system is in good condition, the compressor must be overhauled.

**Removing**

1. Block the wheels to prevent movement of the vehicle during working.
2. Disconnect air, water and oil pipes and close the open ends of pipes to prevent dirt/dust entry.
3. Remove the mounting bolt and detach the compressor from its mounting.
4. Remove the sealing ring from the cylinder mounting groove.
5. Unfold the locking washer. Loosen and remove the crankshaft nut, locking washer and extract out the driver gear.



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Item	Description	Qty
1	Cylinder head mounting bolt	4
2	Hex head bolt	2
3	Sealing Washer	4
4	Steel Washer	2
5	Cyl. head cover	1
6	Gasket	1
7	Plunger stopper	1
8	O ring	1
9	Spring	1
10	O ring	1
11	Unloader plunger	1
12	O ring	1
13	Cylinder head	1
14	Sealing ring	1
15	M26 - plug	1
16	Sealing ring	1
17	M12 - plug	1
18	Plug	1
19	Delivery reed clamping screw	2
20	Baffle	1
21	Governor plate	1
22	Delivery reed clamping screw	1
23	valve plate cover +2 joints	1
24	Valve plate	1
25	Inlet reed	1
26	Inlet reed clamp	1
27	Rivet	1

Item	Description	Qty
28	Inlet joint	1
29	Piston assembly external stepped ring	2
30	Piston	1
31	Gudgeon pin	1
32	Internal circlip	2
33	Oil control ring with expander	1
34	Connecting rod	1
35	Connecting rod bolt	2
36	Steel Washer	2
37	Cylinder block	1
38	Wrapped bush	2
39	Thrust washer	1
40	Wood ruff key	1
41	Lock washer	1
42	Lock nut	1
43	Joint	1
44	cover	1
45	Hexagon screw	4
46	Spring washer	4
47	Sealing ring	1
48	Steel washer	4
49	Hex head screw	4
50	Crank shaft	1
51	End cover	1
52	Wrapped bush	1
53	Double socket	2

**Replacing**

1. Locate the drive gear on the crankshaft and ensure that the gear key way to seat on the woodruff key properly.
2. Locate the lock washer on the crankshaft and ensure that its lug seats in the slot on the drive gear properly.
3. Tighten the lock nut uniformly to a torque of 90 to 120 Nm.
4. Locate the sealing ring on the mounting groove of the cylinder block.
5. Install the unit on its engine mounting and secure tightly.
6. Connect the air/water/oil pipe connections.
7. Carryout 'Operating tests' as given under 'Service check'.

**Dismantling**

1. Clean the exterior of the assembly
2. Mark the position of Cylinder Head in relation to cylinder block before dismantling.
3. Unscrew the four screws (13 A/F) and remove the cylinder head with reed valve assembly and joints from the cylinder block.
4. Loosen the four screws (10 A/F) and remove the base cover plate from the cylinder block.
5. Turn the crankshaft to BDC and unfold the locking strap. Loosen the connecting rod bolts (11 A/F) and remove the cap.
6. Withdraw the piston assembly through the top of the cylinder bore.
7. Remove the piston rings from the piston. If the piston assembly is to be completely dismantled, remove one of the circlips retaining the gudgeon pin and press the gudgeon pin until it comes out of the piston and connecting rod.
8. Loosen the end cover screws (13 A/F) and remove the end cover, crankshaft and thrust washer.
9. Scrap all the old parts which are serviced in the major repair kit.

**Cleaning and inspection**

- Clean all components in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during the reassembly.
- Thoroughly clean the cylinder head scrape carbon, dirt and particles of old joints from all surfaces.
- Clean the oil holes in the crankshaft using a piece of wire if necessary, and flush with cleaning solvent.

Ensure that the oil hole is free from blockage.

- Clean the inlet and delivery reed valves if they are not worn excessively.
- Clean the oil inlet passage in the end cover and blow with compressed air. Ensure that the oil hole is free from blockage.

**Cylinder bore**

Check cylinder bore for any deep score marks and also whether the honing pattern is visible uniformly all over the bore without score marks, then the cylinder and same size piston can be used by renewing the same size rings. Otherwise, the cylinder is to be rebored and re honed to the finished bore sizes as given below and fitted with oversize piston and rings.

Finished bore size after honing (mm)

Standard bore	80.018
	80.000
I O/S bore	80.268
	80.250
II O/S bore	80.518
	80.500

**Piston and connecting rod**

- a) Check the fit of the piston rings in the grooves. The clearance should be within 0.052/ 0.020 mm
- b) Install the rings in the cylinder and ensure that the free end gaps are within 0.45/0.20 mm for compression rings and 0.50/0.20 mm for oil ring. (Ensure correct bore size and proper size of rings prior to check the free end gap of rings.
- c) Inspect the piston, renew ID scored/ cracked/ damaged. Check fit of gudgeon pin in piston and connecting rod. The pin should be a light press fit in the piston and the clearance between the connecting rod and the gudgeon pin should be within 0.011/0.003 mm.
- d) Inspect the connecting rod for cracks and damage and the bearings for correct fit on the crank shaft. Clearance between crankshaft pin and bearing must not be less than 0.013 mm and not more than 0.051 mm.
- e) Inspect crankshaft journal and pin dia for wear score marks, finish and whether the ovality is within 0.04 mm. When crankshaft pin does not meet the above requirements, regrinding the crankshaft pin dia to the size given below to use suitable and change the crank shaft.
- f) The crankshaft should be a neat sliding fit in the bush bearings fitted an end cover and the mounting flange side of cylinder block.

### Cylinder head

Inspect the cylinder head for cracks and damage. Inspect inlet and delivery reed valves and valve plate for any wear/ distortion/ score marks. Replace the reed valve assembly, if excessive/ distortion is observed.

### Joints

Renew all joints and sealing ring by using recommended Repair kit.

Bearing size	Pin Dia (mm)
Standard	34.912
I O/S	34.899

Scrap the old parts which are found to be serviceable.

### Reassembly

1. Use recommended Repair kit to replace the parts scrapped during dismantling and in addition, renew all parts which were found to be unserviceable / defective during inspection. Lubricate all moving parts with clean engine oil to prevent possible damage when the engine is started and oil supply is established.

### 2. Crankshaft and End Cover

Locate the non-metallic thrust washer in the cylinder block.

Insert the crankshaft in the cylinder block after smearing little engine oil on bush and crankshaft journals.

Position a new joint on the End cover. Assemble the end cover with joint on Cylinder block

Insert screw with spring washer and check for free rotation of the crankshaft and then tighten the end cover screws to a torque of 22.5 Nm.

### 3. Piston Assembly

Locate the connecting rod small end in the piston and insert gudgeon pin. Fit the circlip and ensure that the circlip is located in the piston groove properly.

Fit new rings on the piston and ensure that the sides marked 'Top' are upper most and ring gaps set 120 degree (approx) each other.

Assemble thin wall bearings on the connecting rod big end and bearing cap and ensure that the bearing lugs are correctly located in the corresponding notches of connecting rod and cap.

Position the crankshaft journal in BDC and pass the piston assembly through the top of the cylinder bore using a ring guide and ensure that the connecting rod big end is located on the crankshaft properly.

Place the cap with a new locking strap on connecting rod and ensure that the thin wall bearings are located on the crankshaft properly.

Tighten the connecting rod bolts to a torque of 15 Nm and fold the tabs of the locking strap.

Again check for free rotation of crankshaft.

Apply new engine oil over the crankshaft and cylinder walls, place and position the joint and base cover on the sump and secure by screws and spring washers.

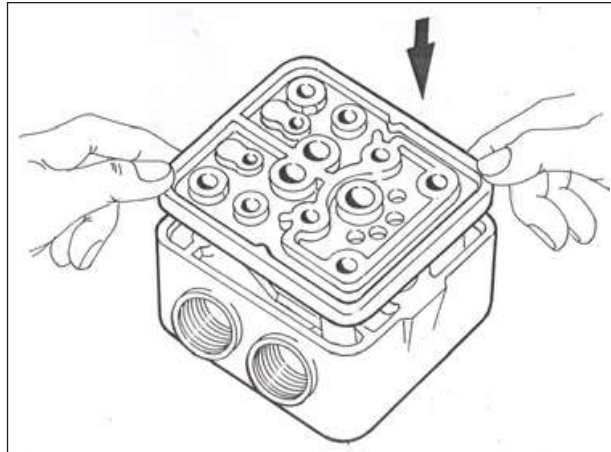
Tighten the screws to a torque of 9 Nm.

Place and position the cylinder head on the cylinder block and tighten the 4 set screws to a torque of 30 to 33 Nm.

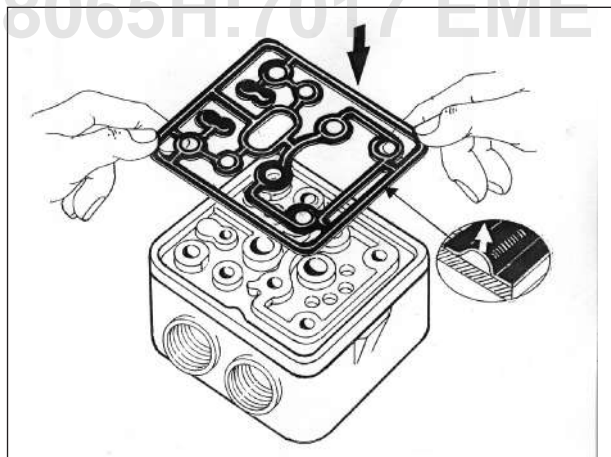
Finally tighten the cylinder head stud nut with washer to a torque of 7 to 9 Nm.

Check for free rotation of crankshaft.

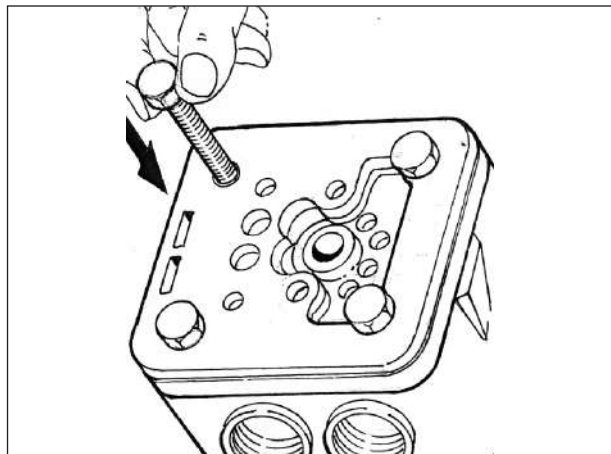
### Power Reduction Cylinder Head Assembly Procedure



Use the cylinder head as a fixture. Keep the valve plate as shown.

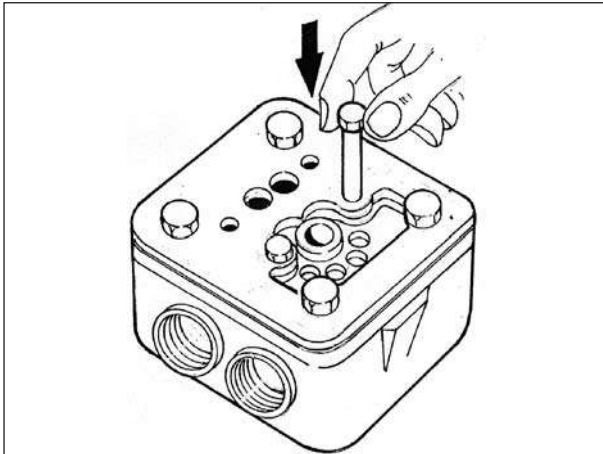


Keep the gasket as shown, ensure proper seating.

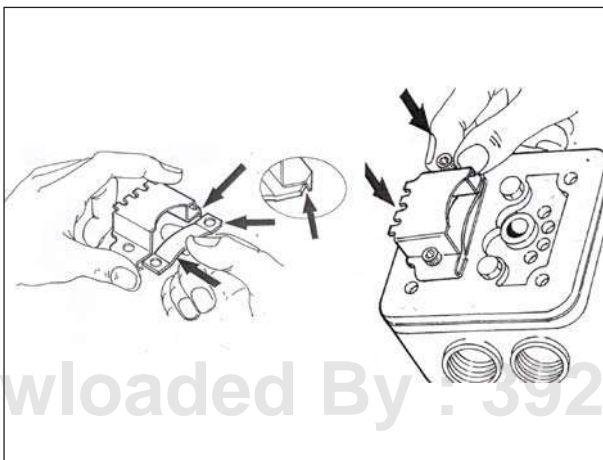


Keep the valve plate cover as shown (use new item only). Use four mounting bolts for locating the plates.

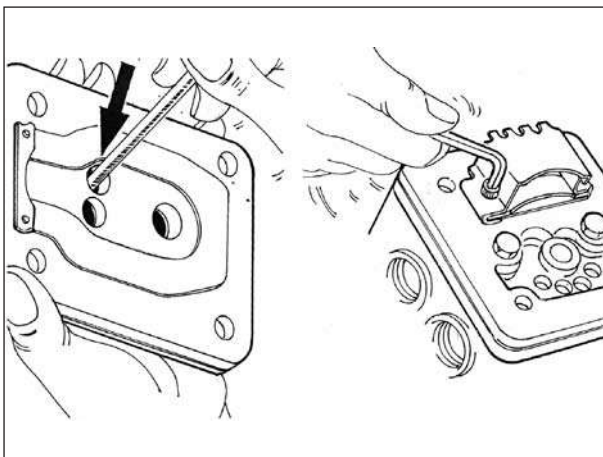




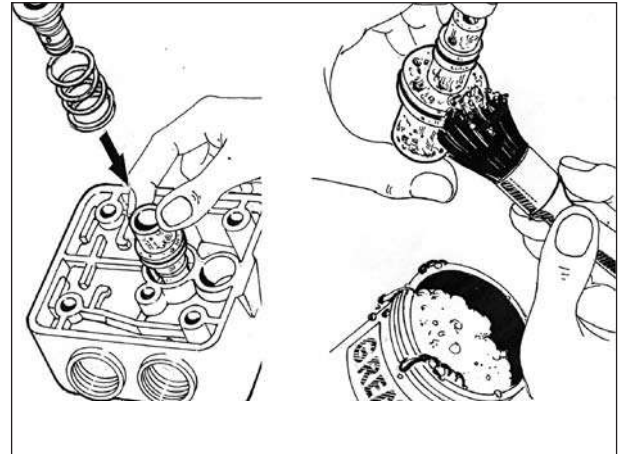
Tighten the centre studs gradually.



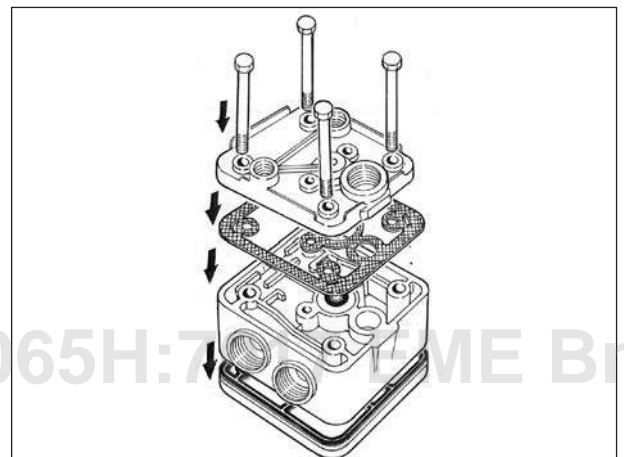
Place the governor plate on the baffle as shown. Ensure that the chamfer in the governor plate matches the notch in the baffle plate. Place the delivery reed as shown.



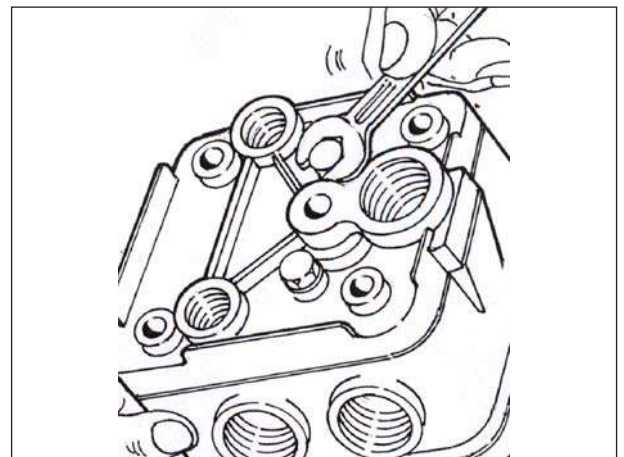
Put the assembly on valve plate cover and tighten the screws. Check for free movement of delivery reed after tightening. Now tighten the screws to the recommended torque.



Apply grease to the plunger stopper and place it in cylinder head. Place the spring and unloader plunger.

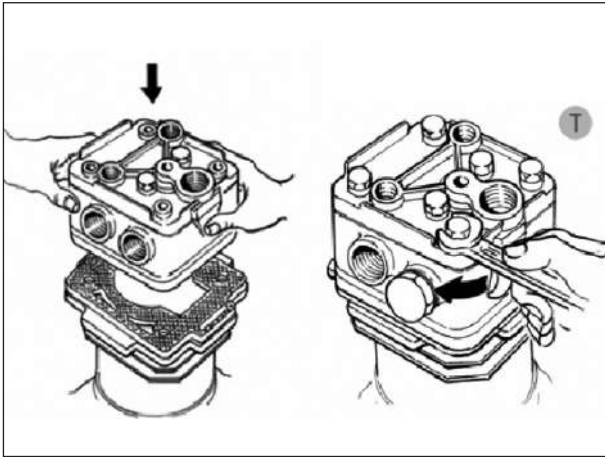


Place the cylinder head and cover. Put it over valve plate assembly as shown. Locate four bolts.

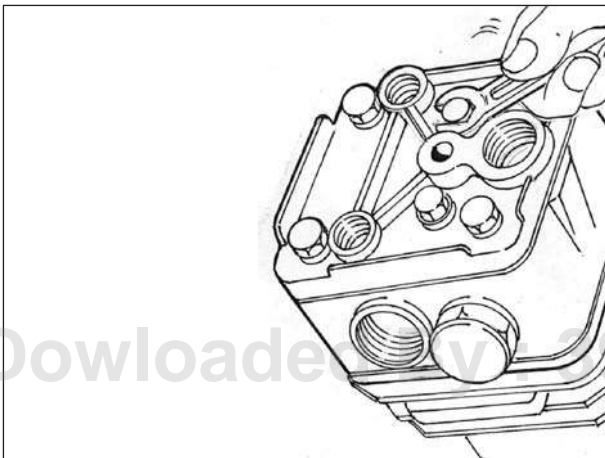


Tighten valve plate clamping bolts (18 Nm)

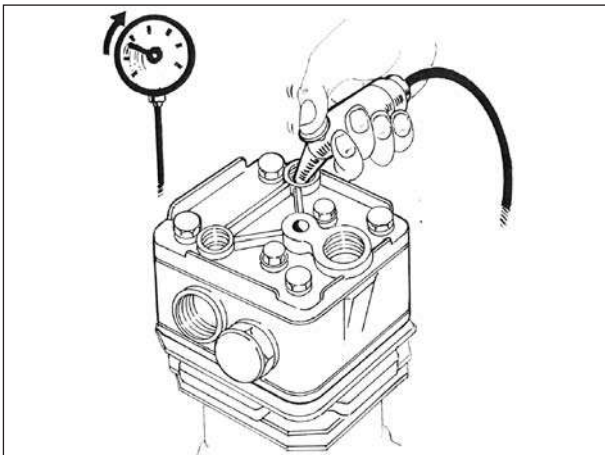




Clean the valve plate and cylinder block surface. Assemble and tighten four mounting bolts (40 Nm).



After tightening four mounting bolts retighten the two valve plate Clamping bolts.



Put air pressure in the water inlet port. Plug the outlet port and see the pressure gauge. There should not be any pressure drop if the assembly is leak free.



**Do not service the inlet reed. If it is damaged use new valve plate assembly only.**

## 55.2 AIR DRYER WITH UNLOADER VALVE & TYRE INFLATOR

### 55.2.0 Function

The function of air dryer with unloader valve and tyre inflator is to dry and clean the compressed air delivered by the compressor and to control the system pressure. It also removes air system contaminants in solid, liquid and vapour form before entering the brake system. The unit also provides facility for inflating tyre tube as and when necessary.

### Description

The air dryer consists of an aluminium body, which houses the components of unloader valve and Tyre Inflator. Molecular desiccant is contained in a sealed cartridge, which is secured to the body through a heavy coil spring and a steel housing.

### 55.2.1 Service check

#### a) Inspection

Check the air lines/compressor mounting bolts for tightness.

Ensure that the air Inlet line is in good condition.

Check for tightness of cylinder head mounting bolts of the compressor.

#### b) Operating Test

Drain the Reservoir and check for presence of moisture/water collection in the reservoir. Presence of moisture is indication of requirement of changing the desiccant cartridge.

Drain the Reservoir and start the engine. Charge the system until the unit cuts out. Record the pressure reading of the dash board gauge. Ensure the correctness of the gauge before commencing the test. If the pressure setting is different to the recommended value loosen the lock nut and adjust the pressure setting screw. Repeat the test until the correct pressure setting is achieved and then tighten the lock nut. For the purpose of setting the pressure, it may be required to deplete the reservoir by applying the brakes a few times.

#### C) Leakage test

Charge the system to just below the 'Cut-out' pressure and stop the engine. Apply soap solution on the entire unit to check for air leakage. Air leak of 25 mm soap bubble is permissible. Excessive air leak, if noticed, the assembly needs to be attended. Ensure that the airline connections are free from air leak.

### 55.2.2 Removing

Block the wheels to prevent movement of the vehicle during working.

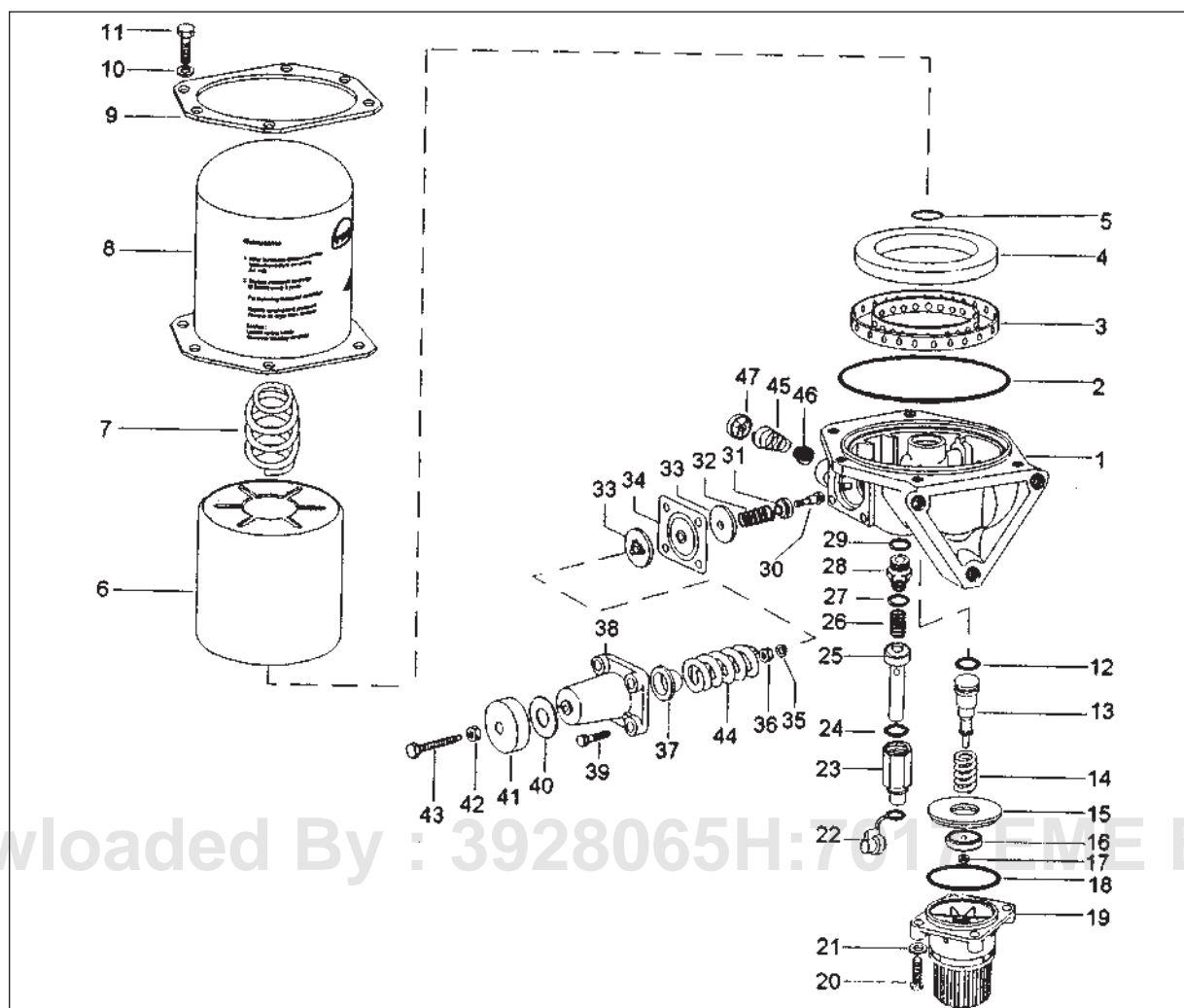
Disconnect the pipelines and close the open ends of the pipes to prevent dust/dirt entry. Identify the pipe connections.

Remove the mounting bolts and the Air Dryer from the bracket.

### 55.2.3 Replacing

Locate the unit on the mounting bracket and secure it tightly by the bolts.

Connect the pipes following the identification made during removal.



Item	Description	Qty	Item	Description	Qty
1	Body	1	25	Valve	1
2	Sealing ring	1	26	Spring	1
3	Filter retainer	1	27	Sealing washer	1
4	Filter	1	28	Tyre inflator adaptor	1
5	Sealing ring	1	29	Sealing washer	1
6	Dessicant cartridge	1	30	Governor plunger	1
7	Spring	1	31	Valve	1
8	Housing	1	32	Spring	1
9	Stiffener plate	1	33	Follower	2
10	Steel washer	6	34	Diaphragm	1
11	Hex. screw	6	35	Spring washer	1
12	Sealing ring	1	36	Hex. nut	1
13	Unloader plunger	1	37	Spring guide	1
14	Compression spring	1	38	Top cover	1
15	Valve seat	1	39	Hexagon head screw	4
16	Valve	1	40	Exhaust flap	1
17	Hex. nyloc nut	1	41	Cup	1
18	Sealing ring	1	42	Hex. nut	1
19	Silencer	1	43	Adjustment screw	1
20	Pan head screw	4	44	Compression spring	1
21	Steel washer	4	45	Conical spring	1
22	Dust cap	1	46	Non return valve	1
23	Tyre inflator body	1	47	Valve stop & spring retainer	1
24	Sealing ring	1			



Carryout the Operating/Leakage test as given under 'Service Check'.

#### 55.2.4 Dismantling

Tools required for servicing:

Philip head screw driver, a good circlip pliers, nose pliers and standard tools and spanners.

Clean the exterior of the Air Dryer thoroughly.

Hold the Air dryer assembly in a vice with suitable vice clamp and loosen and remove the 6 screws (11) securing the housing to the body. (Care must be taken to hold the housing while removing the screws since the housing is held against a heavily loaded spring).

Remove the housing (8), the stiffener plate (9), the spring (7) and the desiccant cartridge (6).

Remove the filter (4), the filter retainer (3), the sealing ring (5) and sealing ring (2) from the valve body (1).

Loosen the lock nut (42) and remove the adjustment screw (43), cup (41) and exhaust flap (40).

Unscrew the four screws (39) securing the top cover to the body. Remove the spring (44), the spring guide (37) and the top cover (38).

Remove the diaphragm sub assembly.

Hold the governor plunger (30) by inserting a suitable pin in the hole and loosen the lock nut (36) and remove the washer (35), the follower (33), the diaphragm (34), spring (32) and valve (31) from the diaphragm sub assembly.

Unscrew the valve stop and spring retainer (47) and remove the spring (45) and the non-return valve (46).

Unscrew the 4 Philip head screws (20) securing the silencer to the body and remove the silencer sub assembly.

Remove the sealing ring (18).

Withdraw the unloader plunger sub assembly by holding the nyloc nut (17) with a flat nose pliers.

Remove the dust cap (22) from the tyre inflator body (23).

Loosen and remove the tyre inflator body (23), sealing ring (24), valve (25), spring (26) and the washer (27).

Loosen and remove the Tyre Inflator adaptor (28) and the washer (29).

Loosen the nyloc nut (17) and the valve (16), valve seat (15) and the spring (14).

Removing the sealing ring (12) from the plunger (13).

#### 55.2.5 Cleaning and inspection

Clean all the metallic parts using cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.

Thoroughly clean the valve body and make sure that the air passage cross-holes are free from blockage.

Check the valve body for damage on the port faces/thread, nick/score marks/damages on the valve seats, excessive wear/score marks on the unloader plunger bore and the governor plunger bore.

Check the springs for distortion, rust formation and permanent set.

Scrap all the old parts, which are found unserviceable.

#### 55.2.6 Reassembly

Use recommended Repair Kit to replace the parts scrapped during dismantling and also replace all parts, which were found to be unserviceable during inspection.

Lubricate all the sliding parts and the bores with silicone grease. This grease is supplied in Repair Kit.

Assemble the conical spring (45) to the non return valve (46) and position the valve in the delivery port of the valve body. Secure the valve in position by screwing in the valve stop and spring retainer (47) in the delivery port.

Install the new sealing ring (24) on the tyre inflator body (23).

Locate the washer (29) on the Tyre inflator adaptor (28) and secure on the valve body (1) by tightening to a torque of 20-25 Nm.

Locate the washer (27), Spring (26), valve (25) in tyre inflator body (23) and secure on the tyre inflator body (23) by tightening to a torque of 20-25 Nm.

Fix the dust cap (22) on the tyre inflator body (23).

Install new sealing ring (12) on the unloader plunger (13).

Locate the spring (14), valve seat (15) and valve (16) on the unloader plunger and secure by tightening the nyloc nut (17) to a torque of 2 Nm.

Locate the unloader plunger sub assembly into the body.

Locate the sealing ring (18) on the silencer body.

Place the silencer assembly (19) over the body. Apply loctite 242 or equivalent on the thread portion of the 4 Philips head screw (20) and secure the silencer with spring washers (21) by tightening to a torque of 3 Nm.

Place the valve (31), the spring (32), bottom follower (33), diaphragm (34), the top follower (33) in the governor plunger (30) and secure by tightening the nut (36) with spring washer (35) to a torque of 3 Nm. Ensure proper orientation of diaphragm during assembly.

Place the diaphragm assembly on the body by guiding the governor plunger into the bore.

Place the graduating spring (44), spring guide (37) and top cover (38) on diaphragm assembly and secure the top cover by tightening the 4 screws (39) to a torque of 9 Nm.

Place the exhaust flap (40) and cup (41) on the top cover and screw in the adjusting screw (43) with the lock nut (42).

Assemble the sealing ring (5) for the desiccant cartridge on the centre of the body.

Assemble the filter (4) onto the filter retainer (3).

Assemble the larger sealing ring (2) on the spigot of the body.

Place the desiccant cartridge (6) over the body and locate the spring (7) over the desiccant cartridge.

Locate the housing (8) and the stiffener plate (9) and secure with the 6 hexagon screws (11) and steel washers (10) to a torque of 25 Nm.

Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.



### 55.3 DRYING & DISTRIBUTION UNIT

#### Design and Function

Drying and distribution unit (DDU) combine the function of the Air dryer with unloader valve, purge tank (fitted with air dryer) and the Quadruple System Protection Valve (QSPV).

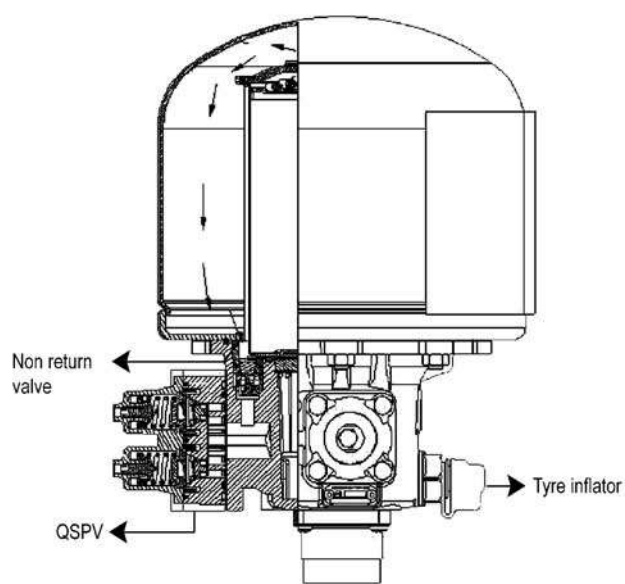
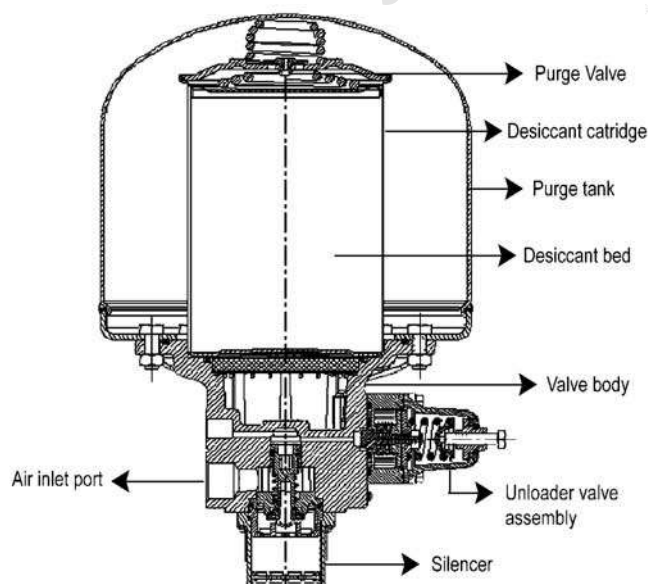
#### Operation

DDU consist of an aluminium body on which the purge tank, integral unloader valve, integral QSPV and the tyre inflator are mounted. The exhaust is fitted with a silencer. Internally, air path consist of coalescent filter, which removes the oil and other contaminants from the compressed air and a desiccant bed, which removes the moisture from the air.

During Charging, the compressor pumps air into the service reservoirs. The water molecules in the air

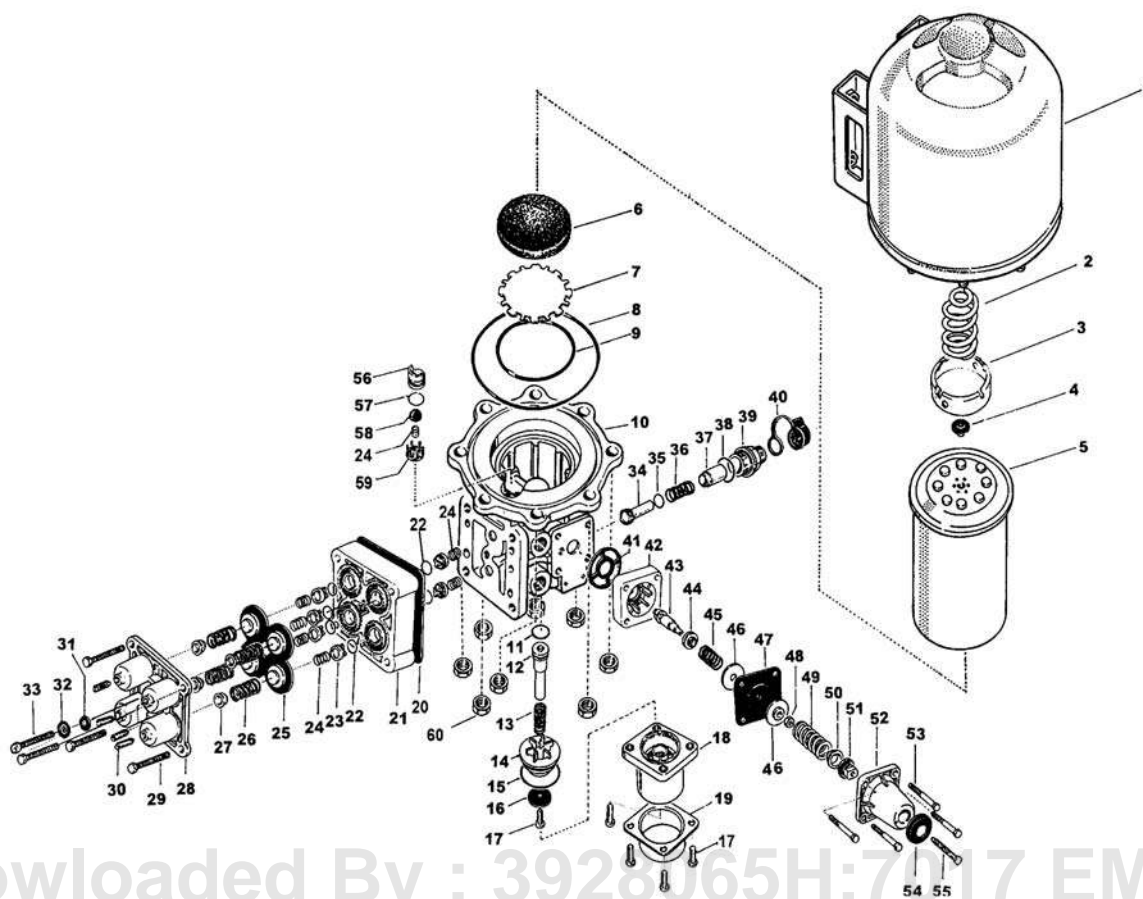
get absorbed on microscopic pores on the surface of the desiccant beads. A portion of the dried air stored in the purge volume contained in the sheet metal purge tank. During unloading cycle, the unloader exhaust the compressor delivery air to the atmosphere.

Non return value present in the DDU body and QSPV body does not allow any back flow from service reservoirs. Because of pressure difference between the air pressure stored in the purge volume and below desiccant bed, the pressurized dry air from the purge volume expands and flow back through a small orifice in the purge valve over a desiccant bed. This expansion and flow of dried air in the reverse direction collects the moisture absorbed by the desiccant during the charging cycle, regenerating the desiccant. The moisture collect by the desiccant, condensed water, oil and other contaminants are also exhausted to the atmosphere in each unloading cycle.





## DRYING AND DISTRIBUTION UNIT



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SL. No.	Description
1	Purge Tank Sub Assembly
2	Spring
3	Cartridge Retainer
4	Purge Valve
5	Dessicant Cartridge
6	Filter
7	Filter Retainer
8	Sealing Ring
9	Sealing Ring
10	Unloader Valve
11	O Ring
12	Unloader Plunger
13	Spring
14	Valve Seat
15	O Ring
16	Spherical Valve
17	Screw
18	Silencer Assembly
19	Cover
20	Gasket - QSPV
21	Body - QSPV
22	O Ring
23	Valve
24	Spring - QSPV
25	Diaphragm - QSPV
26	Spring
27	Spring Guide
28	Top Cover
29	Bolt
30	Adjusting Screw

SL. No.	Description
31	Lip Seat
32	Cover
33	Allen Bolt
34	Spacer
35	O Ring
36	Spring
37	Valve Pressure Test Connector
38	O Ring
39	Body
40	Cap
41	Gasket - ULVTI
42	Boot
43	Governor Plunger
44	Bonded Valve
45	Spring - ULVTI
46	Follower
47	Diaphragm - ULVTI
48	Nut
49	Spring - ULVTI
50	Cap
51	Screw Holder
52	Top Cover - ULVTI
53	Bolt
54	Cap
55	Adjustment Screw
56	Valve Seat
57	O Ring
58	Spherical Valve
59	Spring Guide
60	Bolt

**Maintenance Schedule****Half Yearly**

- Check for moisture, water collection in the reservoirs.
- Check the performance.

**Overhaul**

- Once in 3 Years for vehicles with air tank volume < 120 litres.
- Once in 2 years for vehicles with air tank volume > 120 litres & < 175 litres.
- Overhaul unit using appropriate repair kit.
- Replace desiccant cartridge.

The desiccant generally functions satisfactorily in the field up to 3 years, after which it may have to be replaced. The residual oil vapours carried over beyond the pre-filter, contaminates the desiccant over a period of time and lowers its air drying efficiency. Therefore if the oil carry over of the compressor is high, more frequent replacement of the desiccant is warranted.

When the desiccant is renewed, the coalescent filter and the rubber components in the unloader, QSPV and tyre inflator portions also should be replaced using recommended repair kit.

**Service Check****Inspection**

Check the air lines/DDU mounting bolts for tightness.

Ensure that the air inlet line is in good condition.

**Operating Test:**

Drain the Reservoirs and check for presence of moisture / water collection in the reservoirs. Presence of moisture is the indication of requirement of changing the desiccant cartridge.

Drain the Reservoir and start the engine. Charge the system until the units cuts off. Record the pressure reading of the dash board gauge. Ensure the correctness of the gauge before commencing the test. If the pressure setting is different to the recommended valve adjust the pressure setting screw.

Repeat the test until the correct pressure setting is achieved. For the purpose of setting the pressure, it may be required to deplete the reservoirs by applying the brakes a few times.

**Leakage Test:**

Charge the system to just below the 'cut-out' pressure and stop the engine. Apply the soap solution on the entire unit to check for air leakage. Air leak of 25mm soap bubble is permissible. Excessive air leak, if noticed, the assemble needs to be attended.

Ensure that the airlines connection are free from leak.

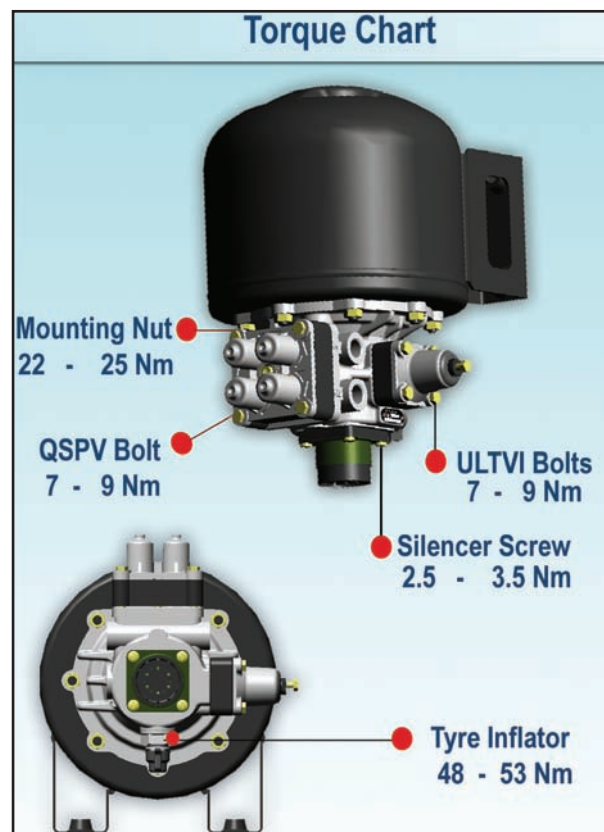
**Removing**

Block the wheels to prevent movement of the vehicle during working.

Disconnect the pipelines and close the open ends of the pipes to prevent dust/dirt entry.

Identify the pipe connections.

Remove the mounting bolts of the DDU.

**Tightening Torque**



## DISMANTLING

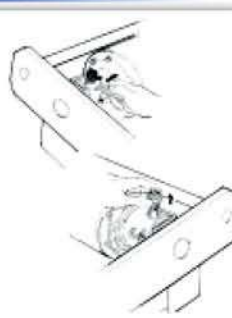
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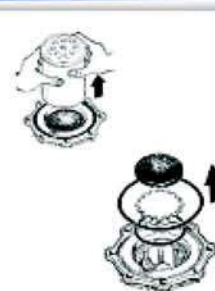
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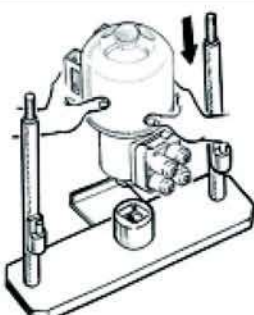
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Step - 16



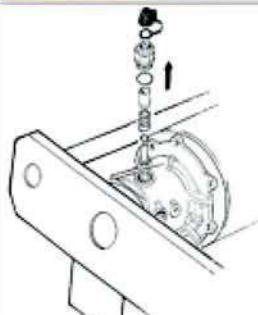
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Step - 7



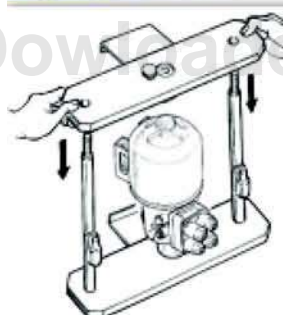
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Step - 17



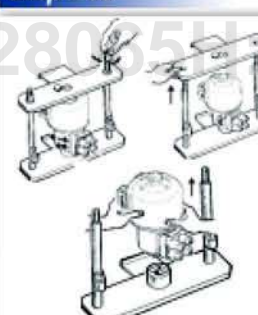
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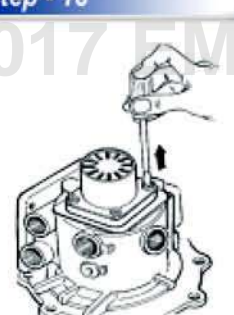
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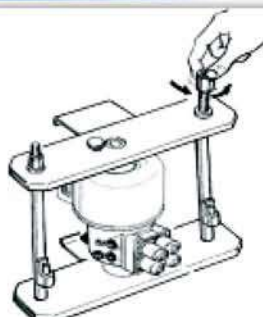
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Step - 18



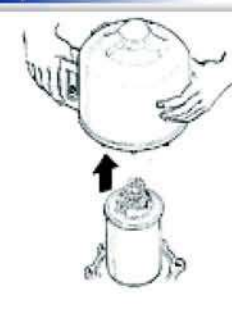
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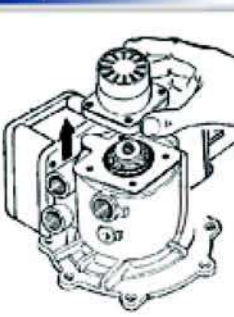
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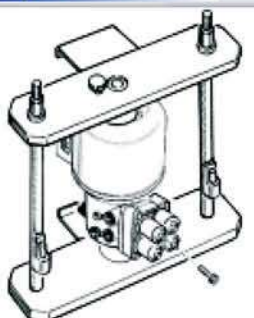
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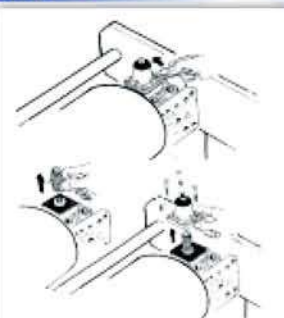
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Step - 5



Step - 10



Step - 15



Step - 20



# ASSEMBLING

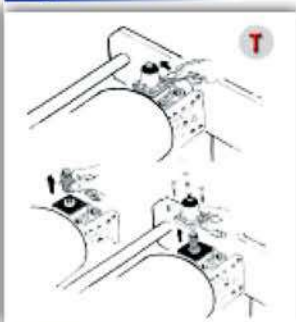
Step - 1



Step - 6



Step - 11



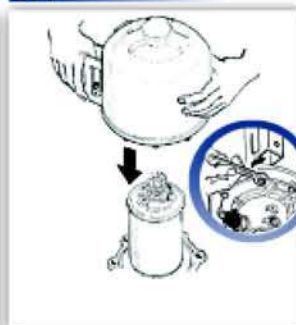
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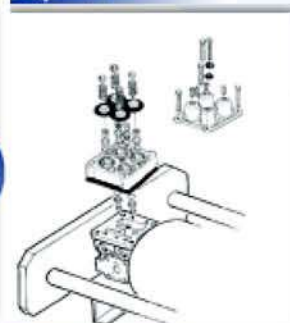
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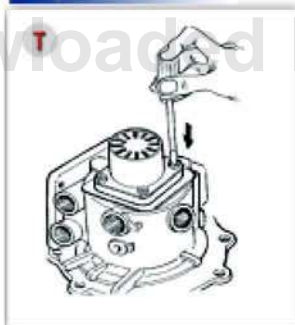
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Step - 3



Step - 8



Step - 13



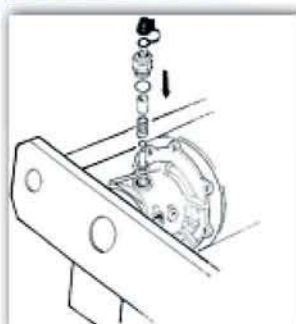
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Step - 4



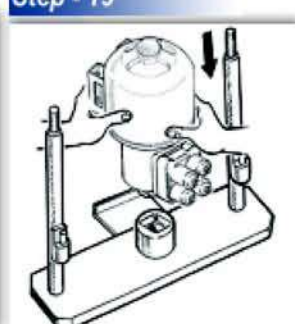
Step - 9



Step - 14



Step - 19



Step - 5



Step - 10



Step - 15



Step - 20





## Cleaning and Inspection

Clean all the metallic parts using cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.

Thoroughly clean the valve body and make sure that the air passage cross-holes are free from blockage.

Check the valve body for damage on the port faces / thread nick/ score marks/ damage on the valve seats. Excessive wear/ score mark on the unloader plunger bore and the governor plunger bore.

Check the spring for distortion, rust formation and permanent set. Scrap all the old parts, which are found unserviceable.

Once cleaning and inspection is completed Assembling procedures starts and note that the reverse steps of dismantling are Assembling steps of the product.

## Replacing

Locate the unit on the mounting bracket and secure it tightly by the bolts.

Connect the pipers following identification made during removal.

Carry out the operating / leakage test as given under "service check".

## Tools

- DDU fixtures
- Star Screw Driver
- Standard Tools
- Spanners

## Installation Aspects

- The DDU should be fitted only on new vehicle where no corrosion of pipes and reservoirs have taken place.
- The DDU should not be mounted near any heat producing source like engine exhaust pipe.
- The piping from the compressor should be sloping

towards the DDU and should avoid any sags or traps which can collect water.

- Air draught should be available for cooling the DDU when the vehicle is in motion.

## Important Please Read :

When working on or around air brake systems & components the following precautions should be observed in the interest of **SAFETY**.

Always block vehicle wheels.

Stop engine when working under vehicle.

Keep hands away from the chamber push rod and slack adjuster ; they may apply as system pressure drops.

Never connect or disconnect a hose or line containing pressure ; it may whip.

Never remove a component or pipe plug unless you are certain all system pressure has depleted.

Never exceed recommended pressure.

Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled.

Use only the proper tools and observe all precautions pertaining to use of those tools.

## USE ONLY GENUINE REPLACEMENT PARTS AND COMPONENTS.

Device with stripped thread or damage parts should be replaced. Repairs requiring machining should not be attempt.



**TECHNICAL SPECIFICATIONS**

Length	:	322 mm
Width (Max.)	:	209 mm
Weight	:	8.5 kg
Working medium	:	Air
Thermal range of operation	:	-25°C to +80°C
Short term resistance to heat	:	100°C
Maximum allowable air inlet temperature	:	60°C
Normal working pressure	:	8 bar
Maximum permissible pressure	:	10 bar
Blow off pressure	:	12 ± 2 bar
Maximum air flow rate	:	400 litres/minute

**Installation Recommendations****Connections of Ports**

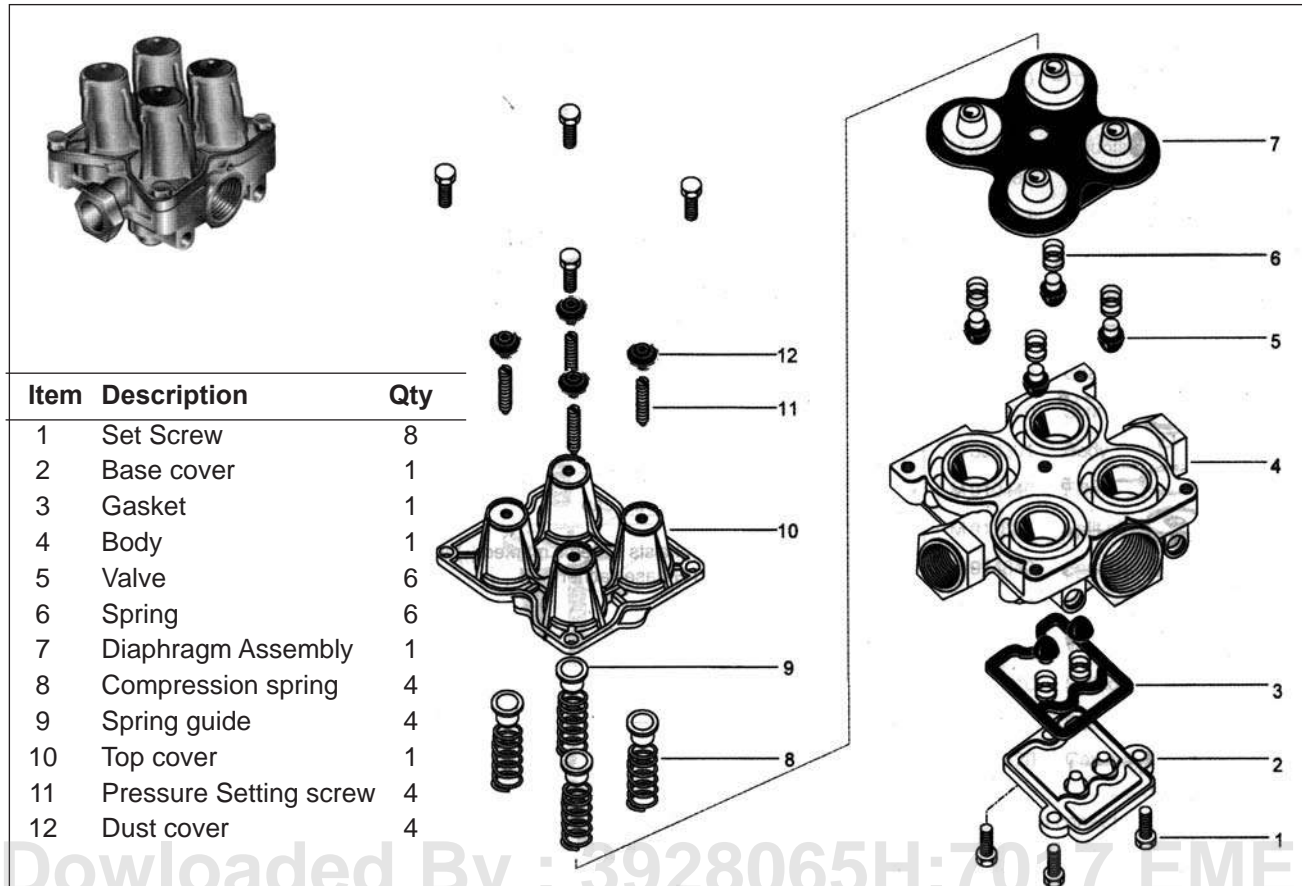
Inlet Port 1	Delivery from compressor
Port 21	Reservoir (Rear axle braking circuit reservoir)
Port 22	Reservoir (Front axle braking circuit reservoir)
Port 23	Delivery for hand brake circuit
Port 24	Delivery for auxiliary circuits like exhaust brake.
Port 4 (Optional)	Control port (for compressors with cylinder head unloading device)

The DDU should be mounted on the vehicle such that the silencer at exhaust is facing vertically downwards.

**Recommended Piping**

Air Inlet	:	>12 mm inner diameter
Air delivery	:	> 10 mm inner diameter for ports 21 and 22 > 4 mm inner diameter for ports 23 and 24.

## 55.4 QUADRUPLE SYSTEM PROTECTION VALVE (DIAPHRAGM TYPE)



Item	Description	Qty
1	Set Screw	8
2	Base cover	1
3	Gasket	1
4	Body	1
5	Valve	6
6	Spring	6
7	Diaphragm Assembly	1
8	Compression spring	4
9	Spring guide	4
10	Top cover	1
11	Pressure Setting screw	4
12	Dust cover	4

## 55.3.0 Function

The function of system protection valve is to charge 4 lines from a compressor and prevent back flow of compressed air from any one line to which the valve is connected. In the event of failure in any one of the lines this valve helps to maintain the other lines intact to their opening pressure.

## Description

The Valve consists of a valve body, a diaphragm assembly, 6 spring-loaded hemispherical valves, graduating spring and a top cover. The body has one inlet port connecting the delivery of the compressor and 4 delivery ports. Two ports labelled 21 and 22 are connected to two independent reservoirs feeding air pressure to the dual brake valve. Port labelled 23 is connected to the hand brake circuit and port 24 is connected to auxiliary circuits like exhaust brakes, air horn, throttle, air suspension and pneumatically actuated door mechanisms.

The body provides valve seats for the 4 elements. Each element has a spring-loaded hemispherical valve. A diaphragm assembly locates the valves. The top cover locates the graduating springs and secures the diaphragm assembly through 5 hexagonal head screws. A dust cover is provided to prevent dust entry into the elements.

## 55.4.1 Service checks

## a) Operating Checks

## 1. Pressure setting

- Deplete air pressure completely from all the lines.
- Connect a test gauge in the inlet line of the system

protection valve (preferably in the sensing tank drain port).

- Connect test gauges one in each of the delivery lines of the system protection valve.
- With any one of the service lines open start the engine and build up air pressure, to check the opening pressure of that element. The stabilised pressure showing in the inlet gauge is the opening pressure of that element.

If the system pressure is not charged to the correct pressure setting the valve element should be removed, serviced and adjusted to give the correct pressure setting.

- For setting the specified pressure, screw in all the adjusting screws (2.5 mm hexagonal socket set screw) to higher pressure and unscrew to get the required pressure setting. For setting the pressure in the service element run the compressor at idling speed of the engine.

Repeat the procedure for all other three elements and attend to them if necessary.



**For service lines the gauges provided in the dash board may be used**

## 2. Closing pressure of auxiliary elements

For checking the closing pressure of an element in the auxiliary line, charge the system fully and release the pressure slowly by opening that line to atmosphere. Pressure retained in the inlet test gauge is the closing pressure of that element.

**3. Closing pressure of service elements**

For checking the closing pressure of an element in the service line, charge the system fully and release the pressure by opening that line to atmosphere. The pressure drops in the test gauge connected to the inlet at a faster rate to a pressure and further keeps dropping slowly. The pressure dropped suddenly to a value is the closing pressure of that element.

**55.4.2 Leakage tests**

1. Charge the system to unloader valve cut out pressure and stop the engine.
2. Apply soap solution on the joint and dust cover and check for air leakage. If air leak is noticed in that joint, check valve body mating faces for nick/score marks and damage and replace if necessary.

Air leak of 25 mm soap bubbles in 5 seconds is permissible

**55.4.3 Non return valve leak**

- Connect test pressure gauges in the delivery of the service and auxiliary lines and charge the system fully.
- Deplete any one of the service reservoirs by disconnecting that line. Apply soap solution in the disconnected lines and first check for air leak. Air leak of 25 mm soap bubbles in 5 seconds is permissible.
- No faster pressure drop is permissible in the other test gauges of the service line and auxiliary lines. Excessive pressure drop in any of the test gauges indicates non-return valve leak in that line. Connect that service line and repeat the above procedure by disconnecting the other lines one by one to detect non-return valve leak in the other lines
- Remove all the test gauges



**Prior to conducting air leakage tests ensure that the entire system is free from air leak. With the system fully charged, if system protection valve gives rise to hissing noise, it leaves an indication that there exists external air leak which has to be attended to first before conducting leak tests.**

**55.4.4 Removing**

- Block the wheels to prevent movement of the vehicle during working.
- Brush away dust/dirt from the air line connections and the system protection valve.
- Deplete the air pressure in all the lines.
- Identify the pipes with its appropriate ports and disconnect the pipes and close the open ends of the pipes to prevent dust/dirt entry.
- Loosen the lock nut and removes the valve with the long adaptor. (Remove the mounting nuts and remove the valve from the bracket where applicable)

**55.4.5 Replacing**

- Fix the short end of the long adaptor with an aluminium washer to the inlet port of the valve.

- Screw in the lock nut and an aluminium washer on the long end of the adaptor and screw in the adaptor to the sensing tank boss and secure tightly.
- (Locate the valve on the mounting bracket and secure tightly where applicable)
- Identify the ports and connect its respective pipes.
- Carryout 'Operating / Leakage tests' as given under "Service check."

**55.4.6 Dismantling****Tools required for servicing :**

Spanners 10, 11, 13 A/F, a 2.5 mm Allen key. No other special tool is required

- Loosen and remove the lock nut from the long adaptor and remove the adaptor and the washer from the valve port.
- Remove the 4 dust covers.
- Loosen and remove the 4 pressure setting screws
- Loosen and remove the 5 hexagonal screws securing the top cover to the body.
- Remove the springs, the spring guides the diaphragm assembly and the 4 valves.
- Loosen and remove the 3 screws securing the base cover to the body.
- Remove the gasket and the 2 valves.
- Scrap all the parts which are serviced in the Repair kit.

**Cleaning and inspection**

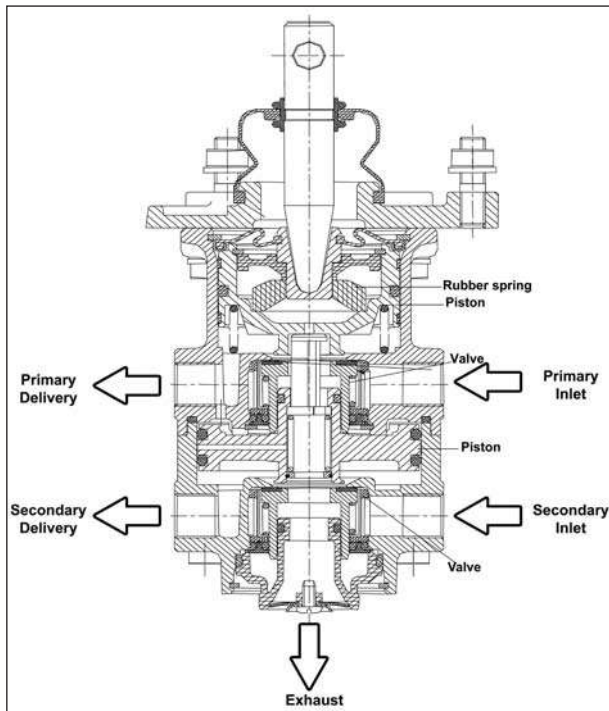
- Clean all the components with a cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Thoroughly clean the body and check the valve seats for damage, nick marks. Check the threads for damage.
- Check the springs for distortion, and permanent set.

**55.4.7 Reassembly**

- Use recommended Repair kit to replace the parts scrapped during dismantling and in addition replace all parts which were found unserviceable / defective during cleaning and inspection.
- Locate the springs on the hemispherical valves and locate the valve assembly on the seat in the valve body.
- Locate the diaphragm assembly on the valve in proper orientation.
- Locate the pressure setting springs on the diaphragm.
- Locate the spring guides on the springs.
- Locate the top cover and secure with 5 hexagonal screws. Tighten the screws evenly.
- Assemble the 4 pressure setting screws on the top cover.
- Assemble the dust covers. Use a small drift of 2 mm dia and insert the cover fully to ensure that it is properly seated.



## 55.5 DUAL BRAKE VALVE



### 55.5.0 Function

Dual brake valve is used to gradually charge and exhaust the brake actuators and also to control the trailer brake systems through trailer control valve in a Dual Brake System

### Description

The Dual Brake Valve mainly consists of an upper body and a lower body in which the pistons and the spring loaded valves are housed. A venting guide assembly is located in the bottom side of the lower body.

The spring-loaded piston houses a rubber spring, a spring seat and a stem and located in upper body. The upper and the lower bodies provide inlet /delivery ports of primary, secondary and gauges/switches ports connections. The upper and lower body are secured together by 4 screws.

### 55.5.1 Service checks

#### a) Operating Test:

Check and ensure that the pipe connections and joint are free from air leakage when the brake is in applied condition.

Connect test gauges in the delivery of the primary / secondary lines of the brake valve and check delivery pressure with the brake pedal fully depressed. The delivery pressure registered in the test gauges should be approximately the same as primary / secondary dashboard gauge pressures.

Depress the brake pedal in several positions between fully released and fully applied positions and check the delivery pressures registered by the test gauges which should vary in accordance with the brake pedal position.

#### b) Leakage Test

##### - Off Leak

Charge the system fully and check for air leak in pipeline joints. Check leak at exhaust in brake valve by applying soap solution.

##### - On Leak

Depress the brake pedal fully and check for air leak in the exhaust of the brake valve. By holding the brake pedal fully depressed, check the delivery pipe joints for air leakage by applying soap solution.

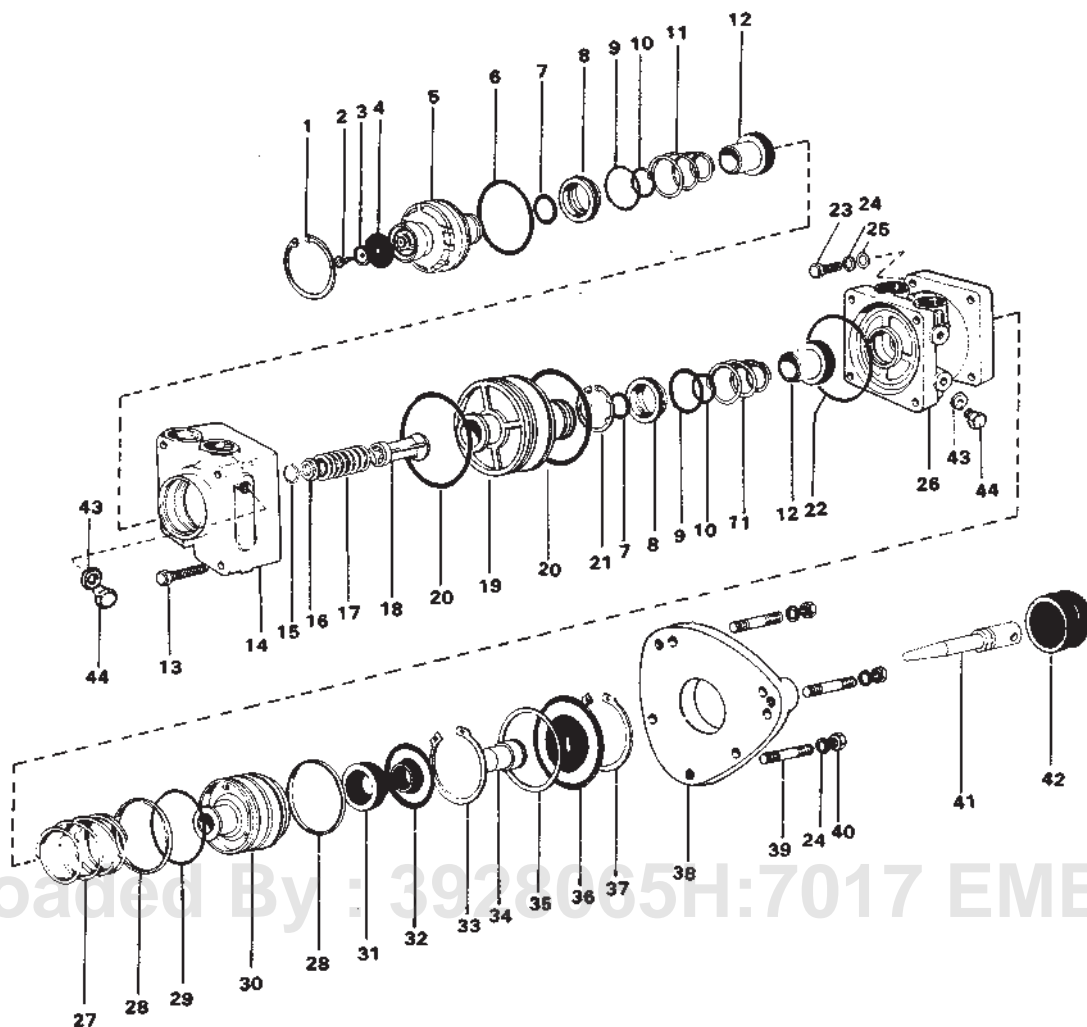
Air leak of 25mm soap bubble in 5 seconds is permissible. If excessive air leak noticed, disconnect either primary or secondary and again check air leak. Air leak noticed in either of the line connected, leaves indication to check and attend to the Primary / Secondary portion of the valve.

### 55.5.2 Removing

- Block the wheels to prevent movement of the vehicle during working.
- Deplete air pressure from the system.
- Brush away dirt / dust from the air pipe connections
- Disconnect pipelines after identifying the pipe connection to avoid wrong connection while replacing the unit on the vehicle.
- Close the open ends of the pipes to prevent dust/dirt entry.
- Disconnect the electrical connections of Low pressure Indicator switches / Stop light switches, if provided.
- Loosen and remove the mounting nuts and remove the valve.

### 55.5.3 Replacing

- Mount the brake valve in its location and secure it tightly.
- Connect the pipelines; Follow the identification of the pipelines to avoid wrong connection.
- Connect the electrical terminals to the low-pressure indicator switches / Stop light switches, if provided.
- Charge the system and check for warning from Low-pressure indicator switches when the system pressure is below the pressure setting of the switch.
- Apply the service brake and check for stop light switch glowing.
- Carry out 'Operating / Leakage tests' as given under 'Service Check'.



Item	Description	Qty	Item	Description	Qty
1	Internal circlip	1	23	M 8 x 1.25 Hex head screw	4
2	Self tapping screw	1	24	Metric spring washer	7
3	Cap	1	25	Steel washer	4
4	Washer	1	26	Upper body	1
5	Venting guide	1	27	Spring	1
6	Sealing ring	1	28	Guide ring	2
7	Sealing ring	2	29	Sealing ring	1
8	Sealing ring spacer	2	30	Piston	1
9	Sealing ring	2	31	Rubber spring	1
10	Sealing ring	2	32	Spring seat	1
11	Spring	2	33	Internal circlip	1
12	Valve	2	34	Stem	1
13	Hexagon head bolt	4	35	Spacer	1
14	Lower body	1	36	Boot	1
15	Snap ring	1	37	Internal circlip	1
16	Spring seat	1	38	Adaptor plate	1
17	Compression spring	1	39	M8x1.25stud	3
18	Plunger	1	40	M 8 x 1.25 hexagon nut	3
19	Piston	1	41	Plunger	1
20	Sealing ring	2	42	Boot	1
21	Internal circlip	1	43	Washer	1
22	Sealing ring	1	44	Plug	1

**55.5.4 Dismantling**

- Clean the exterior of the valve.
- Loosen and remove the Stop light switches and Low-pressure indicator switches, if provided.
- Mark the position of upper and lower bodies to avoid wrong position of ports during reassembly.
- Remove the bottom cover and the filter
- Loosen and remove the 4 screws, which secure the upper, lower and detach the bodies and secondary piston sub-assembly.

**Secondary piston sub-assembly:**

Remove the snap ring from its groove and extract the spring seat, spring and plunger.

**Lower body sub- assembly:**

- Remove the circlip and detach venting guide, spring, integral filter and valve.

**Upper body Sub-assembly:**

- Remove the bottom circlip and detach the spring, integral filter and valve.
- Remove the upper circlip and detach the boot, spacer and stem. Detach the upper primary piston sub-assembly.

**Primary piston Sub-assembly:**

- Remove the circlip and detach the spring seat and rubber spring.
- Remove the sealing rings and guide rings from the primary pistons.

**55.5.5 Cleaning and inspection**

- Clean the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Ensure that metering holes are free from blockage in upper / lower bodies and secondary piston.
- Inspect the bore in the upper body and lower body for score marks / excessive wear, valve seat for damage / nick marks, port thread for damage.
- Check the springs and circlips for corrosion, distortion, and permanent set.
- Clean the filter and the mesh with compressed air. Ensure that the components are clean before assembly.

**55.5.6 Reassembly**

- Use recommended Repair kit to replace the old parts scrapped during dismantling and also replace the parts found to be unserviceable during inspection.
- Lubricate the pistons, bores of upper and lower bodies, integral filters, sealing ring with silicon grease. This grease is supplied in the repair kit.
- Install the new sealing rings on the pistons, venting guide and integral filter and smear with grease.
- Install guide rings on the primary piston and smear with grease.

**Secondary piston sub-assembly:**

- Locate the plunger, spring and spring seat into the piston bore and secure by the snap ring. Ensure that the snap ring is seated in the groove properly.

**Lower body sub-assembly:**

- Place the valve, spring, and integral filter and with sealing ring on venting guide, position and guide the venting guide gently in the valve body bottom bore. Secure the venting guide in the valve body with circlip. Ensure that the circlip is located in the groove properly. Place the mesh in the bottom cover and snap fit to groove in the lower body

**Upper body sub-assembly:**

- Position and place the valve, spring, filter in the bottom side of the body and secure with circlip. Ensure that the circlip is located in the groove properly.

**Primary piston sub-assembly:**

- Place and position the rubber spring, spring seat and stem in the primary piston. Press the stem assemble the circlip. Ensure that the circlip is located in the groove properly.
- Insert the primary piston in the topside of the upper body. Place the spacer, boot along with stem and secure with circlip. Ensure that the circlip is located in the groove properly.
- Locate the sealing ring in the bottom groove of the upper body and secure upper and lower bodies together by the 4 screws by tightening to a torque of 10 Nm. Ensure that the marking on valve bodies is in line.
- Assemble the Low pressure Indicator switches in the auxiliary ports of inlets and Stop light switches in the auxiliary ports of deliveries along with sealing washer.

**55.6 GRADUATED HAND CONTROL VALVE****55.6.0 Function**

The purpose of this valve is to gradually charge and exhaust air from spring brake actuators for releasing/applying the parking or emergency brakes in a truck or a tractor.

**Description**

The valve mainly comprises of a valve body in which a valve and a plunger is operating.

A spring loaded plunger assembly located in the upper side of the valve body houses a graduating spring, shims and a cam follower with a 'O' ring.

The top cover assembly houses a cam, a pivot pin and an operating lever. The movement of the lever is controlled by a spring loaded sleeve and a knob. The top cover assembly is secured on to the upper side of the valve body. A spring loaded flat inlet/exhaust valve is secured to the inlet port of the valve body by an inlet nut in which a valve guide is located. The valve body also has an exhaust passage in which wire mesh filter and strainer plate are located. A rubber gaiter fitted in between the top cover and the sleeve protects dust/dirt entering the valve.

**Port identification**

Port No.	Port connection
Port 1	From system protection valve port 23
Port 2	To spring brake actuator port 12 at rear.

**55.6.1 Service Check****Operating Tests**

Move the lever to the brakes 'OFF' position and charge the system to cutout pressure and stop the engine. Move the lever to brakes 'ON' position gradually. The air should start exhausting from about 10 degrees movement of the lever from 'OFF' position. Further movement will start to apply the spring brakes. Move completely towards brakes 'ON' position and check for full effectiveness of spring brakes. The air in the hand brake line should be exhausted fully within 10 degrees from 'ON' position.

Move the lever from 'ON' to 'OFF' position and observe a sound of air passing through to the spring brakes releasing it. In the final locking position of the lever with spring brakes 'OFF' full inlet pressure must be available at the delivery.

**Leakage Tests**

With the lever in brakes 'ON' position, charge the system fully. Check for air leakage through the exhaust passage. No air leak is permissible.

Air leak, if noticed indicates faulty inlet/exhaust valve or damage on valve seat in valve body.

With the lever in brakes 'OFF' position, charge the system fully and check for air leakage through exhaust passage. No air leak is permissible.

Air leak if noticed, indicates faulty inlet/exhaust valve, damage on the valve seat of the plunger or 'O' rings.

**55.6.2 Removing**

Block the wheels to prevent movement of the vehicle during working.

Deplete the air pressure from the system.

Brush away dust/dirt from the air line connections and the valve.

Disconnect the inlet/delivery pipe lines and close the open ends of pipes to prevent dirt/dust entry.

Mark the valve position with respect to its mounting.

Remove the mounting screws and the dial. Remove the valve from the mounting bracket.

**55.6.3 Replacing**

Identify the marking and locate the valve on the mounting bracket. Place the dial on the bracket and secure the valve tightly by screws and spring washers. Ensure that the dial is located properly.

Connect the pipe lines to its respective ports.

Charge the air pressure and carryout 'operating/air leakage tests' as given under 'Service check'.

**55.6.4 Dismantling**

Mark the position of the top cover assembly with respect to the valve body.

Remove the gaiter from its seating in the top cover.

Unscrew and remove the knob, sleeve, spring and gaiter from the lever.

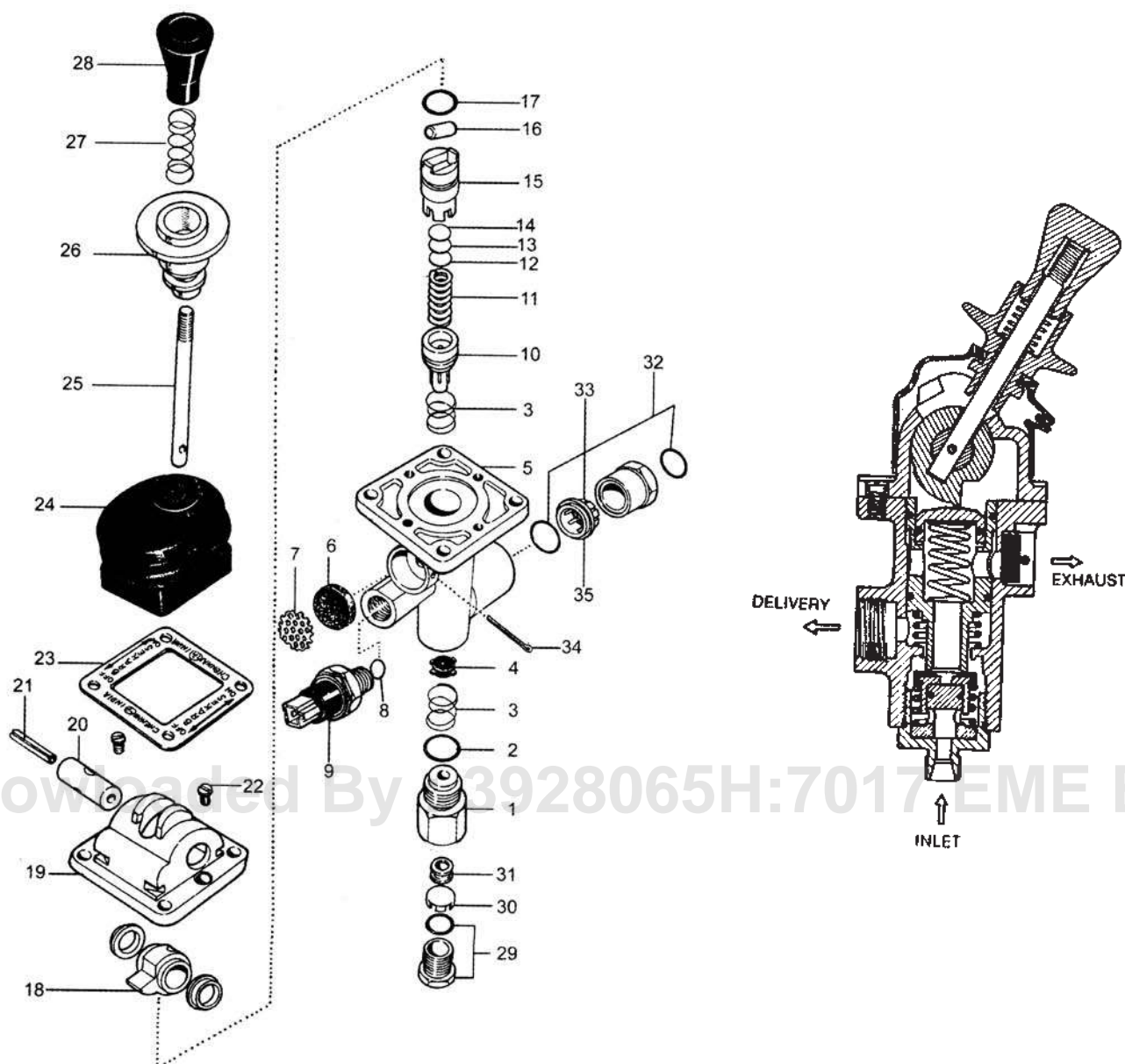
Unscrew and remove the counter sunk screws, top cover assembly and the plunger assembly with its return spring from the valve body.

Press out the tension pin and remove the lever, pivot pin and cam from the top cover.

Remove the cam follower, shims, support plate, graduating spring and 'O' rings from the plunger.

Unscrew and remove the inlet adaptor, spring and inlet/exhaust valve from the valve body. Retain the inlet adaptor and valve guide as a sub assembly.





Item	Description	Qty	Item	Description	Qty
1	Inlet adaptor	1	19	Top cover	1
2	Sealing ring	2	20	Pivot	1
3	Valve Spring	2	21	Tension pin	1
4	Valve	1	22	Slotted c'sunk head screw	2
5	Valve body	1	23	Dial	1
6	Filter	1	24	Gaiter	1
7	Strainer plate	1	25	lever	1
8	Washer	1	26	Sleeve	1
9	Low pressure indicator switch	1	27	Spring	1
10	Plunger	1	28	Knob	1
11	Spring	1	29	NG 8 male nut M 16x1.5 with 'O' ring	1
12	Shim	A/R	30	NG 8 retaining clip	1
13	Shim	A/R	31	NG 8 spring element	1
14	Shim	A/R	32	NG 12 male nut M 22x1.5 with 'O' ring	1
15	Cam follower	1	33	NG 12 retaining clip	1
16	Roller	1	34	Split pin	1
17	Sealing ring	1	35	Spring element	1
18	Cam	1			



Remove the split pin from the exhaust passage of the valve body and detach filter and strainer plate.

Scrap all the old parts for which the new parts are serviced in the repair kit.

#### 55.6.5 Cleaning and Inspection

Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during re-assembly.

Check the valve body, cover, inlet adaptor and plunger for excessive wear, nick/score marks, cracks and damages.

Check the cam and cam follower for excessive wear at the mating surfaces.

Check the springs for distortion, corrosion and permanent set.

Check the cover and the sleeve for excessive wear on its mating surfaces.

Check the cover for excessive wear on pivot pin bore and play of pivot pin in its bore.

Scrap all the old parts found to be unserviceable.

#### 55.6.6 Reassembly

Use recommended kit to replace the old parts scrapped during dismantling and also replace the parts found to be unserviceable during inspection by new ones.

Lubricate all the sliding parts and its mating surfaces with multipurpose grease. Which is supplied in the repair kit.

Install 'O' rings on the Plunger, Cam follower and the inlet adaptor.

Locate the spring, washer and inlet/exhaust valve on the valve guide of the inlet adaptor and screw into the inlet port of the valve body.

#### Plunger Sub Assembly

Place the graduating spring, support plate and shims into the plunger bore and insert the cam follower.

#### Top Cover Sub Assembly

Locate the cam in top cover, align the holes and insert the pivot pin.

Place the lever in the pivot pin, align the holes in the pivot pin and the lever and press in the tension pin into the pivot pin holes.

Locate the return spring on the top side of the plunger bore and then slide the plunger assembly into the valve body allowing the valve seat to enter first.

With the lever in brakes 'ON' position, identify the marking and locate the top cover on the plunger.

Press in the top cover and secure the cover with body by counter sunk screws.

Assemble the gaiter on its groove in the sleeve, slide the sleeve into the lever and assemble the other end of the gaiter on its groove in the top cover.

Place the spring in the sleeve and with a few drops of loctite 242 or its equivalent on the threaded portion of the lever, screw in the knob on the lever.

Locate the filter and the strainer plate on exhaust passage of the valve body and secure by a split pin and fold its ends.

### 55.7 RG2 RELAY VALVE



#### 55.7.0 Function

The RG2 Relay valve is primarily used to speed up the application and release of rear axle(s) brakes. The relay valve is an air operated, graduating directional control valve of high capacity and fast response. It operates on receipt of signal pressure from the service brake valve. The relay valve will graduate, hold and release air pressure from the brake chambers to which it is connected.

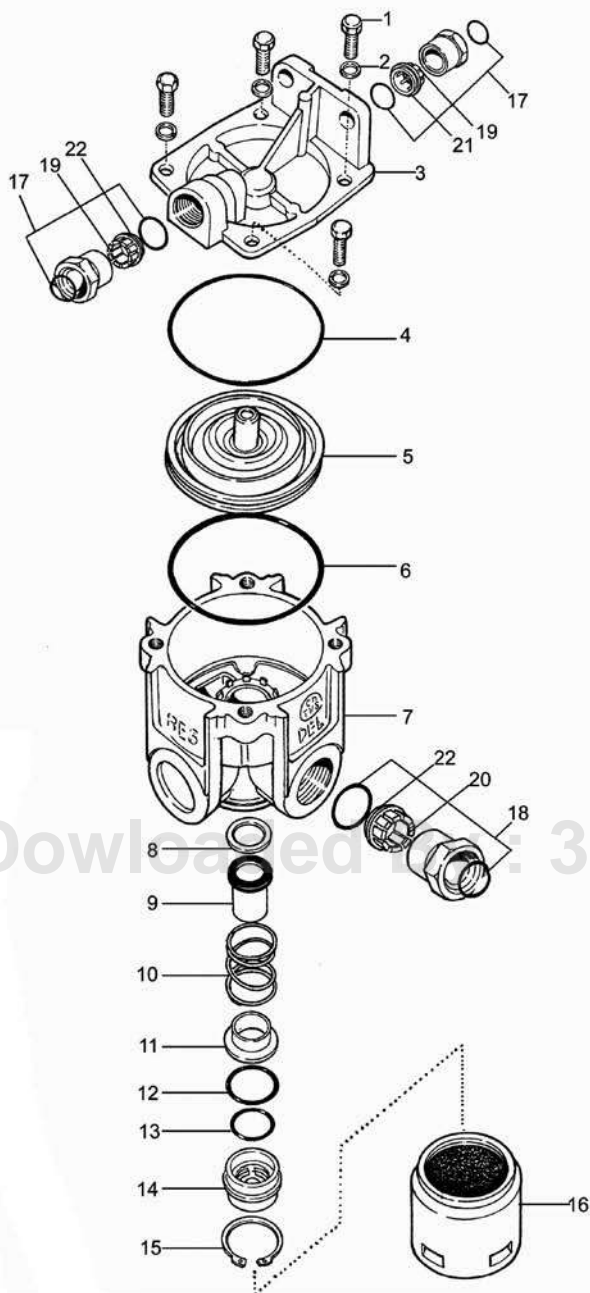
The relay valve is used to balance the time of brake applications on heavy duty vehicles. They are especially needed where large volumes of air required.

The Relay Valve is normally mounted at the rear of the vehicle. The top cover facilitates mounting of valve and provided with a service port. The valve body houses piston and top cover assembly. Valve body and base cover assembly houses the valve assembly. Valve body provides supply and delivery ports. A cross-section view of RG2 valve is shown in Annexure-A.

The RG2 Relay valve is available as 4 versions depending on thread sizes of supply and delivery ports and the orientation of the service ports.



## Operation



Item	Description	Qty
1	M 6x1 hex screw	4
2	Spring washer	4
3	Top cover	1
4	Sealing ring	1
5	Piston	1
6	Sealing ring	1
7	Lower body	1
8	Valve guide	1
9	Valve guide	1
10	Valve spring	
11	Spring retainer	1
12	Sealing ring	1
13	Sealing ring	1
14	'O' ring retainer	1
15	Internal circlip	1
16	Silencer assembly	1
17	NG12 male nut M 22 x 1.5 With 'O' ring	3
18	NG8 male nut M16 x 1.5 With 'O' ring	1
19	NG12 retaining clip	3
20	NG8 retaining clip	1
21	NG12 spring element	3
22	NG8 spring element	1

The following three states define the function of the valve.

### 1. Application :

The signal pressure from service brake valve enters the service port in the relay valve. Inlet / Exhaust valve in the R14 Valve opens the inlet passage and seals the exhaust passage. Air from the supply reservoir flows through delivery ports to the brake chambers or spring brake actuators and consequently applying the brakes. Air pressure in delivery ports will be in direct proportion to the signal pressure applied in the service port.

### 2. Balance :

The air pressure being delivered by the open inlet valve also is effective on the bottom area of the relay piston. When air pressure beneath the piston equals the service air pressure above, the piston lifts slightly and the inlet spring returns the inlet valve to its seat. The

exhaust remains closed as the service line pressure balances the delivery pressure. As delivery air pressure is changed, the valve reacts instantly to the change holding the brake application at that level.

### 3. Exhaust or Release:

When air pressure is released from the service port and air pressure in the cavity above the relay piston is exhausted, air pressure beneath piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted to exhaust through the exhaust port, releasing the brake.

#### 55.7.1 Service check

##### (a) Operating Test

- Charge the system to unloader valve cutout pressure.



- Apply and release the brakes several times and check for free/smooth movement of brake chamber push rod.

**(b) Leakage Test**

- Charge the system to unloader valve cutout pressure and stop the engine.
- Check for air leak on top cover joint, pipe adaptors and exhaust diaphragm by applying the soap solution. Air leak of a 25 mm soap bubble in not less than five seconds is permissible at pipe plugs or fittings and the exhaust.
- Apply the appropriate control valve and recheck for air leakage in the valve. Air leakage more than a 25 mm soap bubble in three seconds is not permissible.

**55.7.2 Removing**

1. Block the wheels to prevent the movement of the vehicle during working.
2. Drain the Reservoirs completely.
3. Brush away dirt / dust from the pipelines and the valve.
4. If the tractor is coupled with the trailer, close the shutoff cock fitted on the trailer Reservoir.
5. Disconnect the airlines and close the open ends of pipes to prevent dirt / dust entry.
6. Loosen the running nuts of the pipes and remove the valve from the mounting.

**55.7.3 Replacing**

1. Position the valve on the mounting bracket and secure tightly by the mounting screws with bolts.
2. Connect the pipelines and ensure adequate tightening of running nuts.
3. Open the shutoff cocks and carryout the 'Operating / Leakage tests as given under 'Service Check'.

**55.7.4 Dismantling**

1. Mark the position of top cover with the body to ensure correct positioning during reassembly.
2. Unscrew and remove the 4 screws with spring washers and remove the top cover and relay piston
3. Remove the sealing ring from the body and the relay piston.
4. Remove the silencer and circlip securing the base cover and the body.
5. Remove the O-rings retainer, sealing rings spring retainer, spring, valve and valve guide.
6. Scrap all the old parts, which are serviced in the Repair kit.

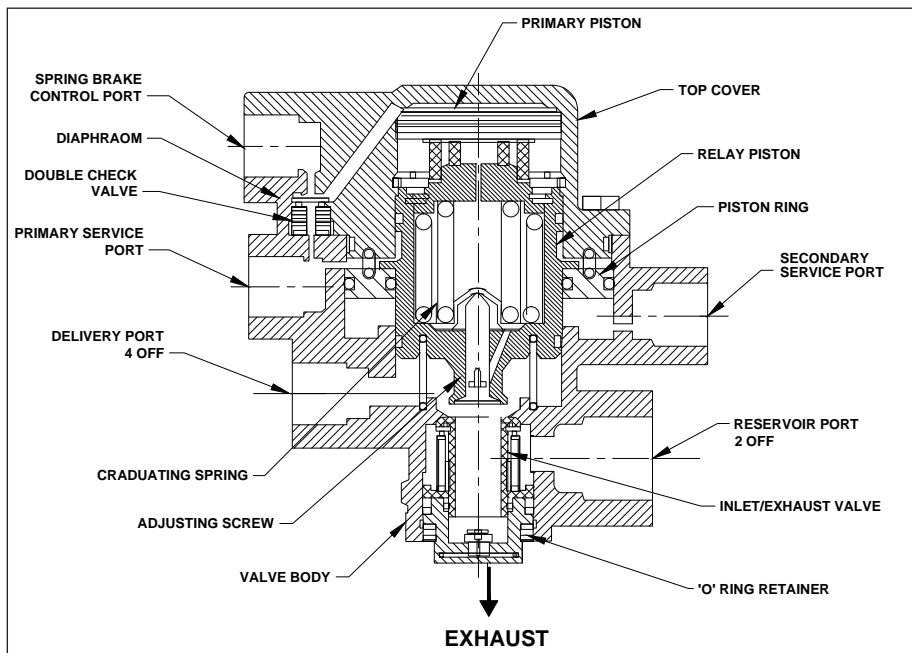
**55.7.5 Cleaning and inspection**

- Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.
- Check top cover, valve body and relay piston for excessive wear, nick / score marks, cracks and damages.
- Check the spring for distortion, corrosion and permanent set.
- Scrap all the old parts found to be unserviceable.

**55.7.6 Reassembly**

- Use recommended Repair kit to replace the old parts scrapped during dismantling and also the parts found to unserviceable during inspection by new ones.
  - Lubricate all the sliding parts and its mating components with the grease, which is supplied in the Repair kit.
  - Install the sealing rings on valve body, Relay piston and valve guide.
7. Assemble the o-ring retainer, sealing rings spring retainer, spring, valve and valve guide. Finally assemble the silencer using small press.

## 55.8 INVERSION RELAY VALVE (IR 2)

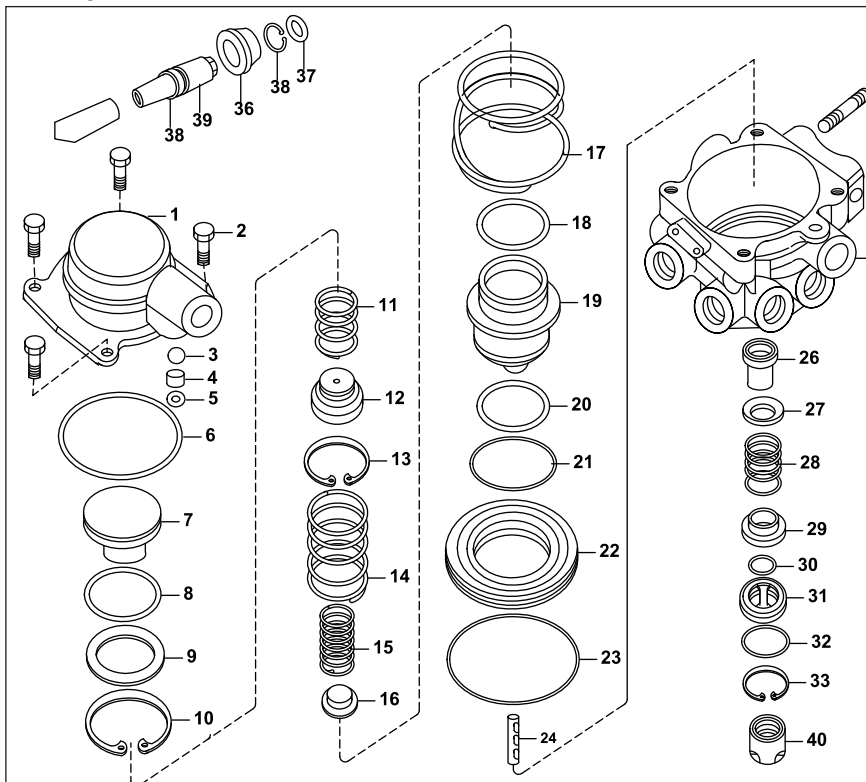


## 55.8.0 Function

The inversion valve along with the double check valve and relay valve is primarily used in trucks or tractors equipped with spring brakes. The combination of these valves is used in dual air brake system to perform the following four functions:

1. During normal operation this valve permits a particular value of hold-off pressure to the spring brakes thereby keeping it released. This hold-off pressure can be varied from 4 bar to 7 bar.
2. During parking of the vehicle, this valve quickly exhausts air from the spring brakes thereby allowing a fast application of the spring brakes
3. Prevents compounding of service brake and spring brake
4. Modulates application of spring brakes in the event of a failure in the primary service circuit

## Description

			Item	Description	Qty
			1	Top Cover	1
			2	Screw	1
			3	Diaphragm	1
			4	Valve Seat	1
			7	Primary Piston	1
			9	Spacer	1
			10	Internal Circlip	1
			12	Spring Retainer	1
			13	Internal Circlip	1
			16	Spring Guide	1
			18	'O' Ring	1
			19	Relay Piston	1
			22	Ring Piston	1
			24	Pressure Setting Screw	1
			25	Valve Body	1
			26	Valve	1
			27	Valve Guide	1
			29	Spring Retainer	1
			31	'O' Ring Retainer	1
			33	Circlip	1
			34	Mounting Stud	1
			35	Sealing Ring NG12	1
			36	Spring Element NG12	1
			37	Retaining Clip NG12	1
			38	Sealing Ring NG12	1
			39	Sealing Ring NG12	1
			40	Silencer	1
			5, 6, 8, 20, 21, 23, 30, 32 'O' Ring		9
			11, 14, 15, 17, 28 Spring		5



The major components of the SCL inversion valve are the valve body, top cover, primary piston, relay piston, an integrated double check valve, inlet/exhaust valve and graduating spring

This valve has five modes of operation and they are detailed below:

### 1. Spring brakes released

When the system is being charged, air pressure enters the supply port and is present in the cavity beneath the inlet/exhaust valve. The inlet/exhaust valve is in contact with the inlet valve seat in the body thus preventing passage of air to delivery as well as through the exhaust. When the full system pressure is reached, the 'park control valve' can be operated to release the spring brakes. The park control valve is a manually operated on/off valve. Shifting the park control valve to the 'on' condition ensures continuous supply of air pressure at the spring brake control port of the inversion valve. Pressurised air at the spring brake control port then enters the double check valve, deflects the diaphragm, and flows into the cavity on top of the primary piston through the cross-hole provided in the top cover. This air pressure forces the primary piston to move downward and contact the relay piston. The relay piston then moves downward and contacts the inlet/exhaust valve. Further movement of the relay piston opens the inlet passage thereby allowing air to flow from the supply port to the delivery ports. Consequently the spring brakes are released. At the same time the exhaust valve seat in the relay piston prevents loss of air through exhaust.

### Balanced Condition

The limiting value of the hold-off pressure (or pressure at the delivery ports) to the spring brakes can be varied between 4 bar and 7 bar by changing the spring load on the relay piston with the help of the adjustment screw. The air pressure that is communicated to the delivery ports also acts on the underside of the relay piston. When the airhead load on the relay piston equals the load exerted by the graduating spring, the valve is in the 'balanced' condition. In this condition the inlet valve seat and the exhaust valve seat are in the same plane thereby preventing further flow of air to delivery ports and at the same time preventing loss of air through exhaust.

### 2. Spring brakes applied

The park control valve is switched to the 'off' position' to apply the parking brakes. Consequently, air pressure at the spring brake control port and on top of the primary piston is exhausted through the park control valve. The primary piston then moves upward. Airhead load beneath the relay piston forces it to move upward thereby opening the exhaust passage and sealing the inlet. Air from the delivery ports is then exhausted thereby applying the spring brakes

### 3. Simultaneous application of service brakes and spring brakes applied (Anti-compounding)

Application of service brakes provides air pressure at the primary service port P1 and secondary service port P2. There is no air pressure in the spring brake control port since the spring brakes are applied. Air entering the service port P1 deflects the diaphragm in the double check valve and seals the passage in the spring brake control port. Air then flows through the cross-hole provided in the top cover to the top of the primary piston. This air pressure forces the primary piston to move downward and contact the relay piston. The relay piston then moves downward and contacts the inlet/exhaust valve. Further movement of the relay piston opens the inlet passage thereby allowing air to flow from the supply port to the delivery ports. Consequently the spring brakes are released thereby preventing the compounding of the service brake and the parking brake

### 4. Application of spring brakes with primary in failed condition (Modulated application)

In the event of failure in the primary circuit, air pressure, upon application of service brakes will be available only in the secondary service port P2. However, air pressure will be available at the spring brake control port and consequently the delivery ports thereby keeping the spring brakes released. Air that enters the valve through the secondary service port P2 acts beneath the relay piston and forces the piston to move upward thereby exhausting air from the delivery ports and applying the spring brakes. The air released from the spring brakes will be proportional to the pressure at secondary service port P2 thus providing the driver with a modulated application of the spring brakes.

Assembly retained by a bracket on the upper bore of the valve body. The Inlet / exhaust valve assembly is secured by an inlet nut in the bottom of the valve body. The graduating spring pre-loaded by the adjusting screw to the required setting, acting on the (reaction) plunger which controls the opening of inlet/exhaust valve.

The exhaust passage is fitted with exhaust check or spout to prevent entry of dirt/ dust.

#### 55.8.1 Service checks

- Check for air leak from assembly and pipe joints. Check for air leakage through the exhaust passage by applying soap solution. Air leak of 25mm bubble in 5 seconds is permissible.
- Excessive air leak if noticed the valve needs to be serviced.
- Check for correctness of delivery pressure. Fix a pressure gauge in the delivery line to check and adjust the recommended pressure.

#### 55.8.2 Removing

- Block the wheels to prevent movement of the vehicle during working.
- Brush away dust/dirt from the air line connections and valve.





- Deplete the air pressure in all the lines.
- Disconnect the inlet/delivery pipelines and close the open ends of the pipes to prevent dust/dirt entry.
- Loosen the mounting bolts and remove the assembly from the vehicle.

### 55.8.3 Replacing

- Locate the valve on its mountings and secure tightly.
- Connect the pipelines to their respective ports.
- Charge the system and carry out 'Operating / air leakage tests' as given under 'Service Check'.

### 55.8.4 Dismantling

- Clean the exterior of the component.
- Loosen and remove the bolt (2)
- Remove the top cover assembly (1). Remove O-ring (6) from Top cover.
- Remove primary piston (7) and Spacer (9).
- Remove O-ring (8) from primary piston (7).
- Remove relay piston assembly and ring piston (21).
- Loosen and remove circlip (13) from relay piston (19).
- Remove O-ring (18 & 20) from relay piston & ring piston (21).
- Unscrew and remove pressure setting screw (24) from relay piston (19)
- Remove spring (11). Loosen and remove circlip (10) from valve body (25).
- Loosen and remove spring retainer (29) & O-ring retainer (31).
- Remove O-ring (30 & 32) from O-ring retainer. Remove spring
- Remove valve (26) and valve guide (27).

### 55.8.5 Cleaning and inspection

- Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during re-assembly.
- Ensure that the metering hole is free from blockage in Top cover (2).
- Check the valve body & top cover for thread/port face damage.
- Check the valve body, valve seat and plunger for excessive wear, nick/score marks, cracks and damages.

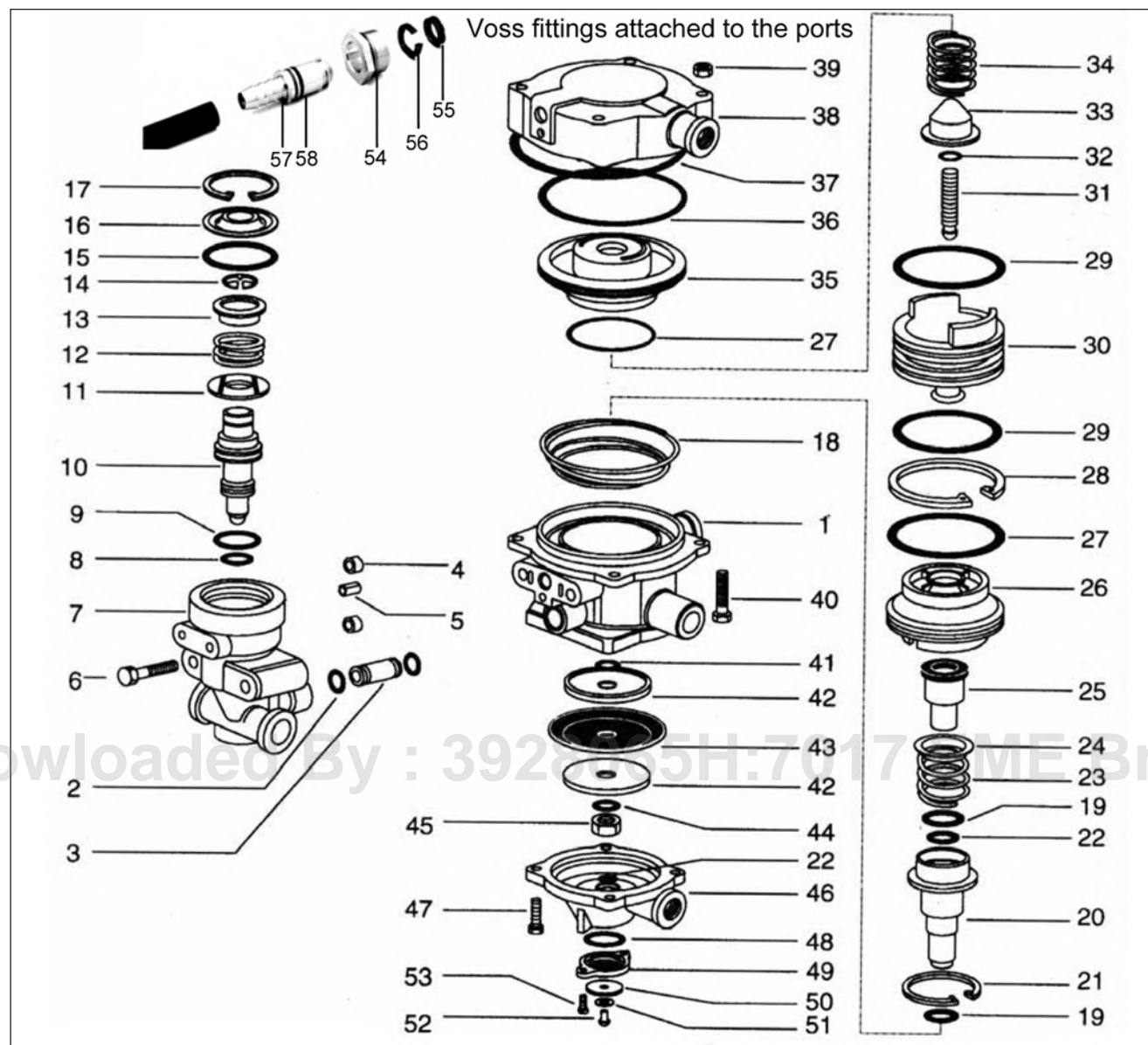
- Check the springs for distortion, corrosion and permanent set.
- Scrap all the old parts which are found unserviceable.

### 55.8.6 Reassembly

- Use recommended Repair kit to replace the parts scrapped during dismantling and in addition replace all parts which were found unserviceable / defective during cleaning and inspection.
- Lubricate all the sliding parts and their mating surfaces with Silicon grease, which is supplied in the Repair kit.
- Assemble sealing rings on respective grooves of the pistons & spacers.
- Place the valve guide (27) over the valve (26) and place it in the body.
- Position the O-rings (30 & 32) in the groove of O-ring retainer (31)
- Place the spring (28) over the bonded valve and then place the O-ring retainer on the spring.
- Secure the O-ring retainer, spring and the valve body in the body with the circlip (33)
- Press the Exhaust flap (31) on to the bottom of the O-ring retainer (29)
- Install O-ring (18 & 20) to the relay piston(19) and ring piston (21)
- Screw the pressure setting screw (24) to the relay piston(19)
- Place the spring (14 & 15) & spring guide (16) in the relay piston.
- Place the spring (11) on the valve body.
- Place relay piston assembly over the spring.
- Secure tightly the springs inside the relay piston using circlip (13).
- Place spring retainer (12) on the relay piston.
- Place spring (17) on the valve body.
- Install O-ring (8) to primary piston (7) and assemble diaphragm (3), Valve seat (4) and O-ring (5).
- Position the Primary piston (7) & spacer (9) inside top cover. Secure tightly using circlip (10).
- Place O-ring (6) between Top cover (1) and valve body (25) secure tightly with bolt (2).

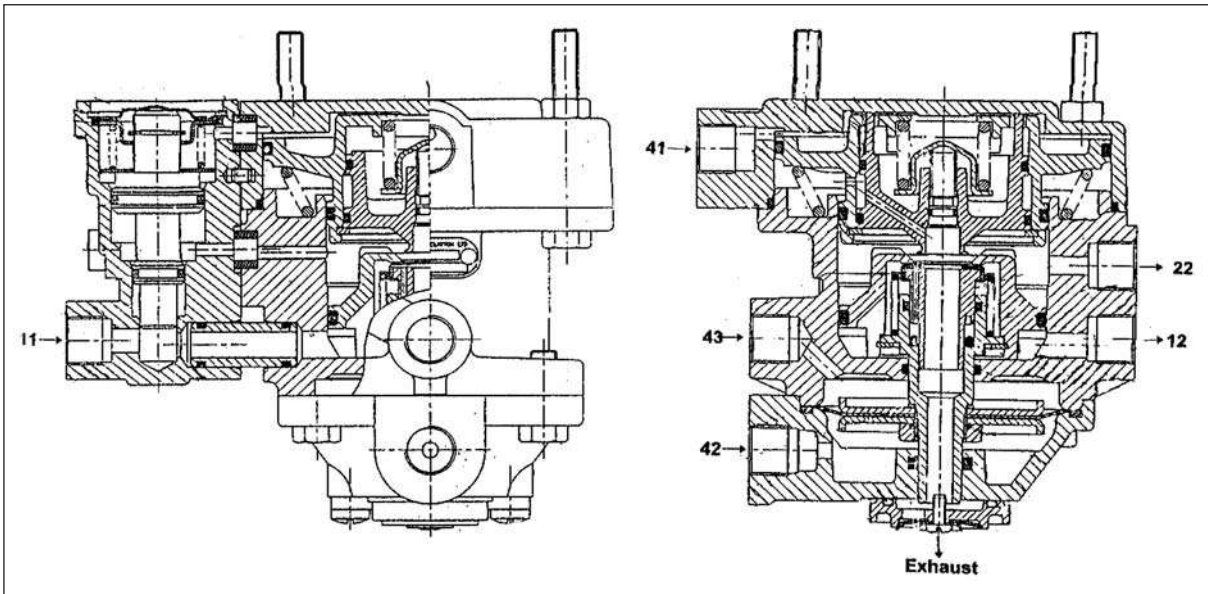


## 55.9 TRAILER CONTROL VALVE



Item	Description	Qty	Item	Description	Qty	Item	Description	Qty
1	Body - middle part	1	20	Piston	1	41	Sealing washer	1
2	Sealing ring	2	21	Retaining ring	1	42	Retaining plate	2
3	Spacer	1	22	Sealing ring	2	43	Diaphragm	1
4	Sealing ring	2	23	Compression spring	1	44	Sealing ring	1
5	Spring dowel sleeve	1	24	Spring guide	1	45	Flat hex. Nut	1
6	Hexagon head screw	2	25	Valve	1	46	Body - lower part	1
	Direction control valve	1	26	Piston	1	47	Hex. Head screw	4
7	Body	1	27	Sealing ring	2	48	Sealing ring	1
8	Sealing ring	1	28	Retaining ring	1		Venting guide assembly	1
9	Sealing ring	1	29	Sealing ring	2	49	Venting guide	1
10	Piston	1	30	Piston	1	50	Washer	1
11	Washer	1	31	Adjusting screw assembly	1	51	Cap	1
12	Compression spring	1	32	Sealing ring	1	52	Self tapping screw	1
13	Cap	1	33	Spring guide	1	53	Fillister head screw	2
14	Retaining ring	1	34	Compression spring	1	54	Sealing ring NG12	1
15	Sealing ring	1	35	Piston	1	55	Spring element NG12	1
16	Cover	1	36	Sealing ring	1	56	Retaining clip NG12	1
17	Internal circlip	1	37	Sealing ring	1	57	Sealing ring NG12	1
18	Conical spring	1	38	Body - upper part	1	58	Sealing ring NG12	1
19	Sealing ring	1	39	Hexagon nut	4			
			40	Hexagon head screw	4			





### 55.9.0 Function

This valve controls twin line brake system on a trailer from the towing vehicle fitted with Dual Brake System and the Hand brake valve for Spring brake actuators.

In addition, this valve also helps to apply the brakes automatically in the trailer when service brakes are applied on the tractor by exhausting the supply line (12) in the event of failure in the service line (22).

### Description

Trailer control valve mainly consists of a Direction control valve and a trailer control valve.

Direction control valve has a valve body housing a piston assembly in the top bore with a spring and cover and secured in position by a circlip. This valve has an inlet, a passage for connecting the inlet to the trailer control valve and two more passages in which one to chamber connecting to service line (22) and the other to chamber connecting to Primary delivery line (41). This valve is secured onto the middle body of the trailer control valve.

Trailer control valve has a Upper body, a middle body and a Lower body.

Between the upper and the middle body a relay piston assembly with a return spring is located. The relay piston assembly has another piston with a spring, a spring guide and an adjusting screw in the bore and secured by a circlip.

In the middle body top bore and below relay piston assembly an emergency plunger assembly is located. The emergency plunger assembly has a spring loaded valve and a piston located in the bottom side and secured in position by a circlip. A diaphragm with upper and lower follower is located on the other side of the piston and secured by a flat hexagon nut. The outer lip of the diaphragm is located between the middle and the lower body. The free end of the piston is guided in the bore of the lower body and an exhaust check arrangement is secured to the lower body.

The upper body has a port (41) connecting to primary delivery line from Dual brake valve and a passage connecting to Direction control valve.

The middle body has a passage connecting to the inlet (1) from Direction control valve, supply port (12) and Service port (22) connecting to trailer, port (43) connecting to the delivery line of Graduated hand control valve and a passage connecting to Direction control valve.

The lower body has a port (42) connecting to the secondary delivery line from Dual brake valve.

### 55.9.1 Operation

#### Charging (air supply to trailer & brakes off position)

- When the braking system is charged, the air supply enters through port 11 of the Direction control valve and acts at bottom of the piston pushing it to the upper stop against the spring force.
- The air supply goes to the supply line through the chamber connecting to port 12.
- If the tractor is coupled to the trailer, the trailer Reservoir is getting charged through the Relay emergency valve fitted on the trailer.
- In this process, air pressure acting below the emergency plunger moves it along with the valve upwards and the valve comes into contact with the piston closing the exhaust passage and subsequently opening the inlet passage, allowing the air supply to service line through the chamber connecting to port 22. This leads to brake application in the trailer.

The brakes are applied both in tractor and trailer as long as the Graduated hand control valve is in "BRAKES ON" position

- When the hand brake is released (i.e. Graduated hand control valve in "BRAKES OFF" position) air is supplied to chamber through port 43.



- Air pressure in the chamber acting on the upper side of the diaphragm pushes the piston downwards along with the emergency plunger. This leads to closing of inlet passage and subsequent opening of exhaust passage allowing the exhaust of air from the service line connecting port 22 ; thereby releasing the brakes in the trailer.
- At the same time, the spring brakes in the tractor are also getting released by air supply through Graduated hand control valve.

**Brakes on position (brakes applied)**

When the Dual brake valve on the tractor is operated, air from the primary delivery enters port 41 and the secondary delivery port 42.

**- Primary**

1. Chambers connecting to port 41 are charged and the air pressure acts on the relay piston (35), piston (30) and piston (10).
2. Pistons (30 & 35) move downwards together.
3. When the piston (30) contacts the valve (25) , it closes the exhaust passage and subsequently opens the inlet.
4. Air from the chamber connecting to port 12 then flows into the trailer service line through chamber connecting to port 22.
5. Brakes fully applied
  - 5.1 In brakes fully applied condition, air pressure in the delivery line of Dual brake valve primary connecting to port 41 acting above the piston (35) predominates and inlet remains open.
6. Brakes partially applied (Predominance)
  - 6.1 In brakes partially applied condition, air pressure in the chamber connecting to port 22 depends on the pressure acting on the relay piston (35) and the preload of the spring (34).
  - 6.2 The preload of the spring (34) can be adjusted by the screw (31).
  - 6.3 The preload of the spring is set to ensure that the outlet pressure in port 22 is higher by  $0.5 \pm 0.2$  bar as compared to pressure at port 41.
  - 6.4 The operation sequence from 1 to 4 continues and the air pressure acting below the relay piston (35) and piston (30) in chamber connecting to port 22 when exceeds  $0.5 \pm 0.2$  bar as compared to the pressure in chamber connecting to port 41, the piston (30) alone moves upwards overcoming the preload of spring (34) and closes the inlet preventing further charging of chamber connecting to port 22.

This is the predominance position.

**- Secondary**

1. At the same time as air enters port 41, air from secondary delivery of Dual brake valve also enters chamber connecting to port 42 and acts below diaphragm (43).

2. However, the pressure in chambers connecting to port 22 and port 43 acting above the emergency piston (26) and diaphragm (43) respectively is greater and the position of the piston is unaltered.
3. If brakes are partially applied, the pressure that builds in chamber connecting to port 22 again forces emergency piston (26) downwards. Thus the inlet passage closes and a balanced condition is reached.

**Brakes released position**

- In brakes released position, air from Chambers connecting to port 41 and port 42 is depleted through Dual brake valve.
- Simultaneously, air in chamber connecting to port 22 acting on the bottom of the relay piston (35) and piston (30) moves together up and air in chamber connecting to port 43 also acting on the diaphragm (43) pushes the emergency piston assembly downwards.
- This leads to opening of exhaust passage and exhausting the air from chamber connecting to port 22 ; thus automatically releases the brakes in the trailer.

**Hand brake application**

- When the Graduated hand control valve is in "BRAKES ON" position, air from the chamber connecting to port 43 and also hand brake line of Spring brake actuators is depleted through Graduated hand control valve.
- Automatically the relay piston assembly is pushed up by the air pressure in chamber connecting to port 12 and in-turn the valve (25) gets into contact with piston (30) closing the exhaust passage and subsequently opening the inlet passage, allowing the flow of air into chamber connecting to port 22. (i.e. air is supplied to service line of the trailer)
- This leads to automatic emergency brake application in the trailer.

The brakes are applied both in tractor and trailer as long as the Graduated hand control valve is in "BRAKES ON" position

**Primary Failed**

- When brake is applied on the tractor, air is supplied to port 42 and its chamber.
- Air pressure in the chamber acts below the diaphragm (43) and pushes the emergency piston assembly upwards; thereby the valve (25) comes into contact with piston (30) closing the exhaust passage and subsequently opening the inlet passage allowing air supply into chamber connecting to port 22.(i.e. into the service line of the trailer)
- This leads to brake application in the trailer.

If the primary of the Dual brake valve fails, operation of the valve is controlled by air from secondary. In this case, the operation of the valve is without predominance.

**Secondary failed**

- When the brake is applied on the tractor, air is supplied to port 41 and its chamber.
- Air pressure in chamber acts on relay piston (35) and piston (30) pushes the pistons together downwards, thereby the piston (30) comes into contact with the valve (25) closing the exhaust passage and subsequently opening the inlet passage, allowing air supply into chamber connecting to port 22. (i.e. into the service line of the trailer)
- This leads to brake application in the trailer.

If the secondary of the Dual brake valve fails, operation of the valve is controlled by air from primary. In this case, the operation of the valve is with predominance.

**Service line of trailer failed**

- In a running vehicle if the service line of trailer breaks from port 22, no air pressure builds up in chamber connecting to port 22 when the service brake on the tractor is applied.
- The piston (10) is then pushed downwards by the air pressure in chamber connecting to port 41 and the flow of air supply from port 11 to port 12 is metered (reduced) by reducing the flow passage from 8 mm dia to 2 mm dia.

This is the Dumping operation.

- At the same time, air pressure in the chamber connecting to port 41 pushes the relay piston (35) and piston (30) together downwards and simultaneously pressure in chamber connecting to port 42 acting on the bottom of the diaphragm (43) pushes the emergency piston assembly upwards.
- Thus the valve (25) comes into contact with piston (30) closing the exhaust passage and subsequently opening the inlet passage.
- This helps to deplete air from chamber connecting to port 12 and the supply line of trailer through the point at which the service line failed, resulting in automatic emergency brake application in the trailer. The pressure in the supply line of the trailer (port 12) comes down to 1.5 bar in less than 2 seconds.

**55.9.2 Service check****a) Operating Test**

- Connect the trailer and charge the system fully. Keep the hand brake valve in 'BRAKES ON' position and check for brake application in tractor and trailer.
- Release the hand brake by shifting the lever to 'BRAKES OFF' position and check for complete release of brakes both in tractor and trailer.

- Apply the service brakes on the tractor fully and check for brake application on the tractor and the trailer.
- Apply the service brakes on the tractor partially and check for the delivery pressure in port 22 and pressure at port 41 by connecting gauges. The pressure at port 22 should be higher by  $0.5 \pm 0.2$  bar as compared to pressure at port 41.
- Deplete secondary reservoir in the tractor and apply the service brakes and check for brake application on rear axle of the tractor and on the trailer.
- Charge the system fully and deplete primary reservoir in the tractor and apply the service brakes and check for brake application on front axle of the tractor and on the trailer.
- Charge the system fully keeping the hand brake valve in 'BRAKES ON' position. Gradually shift the lever to 'BRAKES OFF' position and with gauges in port 43 & port 22. Pressure in port 22 will start dropping gradually as pressure in port 43 increases above 0.5 bar onwards.
- Charge the system fully keeping the hand brake knob in 'BRAKES OFF' position. Gradually shift the lever to 'BRAKES ON' position and with gauges in port 43 & port 22. Pressure in port 22 will start increasing gradually as pressure in port 43 drops below 6.6 bar.

Prior to the above two tests, charge the system fully and keep the hand brake knob in 'BRAKES OFF' position with gauges connected to inlet and delivery. Inlet and delivery gauge pressure should be the same. If required overhaul the unit to achieve.

- Connect gauges in supply line of trailer connecting to port 12 and port 11. Charge the system fully and disconnect port 22. Apply the service brakes on the tractor and note that the pressure in supply line of the trailer connecting to port 12 comes down to 1.5 bar in less than 2 seconds. Simultaneously check for automatic brake application on the trailer. In this process, the pressure differential between port 41 and port 22 when reaches  $2.5 + 0.3/-0.5$  bar, the Direction control valve throttle the flow passage reducing flow area and thereby air flow from port 11 to port 12 is minimised. In this condition, the pressure at port 11 is 5.5 bar.

**b) Leakage Test**

- Charge the system fully and ensure that the pipe lines and joints are free from air leakage. Keep the knob of the Graduated Hand Control valve in 'BRAKES OFF' position and proceed with the tests.
- Check for air leakage in exhaust passage and joints of the valve by applying soap solution. Air leakage of 25 mm soap bubble in 5 seconds is permissible.





- Apply the service brakes on the tractor fully. Check for air leakage in exhaust passage by applying soap solution. Air leakage of 25 mm soap bubble in 3 seconds is permissible.
- Graduated Hand Control Valve in 'BRAKES ON' position, check for air leak in the exhaust passage of Graduated Hand Control valve. If excessive air leakage is noticed, then disconnect port 43 and check for air leakage once again to ascertain the leak is due to Trailer control valve.

**55.9.3 Removing**

- Block the wheels to prevent movement of the vehicle during working.
- Brush away dirt / dust from the pipe lines and the assembly.
- Disconnect the pipes lines and close open ends to prevent dust / dirt entry. Identify the pipe connections.
- Loosen the mounting screws and remove the assembly from the mounting bracket.

**55.9.4 Replacing**

- Locate the assembly on its mounting bracket and secure tightly by mounting screws.
- Connect pipe lines to its respective ports as identified during removal.
- Build up air pressure in the system . Apply soap solution at pipe joints and end fittings and attend if required.
- Carryout the ' Operating / Leakage tests' as given under 'Service Check'.

**55.9.5 Dismantling**

1. Clean the exterior of the valve thoroughly.
2. Mark the position of bodies to facilitate reassembly.
3. Remove internal circlip (17) from the body (7).
4. Remove the cover (16) and sealing ring (15) from the body (7).
5. Remove retaining ring (14) from piston (10) and remove cap (13), compression spring (12) and washer (11) from piston (10).
6. Remove piston (10) from body (7).
7. Remove sealing rings (8 & 9) from piston (10).
8. Unscrew Hex head screws (6) and remove the body (7) from middle body (1).
9. Pull out the spacer (3) along with the sealing rings (2) from body (7) .
10. Remove sealing rings (4) from middle body (1).

11. Unscrew Hex nuts (39) and remove upper body (38) from middle body (1).
12. Remove conical spring (18) and sealing ring (38) from middle body (1).
13. Remove sealing ring (27) from piston (35) .
14. Unscrew adjusting screw (31) out from piston (30).
15. Remove sealing ring (32) from adjusting screw (31).
16. Remove retaining ring (28), piston (30), spring guide (33), spring (34) from piston (30).
17. Remove sealing ring (29) from piston (30).
18. Remove piston (35) from upper body (38).
19. Remove sealing ring (36) from piston (35) .
20. Unscrew Hex head screws (47) and remove lower body (46) from middle body (1).
21. Remove sealing ring (48) from lower body (46) .
22. Unscrew flat hex nut (45) and remove sealing ring (44) from piston (20).
23. Remove retaining plate (42), diaphragm (43) and sealing ring (41) from piston (20) .
24. Push out piston (20) from middle body and remove sealing ring (19) from middle body (1).
25. Remove the second sealing ring (27) from piston (26) .
26. Remove retaining ring (21) and piston (20) from piston (26) .
27. Remove compression spring (23) , spring guide (24) and valve (25) from piston (26).
28. Loosen and remove the screws (52) securing venting guide assembly.
29. Loosen and remove the self tapping screw (53) from venting guide (49) and takeout the cap (51) and rubber washer (50)

**55.9.6 Cleaning and inspection**

- Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.
- Thoroughly clean all the bodies and make sure that the air passages are free from blockage.
- Check for any crack / damage in the bodies, damage on port faces / thread, nick / score marks / damages on the valve seats, excessive wear / score marks / damage on the pistons.
- Check the springs for distortion, rust formation and permanent set .
- Scrap all old parts which are found to be unserviceable.

**55.9.7 Re assembly**

- Use recommended Repair kit to replace old parts scrapped during dismantling and also replace all parts which were found to be unserviceable parts during inspection.
- Smear grease (supplied in the repair kit) in the body bores, piston grooves, pistons and on the sealing rings.
- Assemble the sealing rings on the respective grooves of the pistons and bodies.
- Emergency piston assembly. Locate the valve (25), spring guide (24), spring (23) and piston assembly (20) in piston (26) and secure by retaining ring (21) in the groove of the piston (26). Ensure that the retaining ring (21) is located in its groove properly.
- Insert the above piston assembly in the middle body (1) upper bore and the piston (20) comes out in the bottom of the middle body (1).
- Locate the top retaining plate (42), diaphragm (43) and bottom retaining plate (42) in the protruding end of piston (20) and secure by flat hexagon nut (45) along with sealing ring (44) and tighten to a torque of 7 to 10 Nm.
- Locate the piston (20) in the lower body (46) centre bore and check for proper orientation of lower body (46) with middle body (1) as identified during dismantling.
- Locate outer lip of the diaphragm (43) between lower body (46) and middle body (1).
- Secure both the bodies by 4 hexagon head screws and tighten to a torque of 15 Nm.
- Place the rubber washer (50) and cap (51) on the bottom side of the venting guide (49) and secure tightly by self tapping screw (52).
- Locate the venting guide assembly in the bottom face of the lower body and secure by two fillister head screws and tighten to a torque of 4 Nm.

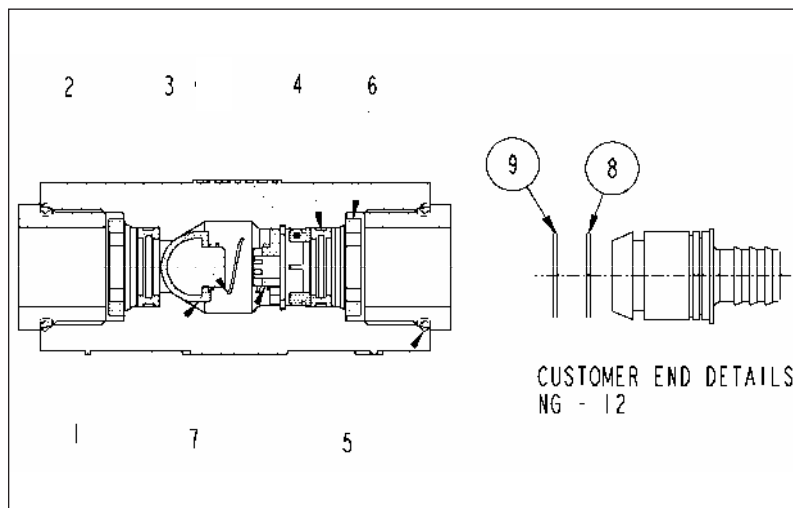
**Relay piston assembly**

- a) Locate the spring (34) and spring guide (33) in the bottom side of the piston (35) and slide the piston (30) and secure by retaining ring (28) in the groove of the piston (35). Ensure that the retaining ring is located in its groove properly.
- b) With sealing ring (32) on the adjusting screw (31) screw in the adjusting screw in the bottom bore of the piston (30) adequately so that the predominance of  $0.5 \pm 0.2$  bar will be achieved during service check. During testing if the predominance set is found to be incorrect once again resetting needs to be done.

- Insert the above piston assembly in the upper body (38) bore.
- Locate the conical spring (18) on the middle body (1).
- Position the upper body (38) on middle body (1) by locating through the four hexagon head screw and check for proper orientation of upper and middle body. Secure both the bodies by four hexagon nuts and tighten to a torque of 15 Nm.

**Direction control valve**

- c) Locate washer (11), compression spring (12) and cap (13) on the piston (10) and secure by retaining ring (14). Ensure that the retaining ring is located in the groove of the piston (10) properly.
- d) Insert the above piston assembly in the bore of body (7) Locate the sealing ring (15) and cover (16) over the piston assembly and secure by internal circlip (17). Ensure that the circlip is located in its groove properly.
- Assemble the sealing rings (2) on the spacer (3).
- Locate spring dowel sleeve (5) and sealing ring (4) in upper body (38).
- Locate the spacer (3) and sealing ring (4) in the middle body.
- Locate the above directional control valve in the corresponding location of spacer and sealing rings and secure by two hexagon head screws and tighten to a torque of 15 Nm.

**55.9.8 NON RETURN VALVE**

Item	Description	Qty
1	Bonded valve	1
2	Conical Spring	1
3	Insert	1
4	Seal	2
5	Sealing Ring	2
6	Retainer	2
7	Valve Stop and spring retainer	1
8	Sealing Ring NG-12	2
9	Sealing Ring NG-12	2

The purpose of the Non-Return Valve in the system is to ensure an unidirectional flow of air from Compressor to the Reservoir.

The Non-return Valve consist of a rubber half-ball valve retained in position by a conical spring on a replaceable valve seat in the body, on the other end of the body an adaptor is screwed in to retain the spring the and the spring guide in position.

**55.9.8.0 Operation**

The air from the Compressor pushes open the half-ball valve against the spring and enters in to the Reservoir. Any return air from the Reservoir will press the valve against its seat, this preventing the flow of air in the opposite direction.

**55.9.8.1 Service check and inspection**

Stop the engine and disconnect the inlet pipe of the Non-Return valve. Check for leak at the inlet with soap suds. In case of leak, release all air pressure from the reservoir and remove the Non-return valve strip open the valve, inspect the parts and check the condition of the half-ball valve. If worn or damaged, replace with a new valve.

**55.9.8.2 Cleaning and reassembly**

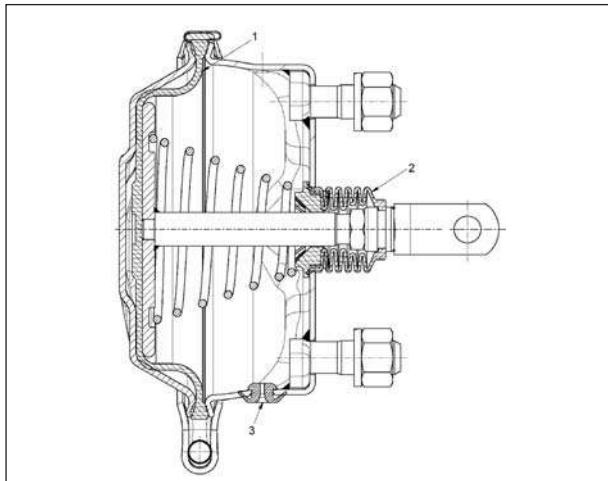
Clean all metal parts in cleaning solvent and blow dry with compressed air. Wipe the rubber cloth. Reposition the valve seat in the body, with thin washer at the bottom and the thick washer at the top of the valve seat. Replace the half-ball valve with its spring and guide on the valve seat. Screw in the adaptor.

**55.9.8.3 Testing of re-built valve**

Connect the outlet of the Non-Return valve to an air supply and check for any leak at 100 lbs/sq.in. (0.75 Kg/sq.cm) and at 103.0 lbs/sq.in (7.0 Kgm. sq. cm) with soap suds.



## 55.10 FRONT BRAKE CHAMBER



### 55.10.0 Function

The function of the Brake chamber is to convert the energy of compressed air into mechanical force and motion necessary to operate the brakes.

### Description

The Brake chamber consists of a sheet metal pressure plate and non-pressure plate housing the diaphragm and return spring and push plate assembly. When air pressure is applied to the brake chamber the diaphragm is flexed and the force is transmitted to the brakes through the push plate assembly to the through the slack adjuster to the brake cam shaft.

### 55.10.1 Service checks

#### a) Operating tests

- Apply brakes and observe that push rods move out promptly without binding.
- Release brake and observe that push rod returns to release position promptly without binding.

#### b) Leakage tests

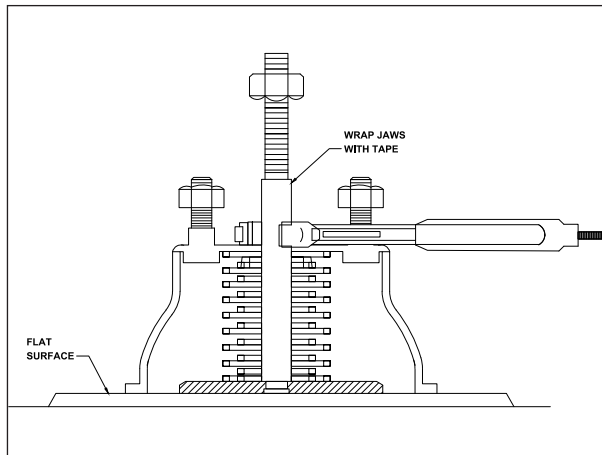
- Apply the brakes fully and hold. Check for leak through the diaphragm joint by applying soap solution on the breather holes in the non-pressure plate. No leak is permitted.

### 55.10.2 Removing

- Block the wheels to prevent movement of the vehicle during working.
- Note the angle of the slack adjuster relative to the brake chamber push rod to ensure correct positioning of the slack adjuster while replacing the unit.
- Remove the split pins from the fork pin and remove the fork pin.
- Loosen the mounting nuts and remove the brake chamber.

### 55.10.3 Replacing

- Position the brake chamber on its mounting bracket.
- Assemble the spring washers and the mounting nuts and tighten to a torque of 5 kgm.



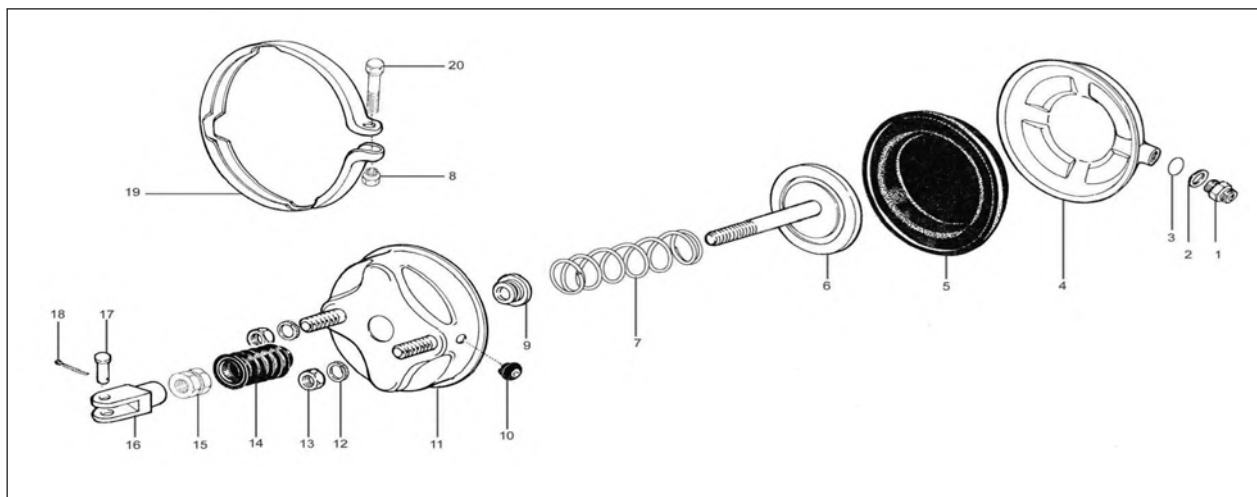
- Adjust the fork such that the relative angle between the slack adjuster and the brake chamber push rod are the same as noted at the time of removal. Tighten the fork lock nut.
- Align the hole in the slack adjuster arm and the hole in the fork.
- Assemble the fork pin.
- Assemble the split pins (unfold them fully).

### 55.10.4 Dismantling

- Clean the exterior of the Brake chamber.
- Mark the non-pressure plate (11) and the pressure plate (4) in relation to the clamp ring and the port.
- Remove the fork (16) and the lock nut (15) gaiter (14) from the push rod (6).
- Pull out the push rod and clamp it at the non-pressure plate in a vice or a vice grip pliers.
- Remove the clamp ring nut (8) and bolt (20).
- Remove the clamp ring (19).
- Remove the pressure plate (4) and the diaphragm (5).
- Carefully release the clamp on the push rod.
- Remove the push rod assembly (6), Push rod return spring (7) and seal (9) from the non-pressure plate (11).

### 55.10.5 Cleaning and inspection

- Clean all the components with a cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Check the spring for distortion / corrosion.



Item	Description	Qty
1	Adaptor	1
2	Special Washer	1
3	Sealing Ring	1
4	Pressure Plate Assy	1
5	Diaphragm	1
6	Push Rod Assy	1
7	Push Rod Return Spring	1
8	Clamp Ring Nut	1
9	Check Valve	1
10	Dust Seal	1

Item	Description	Qty
11	Non Pressure Plate Assembly	1
12	Spring Washer	2
13	Lock Nut	2
14	Gaiter	1
15	Lock Nut	1
16	Fork Assy	1
17	Pin	1
18	Split Pin	1
19	Clamp Ring	1
20	Clamp Ring bolt	1

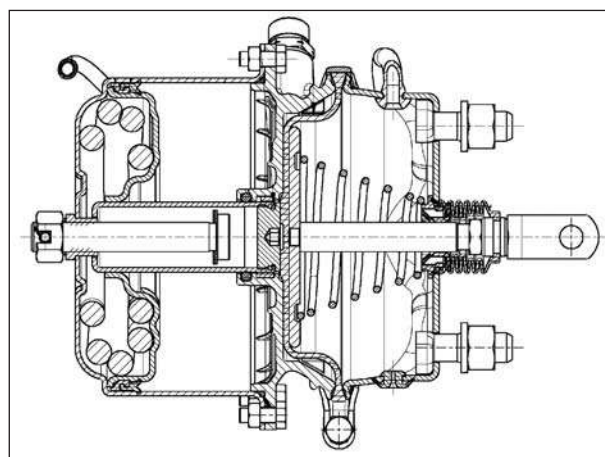
- Check the port for damaged thread.
- Check the pressure and non-pressure plate for damage in the diaphragm seating area.
- Check non-pressure plate for thread damage in the mounting bolts.

#### 55.10.6 Reassembly

- Use recommended repair kit to replace the old parts. Replace all the parts found to be worn out / defective during inspection, with new parts.
- If the spring of brake chamber is replaced due to any defect, it is recommended that the spring of the other brake chamber is also changed to ensure balanced braking between the right and left.
- Rest the push rod assembly (6) on a flat surface.
- Place the Push rod return spring (7) and seal (9) on the rod.
- Position the non-pressure plate (11) on the push rod assembly (6).
- Force down the non-pressure plate into the push rod until it rests down on the flat surface.
- Holding the non-pressure plate in this position clamp the push rod with the vice-grip pliers.
- Locate the diaphragm (5) on the pressure plate (4).
- Locate the non-pressure plate assembly in the clamped condition on the pressure plate.
- Assemble the clamp ring (19) by aligning the marking made during dismantling.

- Assemble the clamp ring bolt (20) and the nut (8) and tighten the clamp ring nut (8) to a torque of 10-13 Nm.
- Release the vice-grip clamp.
- Fit the fork (16) on the Push rod and secure tightly by the lock nut (15)

#### 55.11 SPRING BRAKE ACTUATOR



##### 55.11.0 Function

The function of the Spring Brake Actuator is to produce braking forces at the foundation brakes. It serves the function of Service, Secondary and Parking / Hand brakes.

##### Description

This assembly is a combination of diaphragm brake chamber and spring actuator with mechanical rear wind off arrangement. The diaphragm arrangement is for actuating service brakes. The spring-loaded piston is for actuating secondary/parking brake. The mechanical wind off arrangement helps to release the spring brake

in case of air pressure loss due to some failure. This provision temporarily facilitates movement of vehicle to the nearest garage for rectifying the fault.

### 55.11.1 Service check

#### 1. Inspection

- Check the tightness of the mounting nuts. (Tightening Torque  $115 \pm 15$  Nm).
- Ensure that the wind off bolt is in fully tightened condition.

#### 2. Operating Tests

- Check for free movement of the push rod without binding while applying/releasing the brakes.
- Check and ensure that the pipe connections and joints are free from leakage when service brake is applied.
- Check and ensure that the pipe connections and joints are free from leakage when spring brake is in released condition.

### 55.11.2 Removing

- Block the wheels and operate the hand brake valve to 'BRAKES OFF' condition.

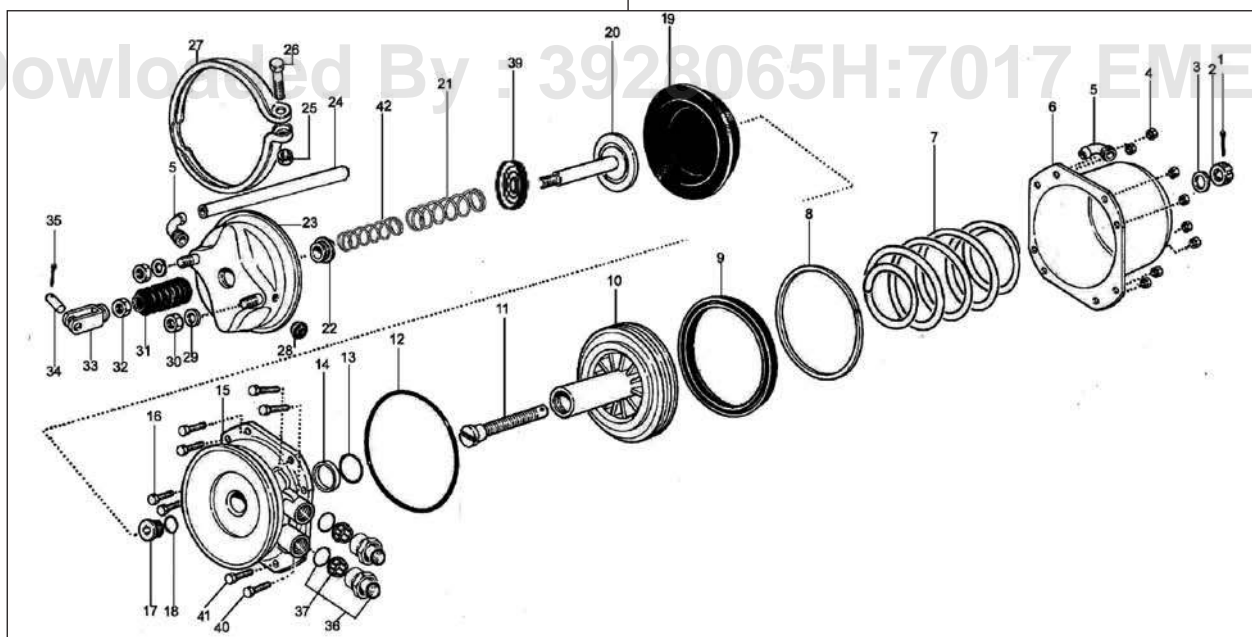
- Rotate the wind off bolt in anticlockwise direction such that wind off bolt comes out fully and remove the Pin connecting the fork to the slack adjuster.
- Operate the hand brake valve to "BRAKES ON" condition and completely drain the system air pressure.
- Disconnect airlines after marking suitable identification of port position with reference to the vehicle installation for easy reinstallation.
- Loosen and remove the mounting nuts (24 A/F) and remove the spring brake actuator.
- Close the open ports to prevent entry of dirt.
- Measure the distance between the fork pin hole and mounting face.

### 55.11.3 Dismantling



**A heavy coil spring is housed in the spring brake actuator and extreme care should be taken while servicing the actuator.**

1. Clean the exterior of the assembly and remove the boot from the fork groove.



Item	Description	Qty
1	Knurl Pin	1
2	Wind Off Nut	1
3	Sealing Washer	1
4	Nut	8
5	Elbow	2
6	Cylinder Assembly	1
7	Heavy Coil Spring	1
8	Bearing	1
9	Integral Seal	1
10	Ram Assy	1
11	Wind Off Rod	1
12	Sealing Ring	1
13	Sealing Ring	1
14	Bearing	1

Item	Description	Qty
15	Flange	1
16	Bolt	6
17	Stem Plug	1
18	Sealing Ring	1
19	Diaphragm	1
20	Push Rod Assy	1
21	Conical Spring	1
22	Dust Seal	1
23	Non Pressure Plate Assy	1
24	Tube	1
25	Clamp Ring Nut	1
26	Clamp Ring Bolt	1
27	Clamp Ring	1
28	Check Valve	1

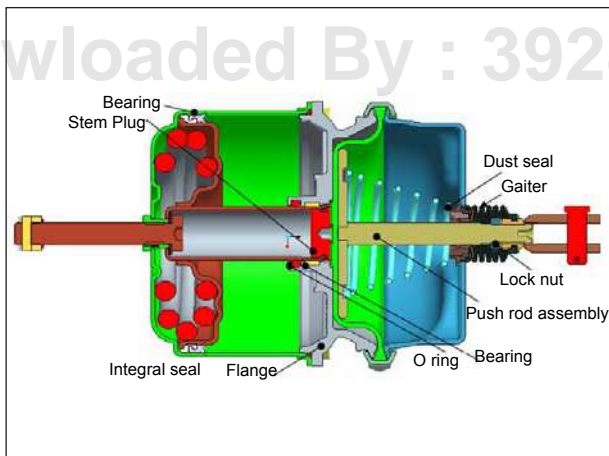
Item	Description	Qty
29	Spring Washer	2
30	Nut	2
31	Gaiter	1
32	Lock Nut	1
33	Fork Assembly	1
34	Pin	1
35	Split Pin	1
36	Adopter	2
37	O-ring	2
39	Stopper Assembly	1
40	Hex. Head Screw	1
41	Hex. Head Screw	1
42	Seal Return Spring	1



2. Then remove the boot from the NPP (non-pressure plate)
3. Remove the breather tube along with the rubber elbows.
4. Loosen and remove the clamp ring nut (14 A/F), bolt and dismantle the clamp rings, non-pressure plate, springs, diaphragm, push rod and dust seal.
5. Loosen and remove the stem plug (by using 8 mm Allen key) with sealing ring from the piston.
6. Remove the knurl pin from the hexagonal sleeve by using 6 mm dia flat drift punch / rod and remove the sleeve from the wind off bolt (Rotate wind off bolt in anti-clock wise direction to bring the Hex sleeve away from the cylinder face - if not done during removal).

#### If compressed air supply facility is available -

Apply air pressure of  $8.1 \pm 0.2$  bar to spring brake actuator port (12) using suitable pipe connections. Remove the knurl pin, hex sleeve and the wind off bolt and follow the procedure laid down in instruction 9 and 10. Release air pressure from spring brake actuator and dismantle the assembly as per instruction 11, 12 and 13 (i.e.) Procedure laid down in 6, 7 and 8 need not be carried out.



7. Fit special tool sleeve on the wind off bolt and insert M6 screw through the cross holes on sleeve and wind off bolt and tighten
8. Rotate the special tool sleeve (24 A/F) using a Ring Spanner in clockwise direction until the sleeve touches the flange face.
9. Remove the special tool sleeve after unscrewing M6 Screw and remove the wind off bolt from the piston.
10. Insert the Rod (part of special tool) through the piston and screw into the cylinder boss.
11. Fix the special tool sleeve on the rod as given in instruction 6 and rotate the special tool sleeve in anti-clock wise direction until rod starts to compress the spring.
12. Unscrew eight M8 nuts (13 A/F) and remove the stiffener plate from the cylinder.

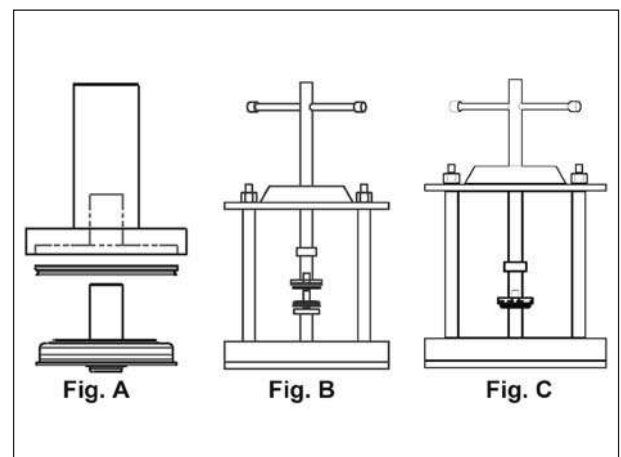
13. Rotate the special tool sleeve in clock-wise direction until the spring load is fully released and remove the special tool to dismantle the piston, spring and cylinder.
14. Remove all bearings (nylon) and seal from the piston and the sealing ring from the flange.

#### 55.11.4 Cleaning and inspection

- Clean all metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.
- Inspect all parts for excessive wear and deterioration. Check cylinder bore, flange and ram piston for any score mark/crack/damage.
- Check the springs for distortion, corrosion and permanent set.
- Scrap all the old parts which are unserviceable

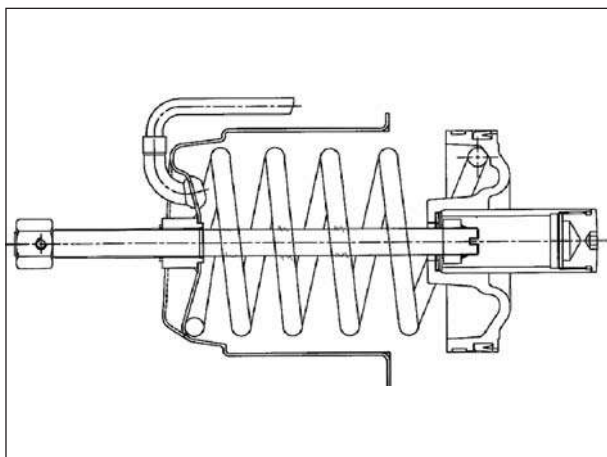
#### 55.11.5 Reassembly

1. Use recommended Repair Kit to replace the old parts scrapped during dismantling. Replace all parts found to be worn out/defective during inspection by new ones.
2. Lubricate all moving parts and sealing rings with grease, which is supplied in repair kit.
3. Fit the bearing by using special tool.



- Place the bearing in the bearing guide tool fig. a.
  - Place the tool along with bearing on the ram.
  - Place the whole sub assembly on the special tool. Fig B & C
  - Tighten the lock nut.
4. Fit the seal (ensuring the correct position of the lip) and bearing on the respective grooves of the piston.
  5. Place the Heavy coil spring inside the cylinder and locate the piston over the spring. (Lightly coat grease over the entire spring before assembly).





6. Insert the special tool rod with nylon washer into the piston and assemble the special tool sleeve with M6 screw on to the other end of the rod.
7. Rotate the special tool sleeve to compress the spring until the piston seal goes inside the cylinder. Ensure that the seal lip is not folded while inserting.
8. Fit sealing ring and bearing in the respective grooves in the bore of the flange.
9. Position the flange on the cylinder ensuring proper orientation of the ports and alignment of 8 holes.
10. Locate the stiffener plate and tighten the eight M8 screws and tighten to a torque of 22-25 Nm.
11. Rotate the special tool sleeve to release the spring load and remove the special sleeve from the rod.
12. Remove the rod and nylon washer from the piston and insert the wind off rod.
13. Assemble the special tool sleeve with M6 screw on the wind off rod and rotate in anti-clock wise direction such that wind off rod fully comes out. **If compressed air supply facility is available –**

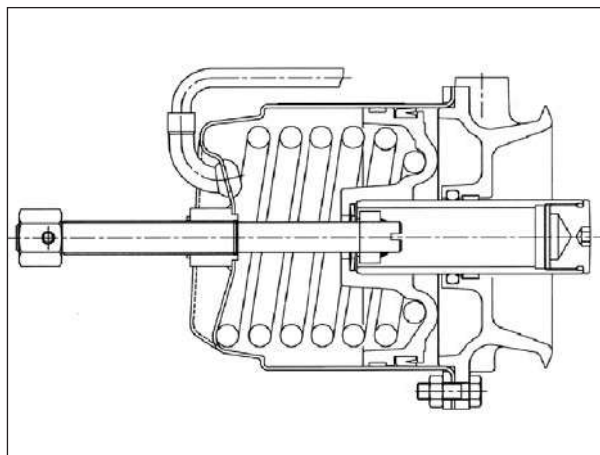
Apply air pressure of  $8.1 \pm 0.2$  bar to spring brake port using suitable pipe connections. Screw in the wind off rod. Fit the hex sleeve with aluminium washer and press in the knurl pin in the sleeve after aligning the holes in the sleeve and the wind off rod. Follow the procedure laid down in instruction 15, 16, 17, 18 and 19 under 'Reassembly'. Procedure laid down in 13 and 14 need not be carried out.

14. Remove the special tool sleeve, insert aluminium washer and assemble the hexagonal sleeve on the wind off rod by inserting the knurl pin aligning the cross holes on the sleeve and the wind off rod.
15. Assemble the stem plug with sealing ring on the piston and tighten to torque of 30 Nm.
16. Locate the diaphragm on the flange.

**Do not apply grease or oil on the diaphragm.**

17. Locate the push rod assembly over the diaphragm.
18. Locate the springs on the push rod.
19. Locate the dust seal on the seal retaining spring.

20. Locate the non-pressure plate guiding its hole on the dust seal.



21. Assemble the clamp ring and check for proper orientation during positioning and tighten the clamp ring nut to a torque of 15 to 18 Nm.
22. Fix the rubber elbows on the cylinder and the non-pressure plate.
23. Apply 'PVC solvent cement' at both ends of the tube and insert the tube into the elbows to a length of 17 mm. Position the gaiter properly on the groove provided in the NPP and the fork.
24. Assemble the lock nut and fork on the push rod.
25. Set the distance between the for pin hole centre and the mounting face to the value as measured during removing. (Distance in brakes released position is 72 mm).
26. Tighten the lock nut.
27. Release the wind off rod and finally when the sleeve touches the cylinder tighten to a torque of 22.5 Nm.
28. Fit the adaptors in the service port (11) and the spring brake port (12) with sealing washers. Tighten the adaptor in port 11 to a torque of 29-34 Nm and the adaptor in port 12 to a torque of 20-25 Nm
28. Fit the assembly on the vehicle and tighten the mounting nuts to a torque of 100 to 130 Nm.
29. Connect the pipes and fit the pin on the fork with slack adjuster and lock by folding split pin.
30. Adjust the brakes and check for air leak in pipe joints before the vehicle is put into service.

#### 55.11.6 Test procedure

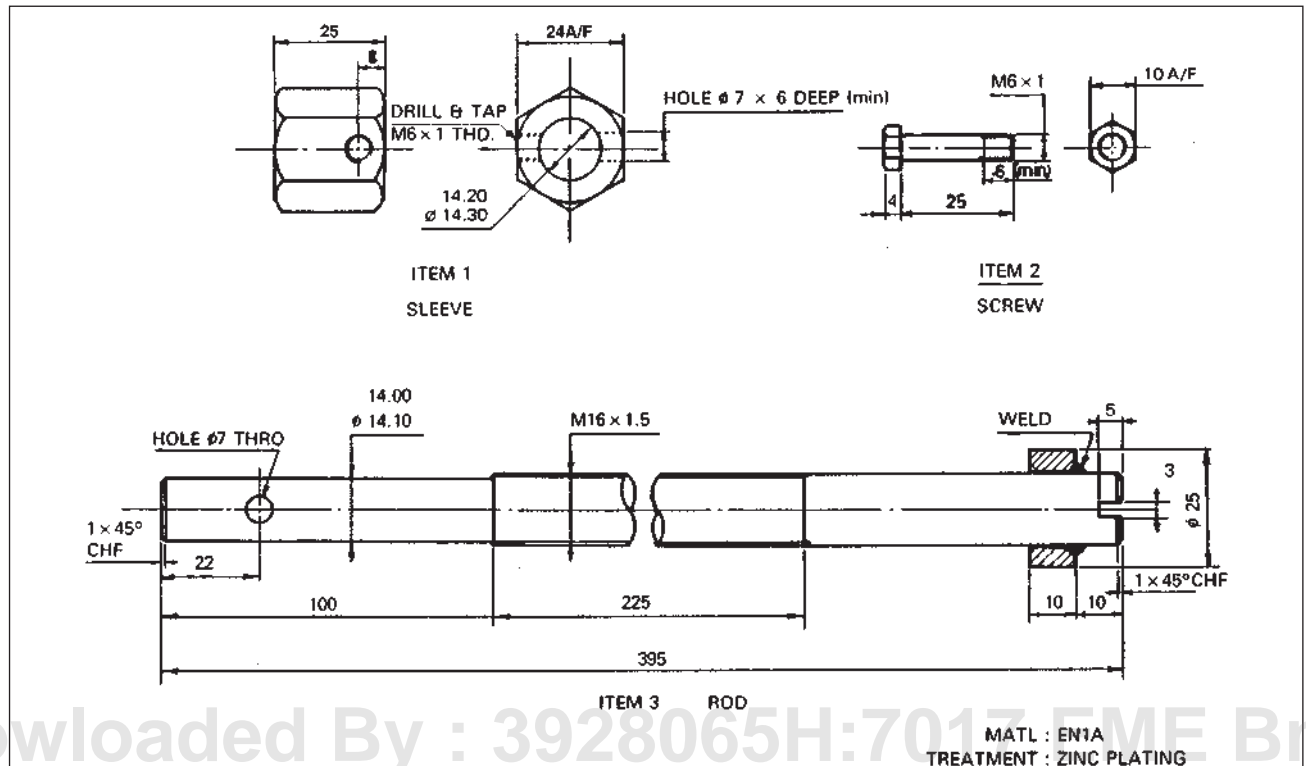
- Connect spring brake actuator port (12) with airline through a 'ON/OFF' Valve.
- Apply air pressure to spring brake actuator port and check for release of piston / push rod.
- Operate the valve to "ON" position and check for leak through breather holes on non-pressure plate, flange and port 11 to check for leak through piston stem.
- Connect the pipe to service port (11) through a separate "ON-OFF" valve and apply pressure to



spring brake port to keep the heavy coil spring in compressed condition. Operate "ON-OFF" valve of service brake a few times and check for free movement of push rod.

- Operate the valve connected to service brake to "ON" position and check for leak through diaphragm and clamp ring joints.

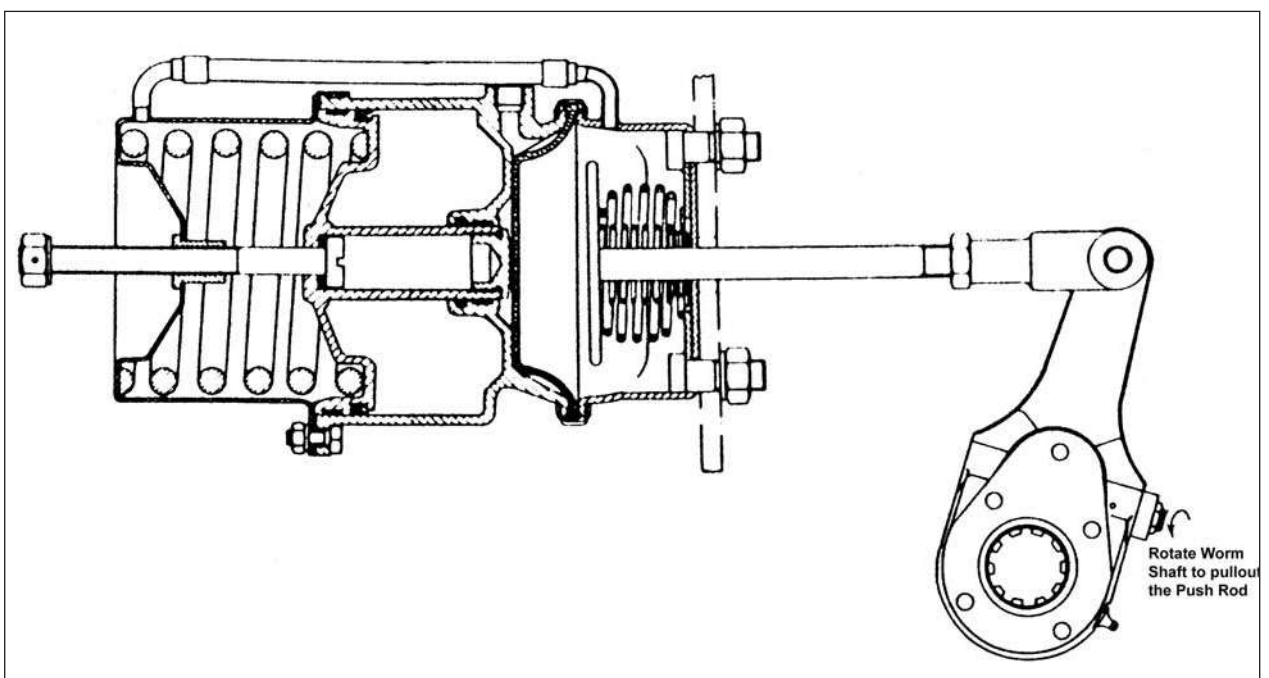
The above procedures are to be adopted after fitment onto the vehicle if not tested earlier.



### Procedure for replacing diaphragm on spring brake actuator

Whenever replacement of diaphragm in spring brake actuator is required during regular maintenance of brake system, it is possible to replace it without removing the spring brake actuator from the vehicle, as per the procedure given below: -

- Apply hand brake
- Wind off the spring brake actuator to release the Spring Brake mechanically



- Release the worm shaft lock and rotate the worm shaft on the Slack Adjuster so as to pull the spring brake push rod out (This is to eliminate push rod return spring force acting over the Diaphragm).



- Loosen both running nuts of Service and Spring brake port pipelines (Do not remove the pipe from the Adaptor).

(Hold the adaptor with suitable spanner while loosening the running nut).

- Unscrew the Clamp ring bolt and nut and remove the clamp ring.
- Remove the diaphragm and place the new diaphragm in position.

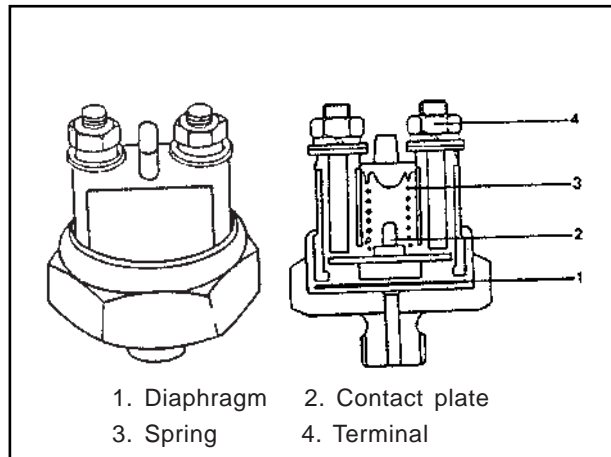
**(Use only diaphragm with centre pad)**

- Fix the clamp ring ensuring correct engagement of clamp ring all over.
- Tighten clamp ring bolt and nut to a torque of 10 -13 Nm.
- Tighten both pipeline running nuts.

**Important**

- Adjust the brake to ensure correct lining clearance
- Tighten wind off sleeve to apply spring brake.
- Release the hand brake with wheels blocked suitably.
- Check and ensure leak free joint on spring brake Pipeline joints.
- Check and ensure leak free joint around diaphragm and pipeline joint with the service brake in applied condition.
- This procedure is only for replacing diaphragm.
- For overhauling of spring brake actuator, it is necessary to remove the assembly from the vehicle.

**55.12 STOP LIGHT SWITCH**



**Function**

To switch on warning lamp when the brakes are applied.

**Operation**

Air pressure acts under the diaphragm (1) and pushes it up overcoming the load of the spring (3). The Contact plate (2) carried along with the Diaphragm (1) makes contact with the contacts of terminals (4) The circuit closes to signal the STOP warning lamp.

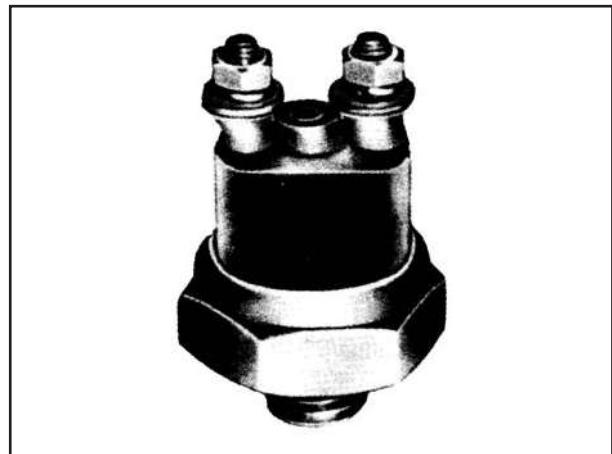
When the air pressure reduces, the spring force overcomes the air head load under the Diaphragm (1) and the Control plate (2) moves downward breaking the contact and opening the circuit.

**Maintenance**

No special care is necessary during normal service. However, check the electrical connections periodically for tightness. This unit is not repairable.

**55.13 LOW PRESSURE WARNING SWITCH**

**Description**



In an air brake system a warning is necessary to the driver when the air pressure in the system comes down to the minimum safe working level. This is achieved by the low pressure warning switch which operates an electrical buzzer or a warning



light or both, which are audible or visible to the driver. This is generally connected in the main air circuit. The electrical connection is given in series with the ignition switch and the warning device.

#### Leakage Test

With air pressure present at the inlet port coat the switch with soap solution no leak is permissible.

#### Fitment

Screw the switch to the place from which it was removed using a new sealing washer, connect the electrical connections properly and securely operation of the low pressure warning switch may be checked with ignition switch on and by reducing the system pressure and observing the pressure at which the warning lamp or the buzzer comes on this pressure should not vary by  $\pm 0.25$  kg/cm<sup>2</sup> from that indicated on the body.



**If the vehicle is operated when the warning switch is 'ON' then the brake linings will be grabbing and their life will be reduced.**

With the switch 'ON' if the driver starts to move the vehicle from the parked condition, it may stall the engine or alternatively the engine will be strained too much depending upon the level of air pressure below the warning limit and also the brake linings will be affected.

### 55.14 S CAM ROLLER FOLLOWER BRAKE

#### 55.14.0 Description

The 'S' Cam Roller Follower brake is of sound rugged construction combining simplicity with strength, designed for use on heavy commercial vehicles. The brake is operated by a 'S' form cam which is an integral part of the cam shaft, the shaft being mounted on bushes in the chamber brackets and spider. The expanding force at the 'S' cam is applied to the shoes through rollers seated between shoe webs. A slack adjuster, which provides a quick and easy method of adjusting brakes, is fitted to spline end of cam shaft.

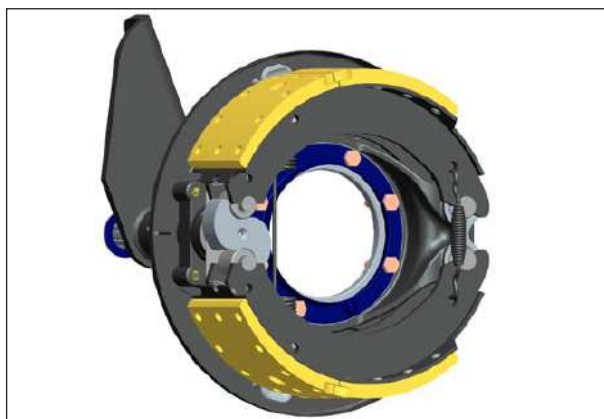
The brake is actuated by air chamber through push rod connected to the slack adjuster.

The twin web shoes are of pressed shell construction. They are pivoted on to two hardened steel fulcrum pins fitted into the stainless steel bushes pressed in the spider. The brake is protected from dust/road pebbles by two semi circular dust shields fitted to the spider.

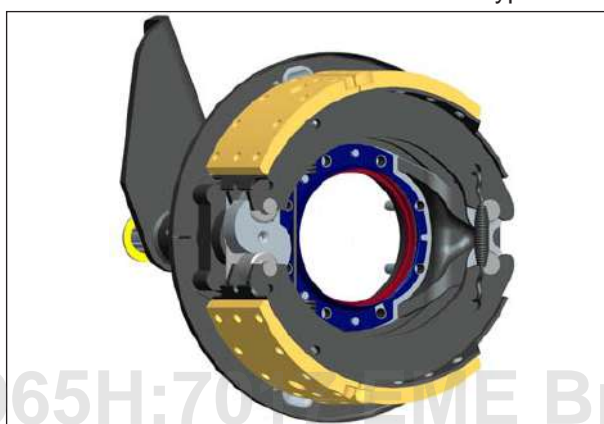
#### 55.14.1 Brake Overhauling

The Q Series brake shoe has an open end on the anchor pin ends for "quick change" service. An anchor pin fastens each brake shoe to the spider. The linings are fastened to the brake shoes with rivets. Two retaining springs and one return spring hold the shoes together on the spider. Ø 15.5" "Q" brake is available with different widths with taper lining.

#### Front

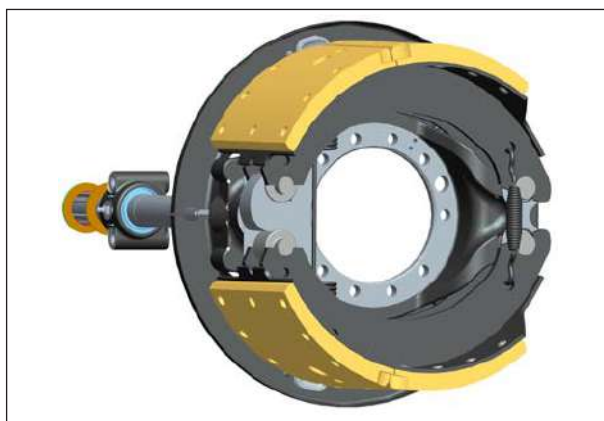


Serrated bolt version. Unit mounted type.

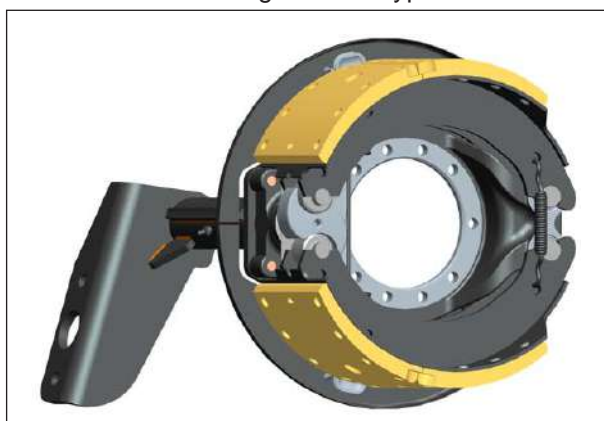


Stud version - Unit mounted type.

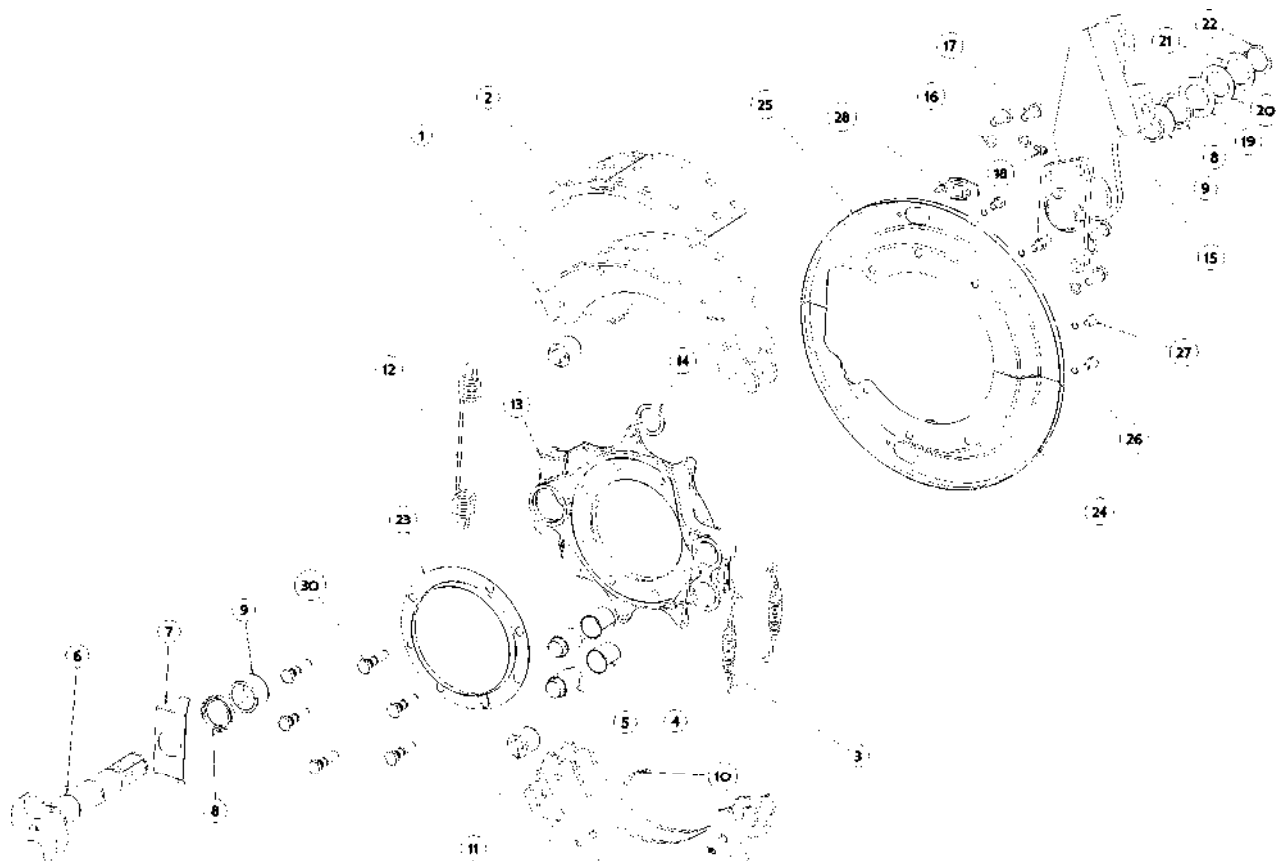
#### Rear



Housing mounted type.

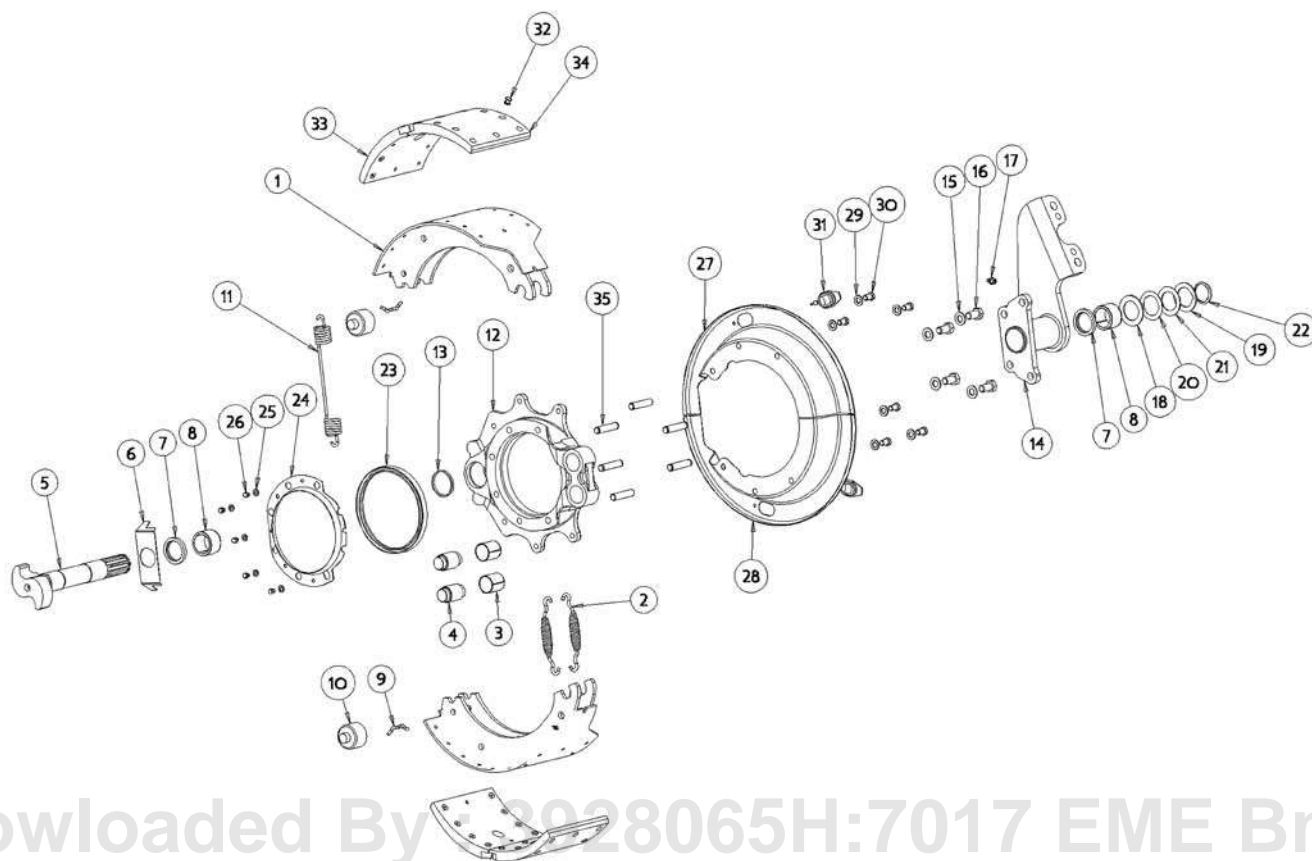


Unit mounted type.



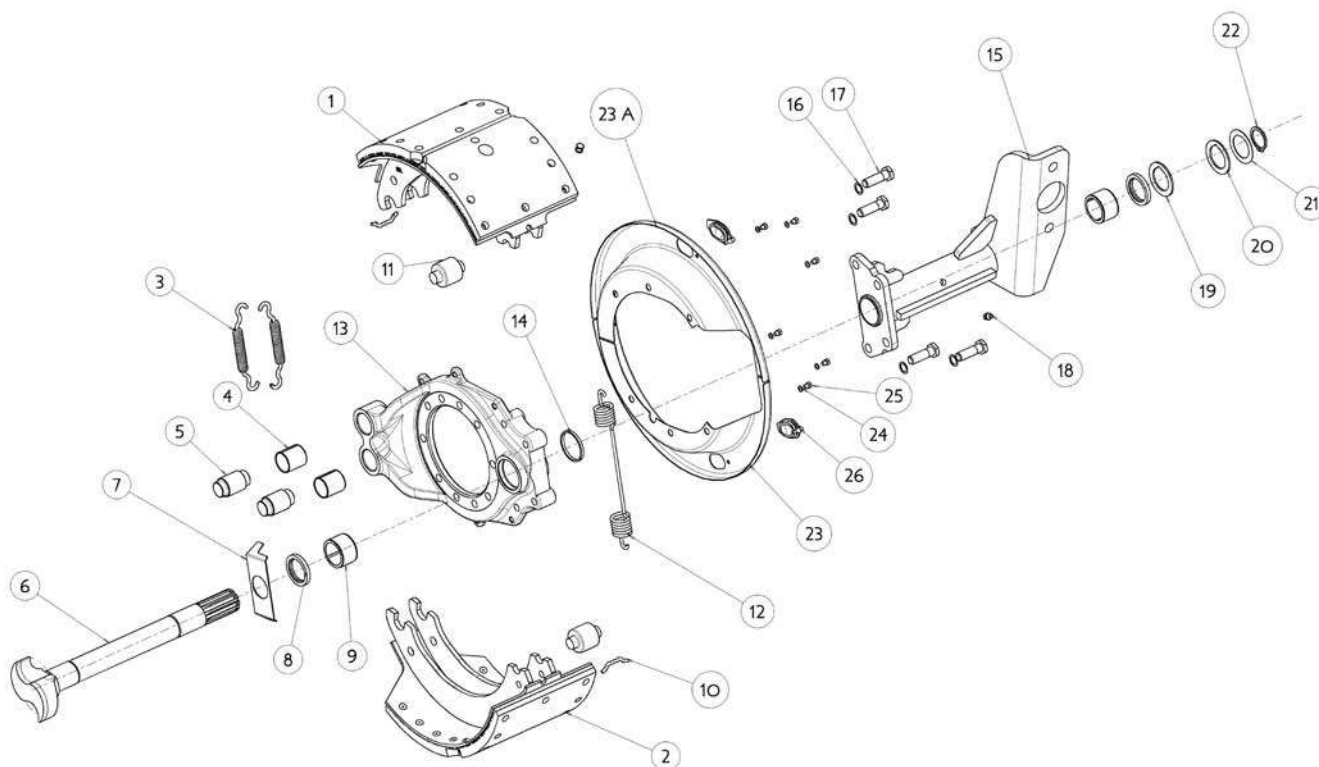
**15.5" Dia Front brake – Unit mounted design – Serrated bolt version**

1	Brake shoe lining & roller assy	15	Bracket assy-cam shaft
2	Lining brake – Cam end & Anchor End	16	Washer-bracket assy
3	Spring - brake shoe retaining	17	Cap screw-bracket assy
4	Bushing-anchor pin	18	Fitting grease
5	Anchor pin-brake shoe	19	Washer (2.5 mm)
6	Cam shaft	20	Washer (0.8 mm)
7	Washer-cam head	21	Washer (2.5 mm)
8	Seal-cam shaft	22	Lock ring-camshaft
9	Bushing – Cam Spider & - Cam - Bracket	23, 23A	Dust shield
10	Pin-return spring	24	Washer-dust shield
11	Roller – brake shoe	25	Cap screw-dust shield
12	Return spring-brake shoe	26	Plug – Dust shield
13	Spider	27	Rivet
14	Gasket-bracket & spider		



**15.5" Dia Front brake – Unit mounted design – Stud version**

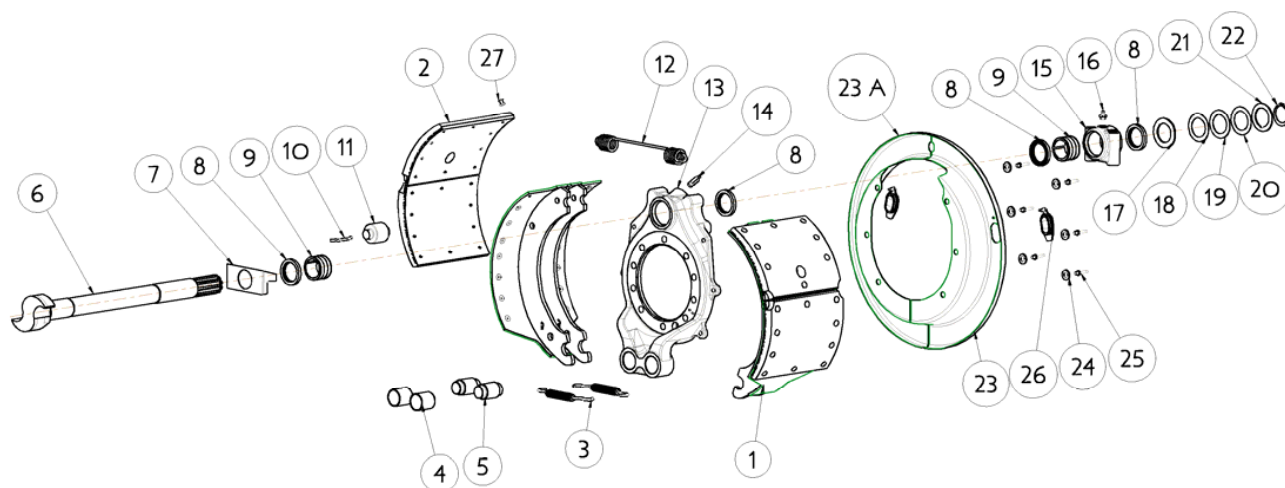
1	Brake shoe lining & roller assy	15	Bracket assy-cam shaft
2	Lining brake – Cam end & Anchor End	16	Washer-bracket assy
3	Spring - brake shoe retaining	17	Cap screw-bracket assy
4	Bushing-anchor pin	18	Fitting grease
5	Anchor pin-brake shoe	19	Washer (2.5 mm)
6	Cam shaft	20	Washer (0.8 mm)
7	Washer-cam head	21	Washer (2.5 mm)
8	Seal-cam shaft	22	Lock ring-camshaft
9	Bushing – Cam Spider & - Cam - Bracket	23, 23A	Dust shield
10	Pin-return spring	24	Washer-dust shield
11	Roller – brake shoe	25	Cap screw-dust shield
12	Return spring-brake shoe	26	Plug – Dust shield
13	Spider	27	Rivet
14	Gasket-bracket & spider		



### 15.5" Dia Rear brake – Unit mounted design

1	Brake shoe lining & roller assy	15	Bracket assy-cam shaft
2	Lining brake – Cam end & Anchor End	16	Washer-bracket assy
3	Spring - brake shoe retaining	17	Cap screw-bracket assy
4	Bushing-anchor pin	18	Fitting grease
5	Anchor pin-brake shoe	19	Washer (2.5 mm)
6	Cam shaft	20	Washer (0.8 mm)
7	Washer-cam head	21	Washer (2.5 mm)
8	Seal-cam shaft	22	Lock ring-camshaft
9	Bushing – Cam Spider & - Cam - Bracket	23, 23A	Dust shield
10	Pin-return spring	24	Washer-dust shield
11	Roller – brake shoe	25	Cap screw-dust shield
12	Return spring-brake shoe	26	Plug – Dust shield
13	Spider	27	Rivet
14	Gasket-bracket & spider		



**15.5" Dia Rear brake – Housing mounted design**

1	Brake shoe lining & roller assy	15	Plummer Block
2	Lining brake – Cam end & Anchor End	16	Fitting grease Plummer Block
3	Spring - brake shoe retaining	17	Washer
4	Bushing-anchor pin	18	Washer
5	Anchor pin-brake shoe	19	Washer
6	Cam shaft	20	Washer
7	Washer-cam head	21	Washer
8	Seal-cam shaft	22	Lock ring-camshaft
9	Bushing – Cam Spider & - Cam - Bracket	23, 23A	Dust shield
10	Pin-return spring	24	Washer-dust shield
11	Roller – brake shoe	25	Cap screw-dust shield
12	Return spring-brake shoe	26	Plug – Dust shield
13	Spider	27	Rivet
14	Fitting grease - spider		

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**55.14.2 Removal**

Read and observe all warning and caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.



**To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance and service.**

**Asbestos and Non-asbestos fibers**

**Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose longterm effects to health are unknown. You must use caution when you handle both asbestos and nonasbestos materials.**

**Wheel Components**

Park the vehicle on a level surface. Block the wheels to Prevent the vehicle from moving. Support the vehicle with Safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Use a jack to raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
3. Remove the wheel nuts, and tire and rim assemblies.



**Before you service a spring chamber, carefully follow the instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.**

4. If the brake has spring chambers, carefully cage and lock the spring, so that the spring cannot actuate during assembly.
5. Release the slack adjuster to retract the shoes so the drum can clear the lining.

**Brake Drums**

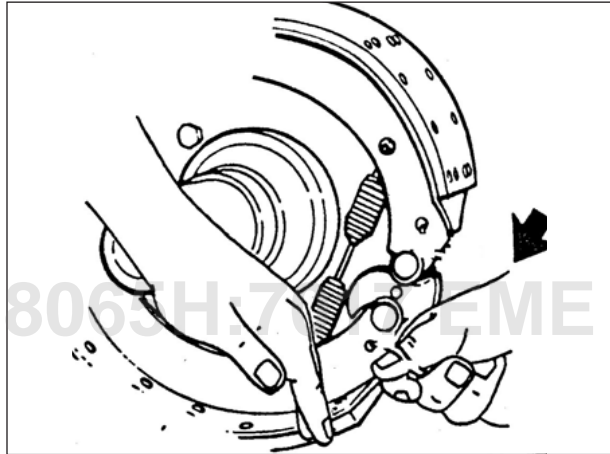
1. If equipped, remove the screws that secure the brake drum to the hub.



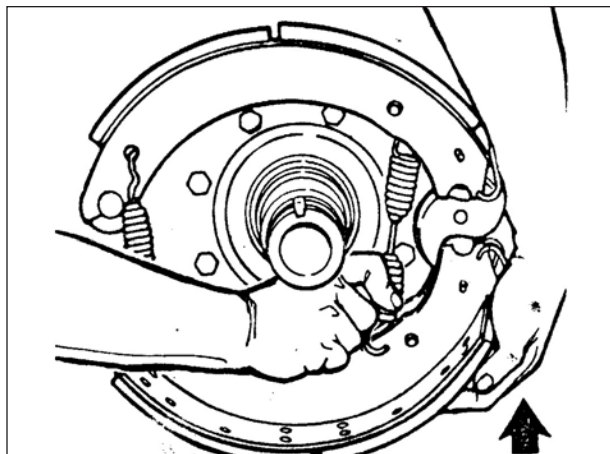
**To avoid serious personal injury and damage to components, take care when using lifting devices during service and maintenance procedures. Inspect a lifting strap to ensure that it is not damaged. Do not subject lifting straps to shocks or drop loading. The lifting bolt threads must be fully engaged.**

2. Use a lifting device to remove the brake drum. If the drum is difficult to remove and is equipped with push holes: Install the bolts into the push holes.

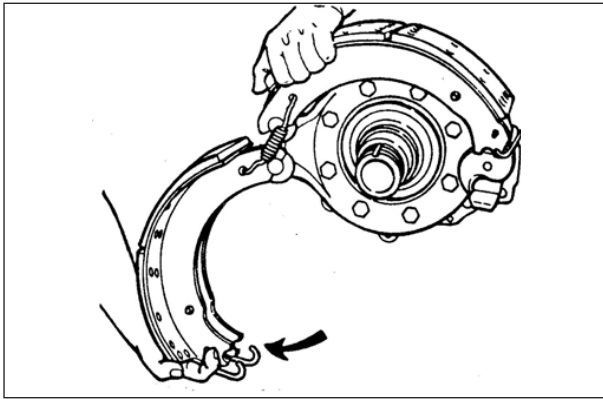
Tighten the bolts sequentially until the drum separates from the hub.



- Push down bottom brake shoe and remove the bottom cam roller.
- Lift the top brake shoe and remove the top cam roller.



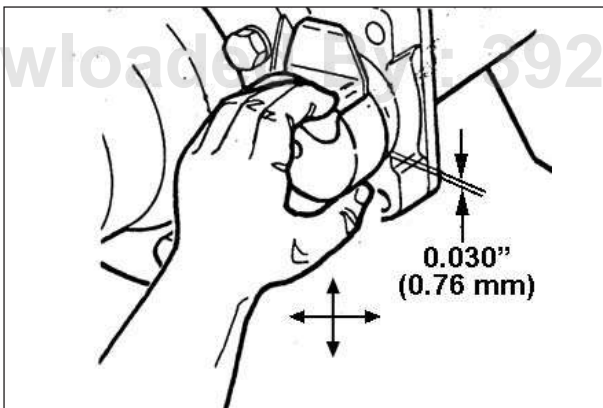
- Lift the bottom shoe.
- Use brake shoe return spring tool / remover to remove the return spring.
- Remove the return spring.



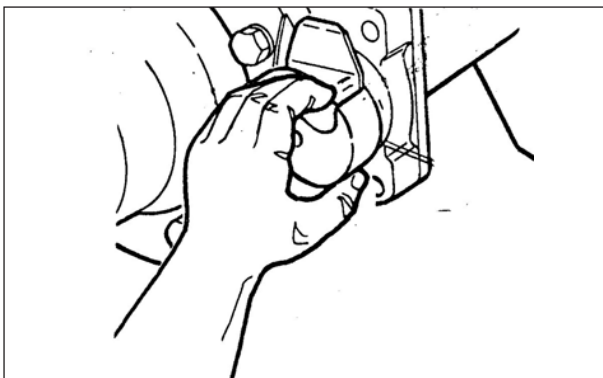
- Swing the bottom shoe such that the anchor spring will be free from tension.
- Remove the anchor springs and brake shoes.
- Remove the anchor pins
- Remove the lock ring, washers and slack adjuster from camshaft.

**Check Cam-to-Bushing Radial Free Play**

- Replace the camshaft bushings if the S-cam is replaced, if the radial movement exceeds 0.80 mm and at every brake shoe reline. Always replace the S-cam seals when you replace the S-cam bushings.



- Before you remove the automatic slack adjuster and camshaft, move the camshaft. Use a dial indicator to verify that the cam-to-bushing radial free play is within specification.
- If radial free play movement exceeds 0.80 mm, replace the bushings and seals.



- Pull out the camshaft from spider.

- Take out the dust shields by removing the mounting bolts.
- Remove camshaft bracket mounting bolts and remove the bracket.
- Remove the mounting bolts and take out the spider.

**Slack Adjuster and Camshaft**

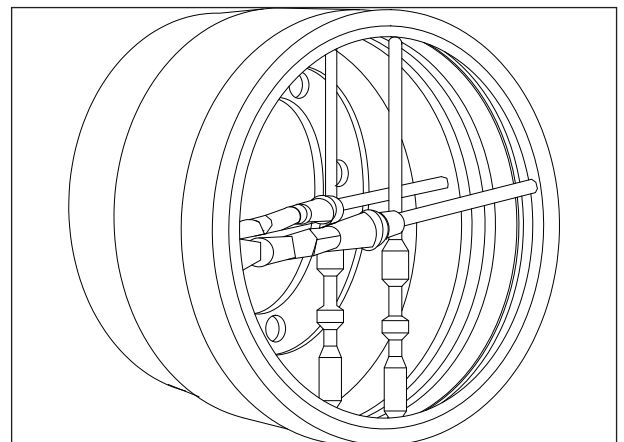
1. Remove the slack adjuster from the camshaft.
2. If necessary, remove the hub from the axle. Refer to the axle maintenance manual for hub removal procedures.
3. Remove the camshaft from the spider and bracket.
4. Use the correct size driver to remove the bushings and seals from the spider and bracket.
6. Remove the cap screws that fasten the bracket to the spider. Remove the bracket and the seal.
7. If the spider must be removed, mark the position of the spider on the axle flange. Remove the cap screws that fasten the spider to the flange. Remove the spider. Inspect the axle flange for damage.

**55.14.3 Cleaning – Inspection and Replacement of Parts****Cleaning of parts**

- Use a cleaning solvent, kerosene or diesel.
- Dry the parts immediately after cleaning.
- Coat all the parts with lubricant to prevent corrosion and rust.

**Inspection and replacement of parts**

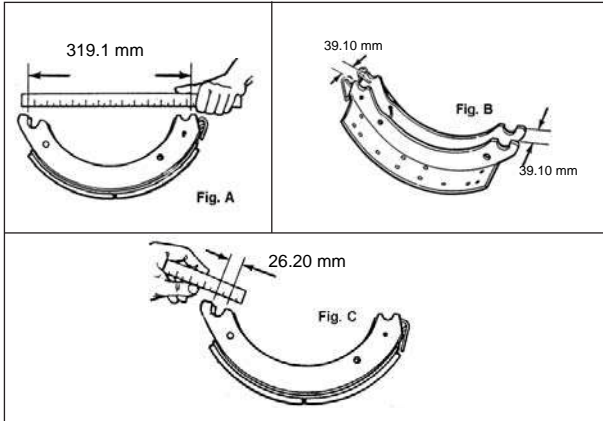
1. Check the brake drums for cracks, scoring, pitting, heat spotting and distortion. Replace drums as required.



2. Measure the inside diameter of the drum in several locations with a drum caliper or internal micrometer. If the diameter exceeds the specifications supplied by the drum manufacturer or is close enough that the drum will wear past the specification before the next inspection: Replace the drum.



3. Check dust shield for rust and distortion. Repair or replace as necessary.
4. Check camshaft for cracks and wear. Check cam head, journals and splines for wear. Replace worn out camshafts.
5. Check and replace camshaft brackets if found with cracks and broken welds.



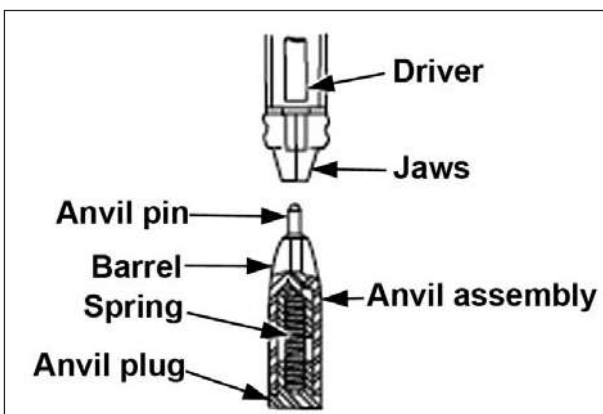
6. Check the shoes for elongated rivets holes. Weld damages and for the wear.
7. Replace the shoes if any one of the readings exceeds the specified limits. Figure A, B, & C.
8. Check the roller for flat spotting and brinelling. If found replace the rollers.
9. Check and replace the cam head washer if found worn out and distorted.
10. Replace return spring, anchor springs and roller retainers if found elongated and damaged
  - It is recommended to replace all the springs at the same time.
11. Check camshaft seals for wear and damages
  - It is recommended to replace all the camshafts seals during overhauling.

#### 55.14.4 Riveting lining

##### Inspection

Before riveting the linings, you must inspect the rivet machine components as detailed in this section. You must also verify that the gaps between the brake linings and shoes are correct before you rivet the linings onto cam brake shoes.

##### Rivet Machine Components



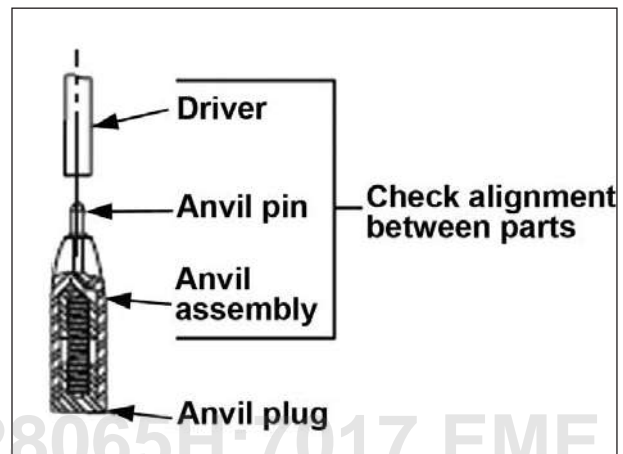
Inspect the rivet machine components.

You must adjust, repair or replace the rivet machine components when necessary to ensure that the machine presses the rivets into the correct position.

##### Rivet Machine Jaws

1. Remove the jaws from the rivet machine. Refer to the Manufacturer's instructions.
2. Check the condition of the jaws. Carefully inspect the inner and outer surfaces for damage. Replace the damaged jaws.

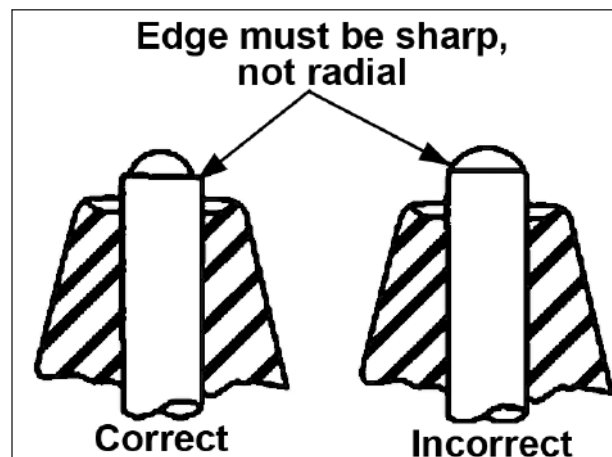
##### Driver and Anvil Pin Alignment



The driver must align with the anvil pin. Use the following steps to check the driver and anvil pin alignment.

1. Use your hand to align the center of the driver with the anvil pin.
2. Adjust the alignment, if necessary.
3. If you cannot obtain the correct driver and anvil pin alignment, repair or replace the driver, anvil pin or anvil assembly.

##### Anvil Pin Condition



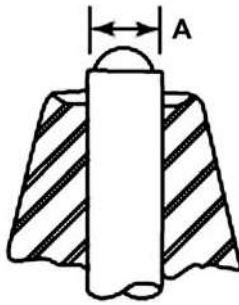
1. Inspect the edge of the anvil pin. The corner must be sharp, not radial.
2. If the corner is not sharp, repair or replace the anvil pin.



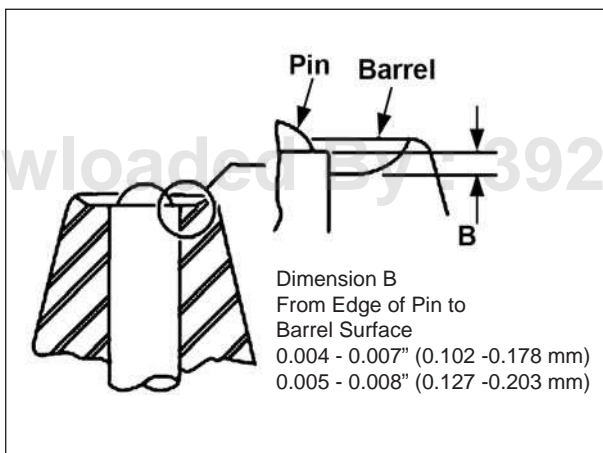
Pin diameter must match the body diameter of the rivet being installed.

Dimension A  
Dia of Anvil pin  
0.19" (4.83 mm)  
0.25" (6.35 mm)

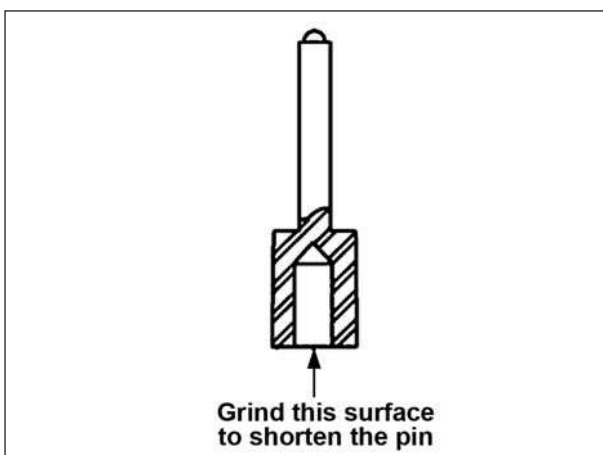
Note : Dimension A must match the body diameter of the rivet being installed.



3. Use a micrometer to measure the diameter, Dimension A, of the anvil pin. Record the dimension.
4. Push the anvil pin into the barrel of the anvil assembly until the base of the anvil pin contacts the top of the anvil assembly plug. Hold the anvil pin in this position.

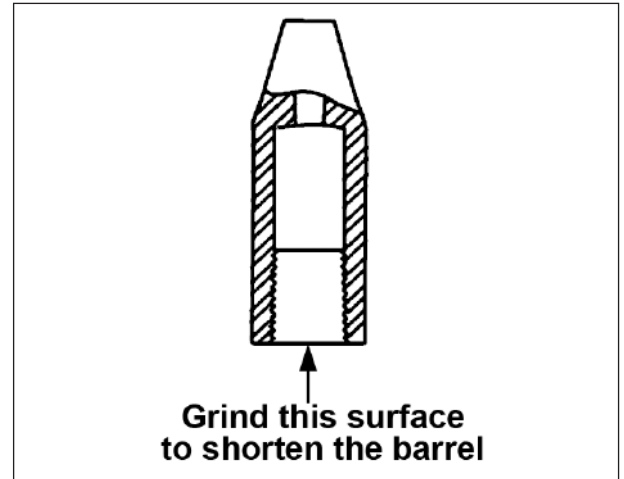


- 5 Measure Dimension B from the sharp edge of the anvil pin to the bottom surface in the head of the barrel.
- If Dimension B exceeds the specification, use the following procedure to shorten the anvil pin.
- a. Remove the anvil pin from the barrel.



- b. Grind the bottom of the anvil pin as needed.

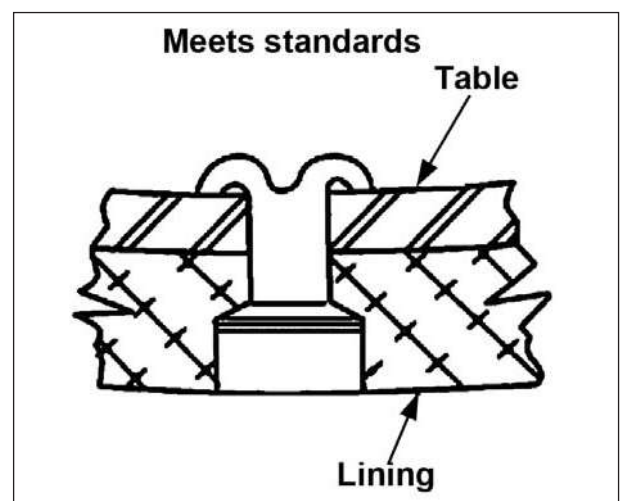
- c. Assemble the anvil assembly.
- d. Repeat Step 4 and Step 5.
- e. Install the jaws onto the rivet machine.
- If dimension B is less than the specification, use the following procedure to shorten the barrel.
- a. Remove the plug, spring and anvil from the barrel.



- b. Grind the bottom of the barrel as needed.
- c. Assemble the anvil assembly.
- d. Repeat Step 4 and Step 5.
- e. Install the jaws onto the rivet machine.

### Riveting Lining inspection

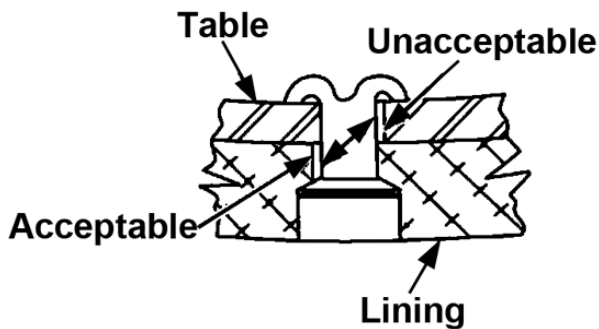
Refer to the following standards to inspect rivets and verify that the gaps between the linings and shoes are correct.



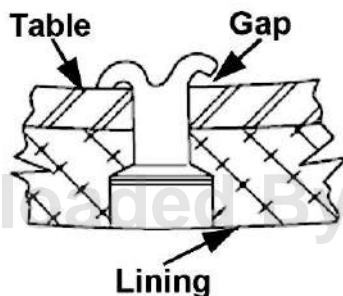
A rivet must fill the holes in the lining and shoe table.

A rivet that does not fill the holes in the lining and shoe table does not meet standards.



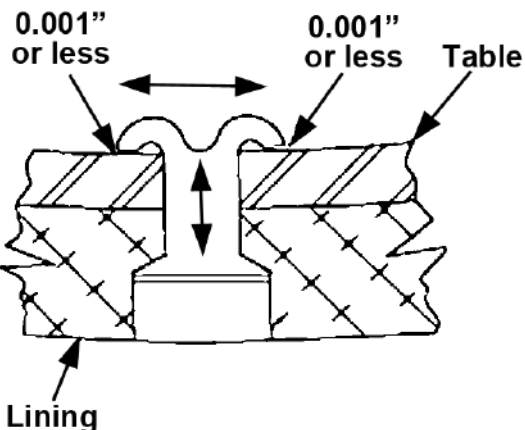
**Does not meet standards**

A rivet curl must completely contact the shoe table so that there's not a gap between the rivet curl and shoe. You must replace the rivet to correct the gap.

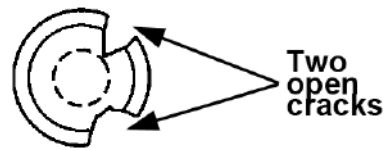
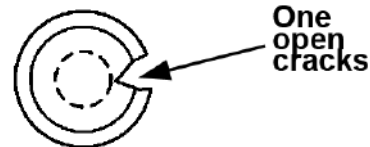
**Does not meet standards**

Standards do not permit rivet movement. Use the following procedure to check for loose-rivet movement.

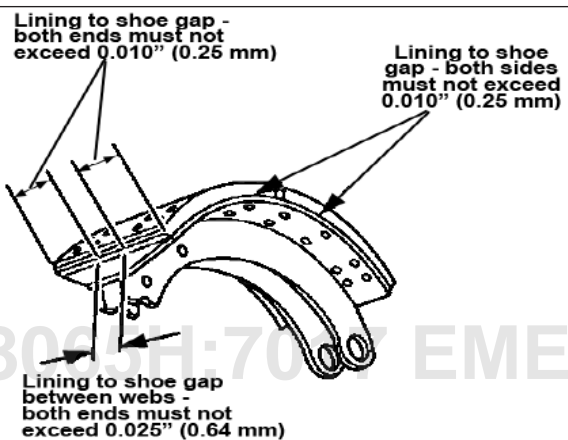
1. Use your hand to check for side-to-side and up-and-down rivet movement.
2. Place a punch on the driver side of the rivet. Gently tap the punch with a ball peen hammer. Check the roll side of the rivet with a 0.001-inch feeler gauge to ensure that the roll has not been lifted off the surface of the shoe.



If rivet movement occurs during Step 1 or Step 2:  
Remove the rivet and install another one

**Does not meet standards****Meet standards**

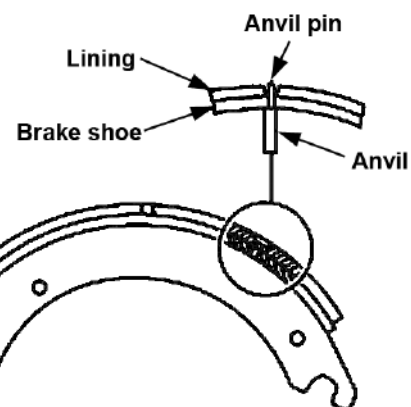
A rivet curl with more than one crack does not meet standards.



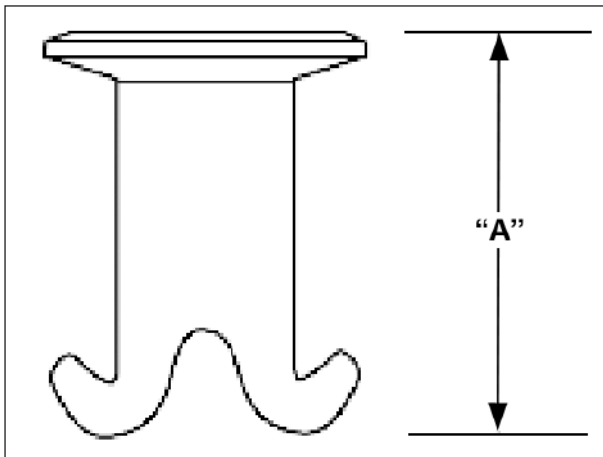
The maximum acceptable lining-to-shoe gap along the sides and ends of the assembly is 0.010 inch (0.25 mm). The maximum acceptable lining-to-shoe gap between webs is 0.025 inch (0.64 mm).

**Lining with Rivets**

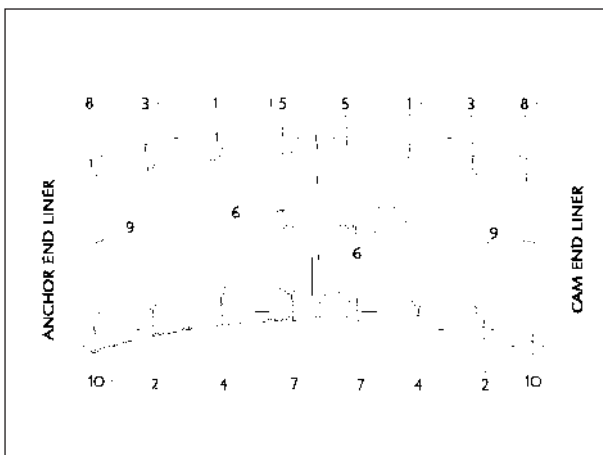
Before riveting the linings, you must inspect the rivet machine components as detailed in this section.



1. Verify that the gaps between the brake linings and shoes are correct before you rivet the linings onto shoes.

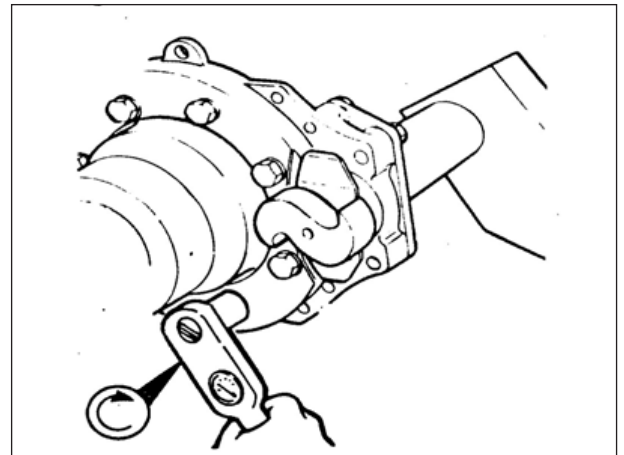


2. Before you install the linings onto a shoe, check the compressed height of a rivet.
  - a. Press a rivet into the machine.
  - b. Measure distance A, which must be 0.4600-0.475 inch (11.684-12.065 mm).
3. Verify that the lining and shoe contact faces are clean.
4. Align the rivet holes in the lining with the rivet holes in the shoe.
5. Before you cycle the rivet machine to fasten the linings to the brake shoe, check that the anvil pin extends through the table and lining assembly to ensure correct driver and anvil pin alignment.

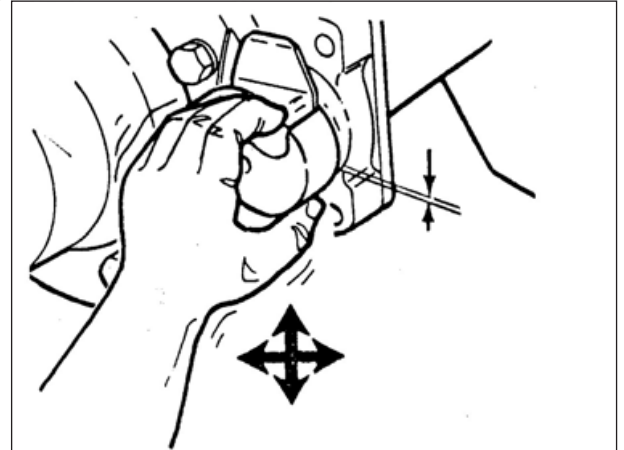


6. Install the rivets into the rivet holes following the sequence. For shoes with fewer rivet holes, start at the middle of the shoe and work toward the end. The rivets must be the correct body diameter, head size and shape, and length and material. A 0.010 inch (0.25 mm) maximum gap is acceptable between the shoe and linings along the sides and ends of the assembly, except between the double web. Between the webs, a 0.025 inch (0.64 mm) gap is acceptable.

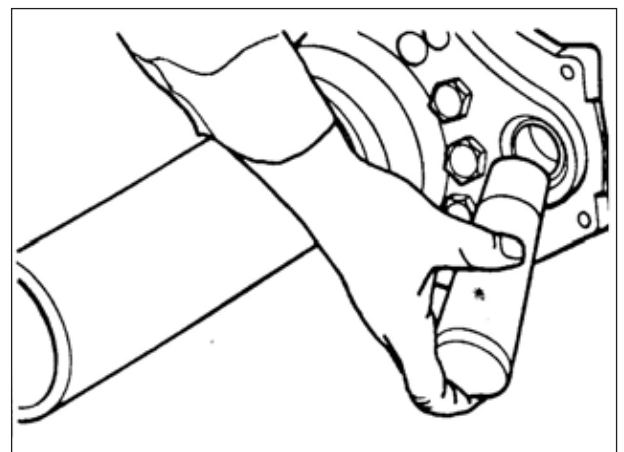
#### 55.14.5 Installation of brake assembly



- Install the spider mounting bolts and nuts.
- Tighten to the Specified torque. Refer Torque specification chart.
- Install the camshaft bracket in the spider with the new gasket.
- Tighten the bracket mounting bolts to Specified torque. Refer Torque specification chart.
- Install the camshaft along with the cam head washer.

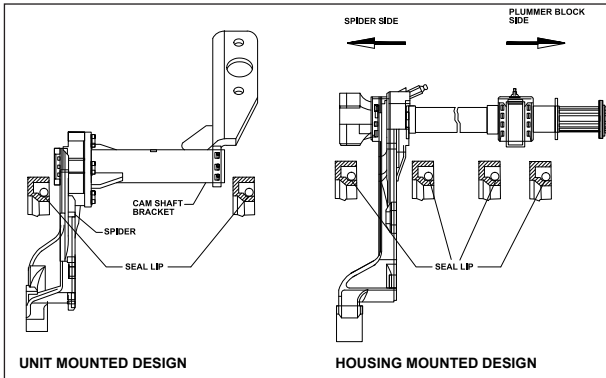


- Check the radial play of the camshaft bushing.

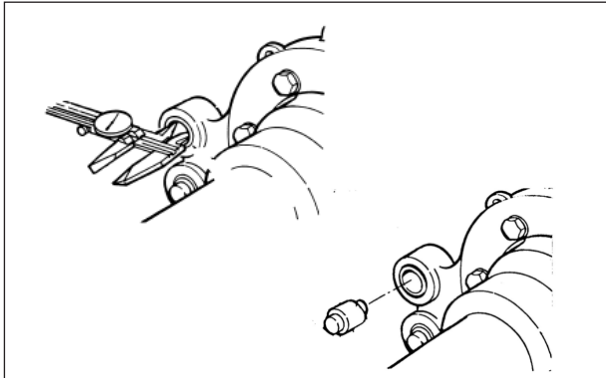


- If it exceeds 0.80 mm replaces the bushes.

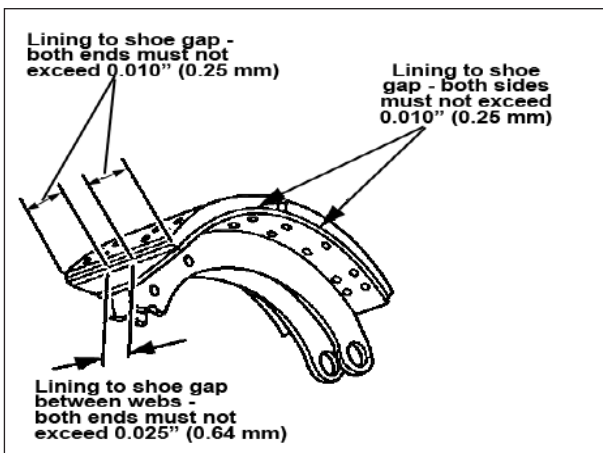




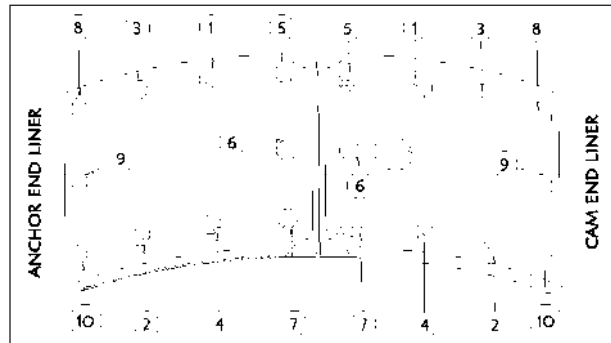
- While replacing the seals in the both spider and bracket, ensure seal lips face the slack adjuster.



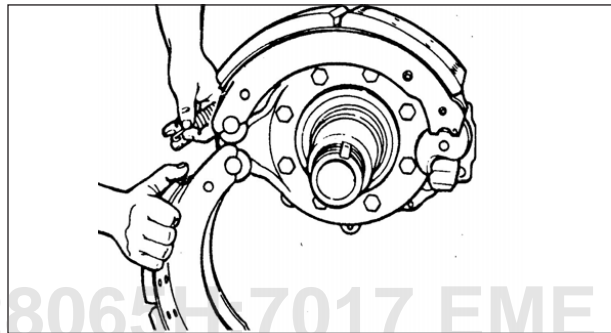
- Check the inside diameter of the anchor pin bushings. The inside diameter of the bushing must not exceed 31.98 mm. Replace worn bushings.
- Smear the grease in the stainless steel bushes of the spiders.
  - Install the anchor pins.
  - Check their radial play in the bushes.
- With the new bushes if there is more than 0.40 mm play, then replace the anchor pins.



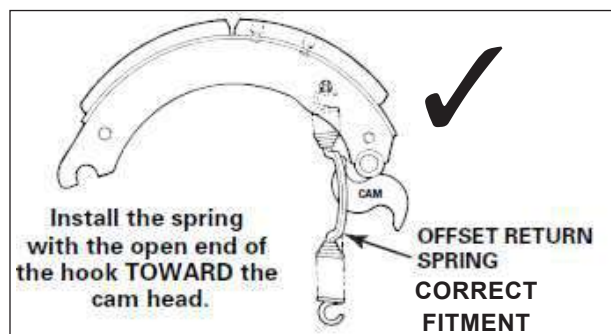
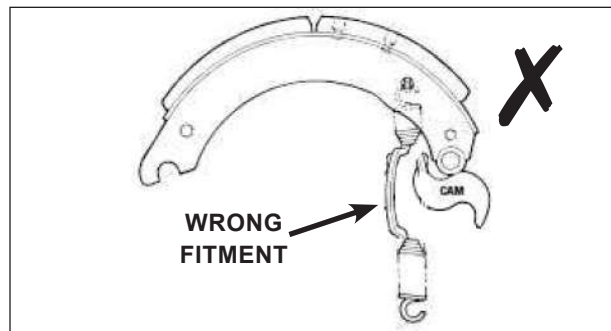
- Check the brake linings.
- Replace the lining when found worn to the level of wear indicator (built in the sidewall of the linings at 4.5 mm thickness).
- During relining, make sure the contact surfaces of shoe and lining is clean.
- Install the rivets in the sequences shown above.



- Check the gap between the shoe and lining along the sides and the ends. This should not exceed 0.25 mm but between webs 0.60 mm gap is acceptable.
- Smear the grease on all the slots of the shoes.
  - Position the shoe over the anchor pin.
  - Hold the bottom shoe over the anchor pins.



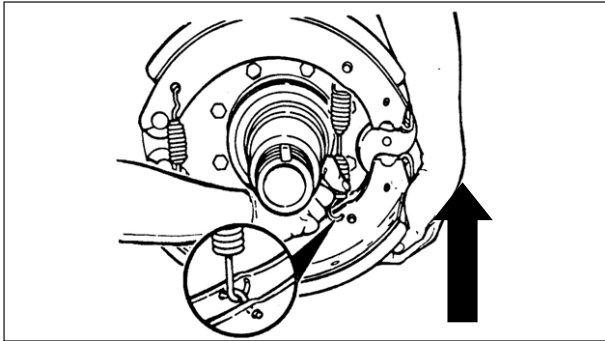
- Install the shoe retaining (anchor) springs.
- Swing and bring the bottom shoe closer to cam head.



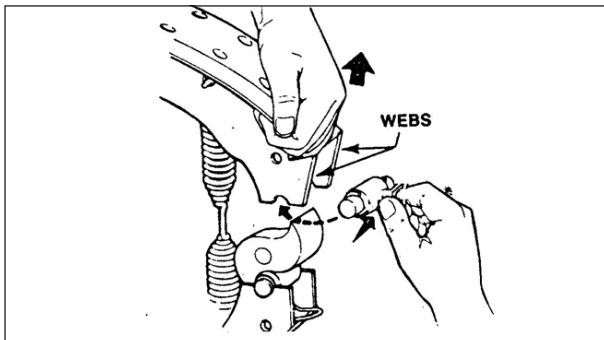
- Install the shoe return spring with the open end of the hook **TOWARD** the cam head so that there will be clearance between spring center bar to hub outer diameter as shown in above figure.



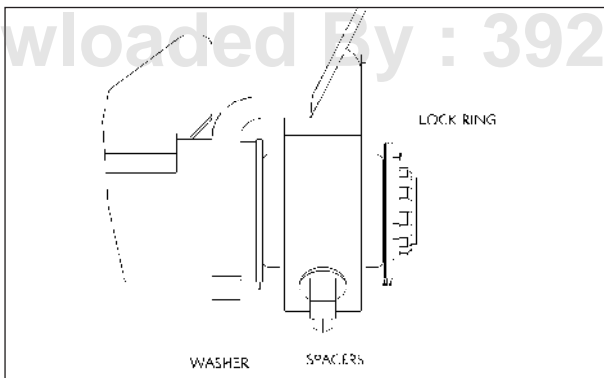
If the spring is fitted other way i.e. open end of the hook is away from the cam head, the spring center bar will foul with the hub outer diameter.



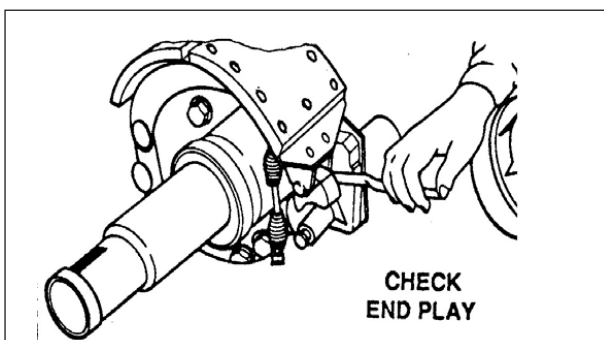
During installation of the spring, make sure the hook is sitting properly on the pins.



- Pull the shoes away from the cam head and install the rollers.

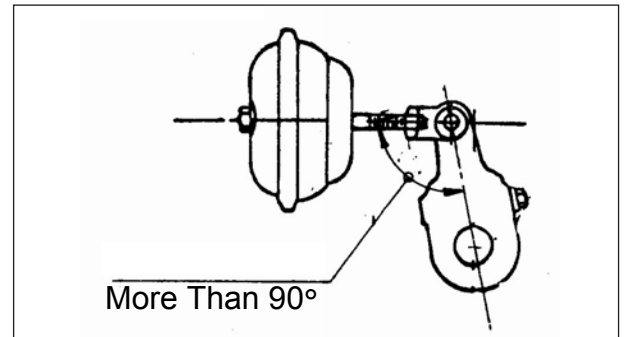


- Install the spacer washer (2.5 mm thick) at the ends of camshaft bracket.
- Install the slack adjuster.
- Assemble one spacer adjacent to slack adjuster
- Next to slack adjuster, add spacer washer's (Ensure 2.5 mm-hardened washers is next to lock ring. Hardened washer can be identified with the semi circular groove on the I.D.)
- Install the new lock ring.



- Check the camshaft end play.

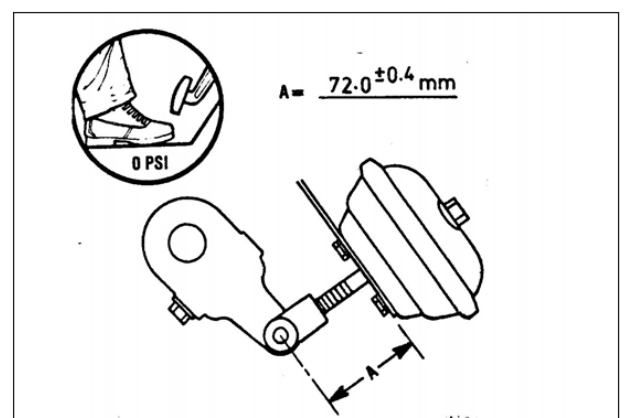
- Recommended play is 0.40- 0.80 mm maximum.
- To reduce the play, increase the spacer washers. (Readjust the end play when it exceeds 1.5 mm during the operation)
- Connect the slack adjuster to the air chamber push rod.



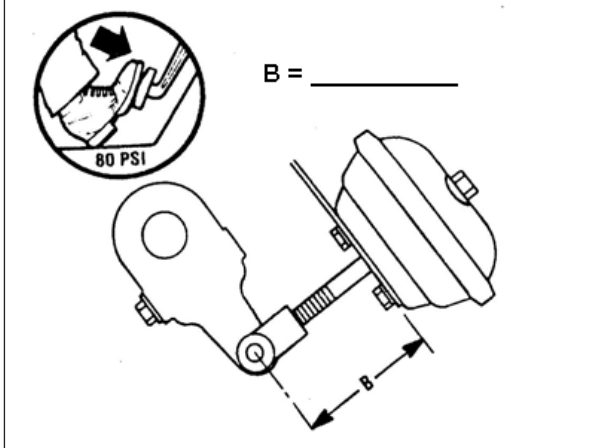
- Check the position of the chamber push rod and the slack adjuster in ' off' position.
- The angle between the center line of the push rod and the slack adjuster should be more than 90°.
- If necessary, remove the slack adjuster Reposition on the splines.
- Install the dust shields.
- Tighten the dust shield mounting bolts to the torque specification, Refer Torque chat.

#### Brake adjustment

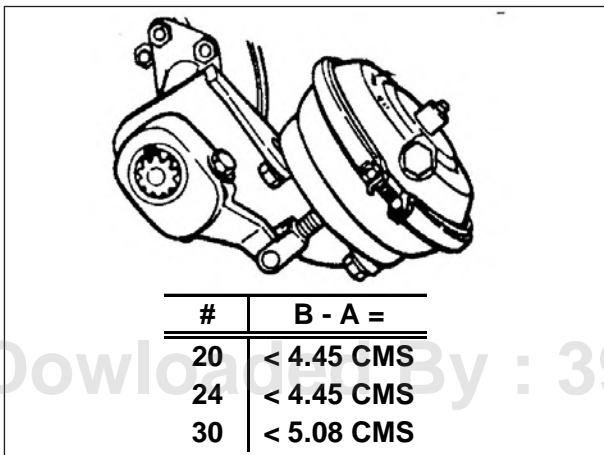
- Refix the drum and mount the wheels.
- Turn the adjusting nut of the slack adjuster till the lining touches the drum.
- Turning the adjusting nut in the opposite direction for one or two clicks so that the lining just clears the drum.
- Rotate the drum and check the running clearance. It will be around 0.25 to 0.40 mm.



- While the brakes are not applied check the distance between the air chamber mounting face and the center of the slack adjuster clevis pin.
- If the reading is not  $72 \pm 0.40$  mm, disconnect the yoke from slack adjuster. Slacken the lock nut rotate the yoke as necessary and refit.



- While the brakes are applied, measure the distance again.

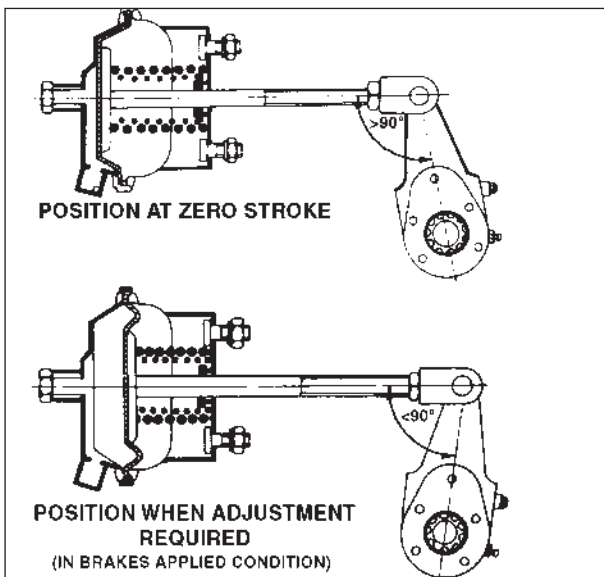


- The difference between the above two readings is the stroke of the air chamber. This should not exceed the prescribed limit.
- Keep the stroke as minimum as possible.
- Brakes are to be adjusted whenever the stroke length exceeds as per the chart shown above.

#### 55.14.6 Maintenance

##### Visual inspection

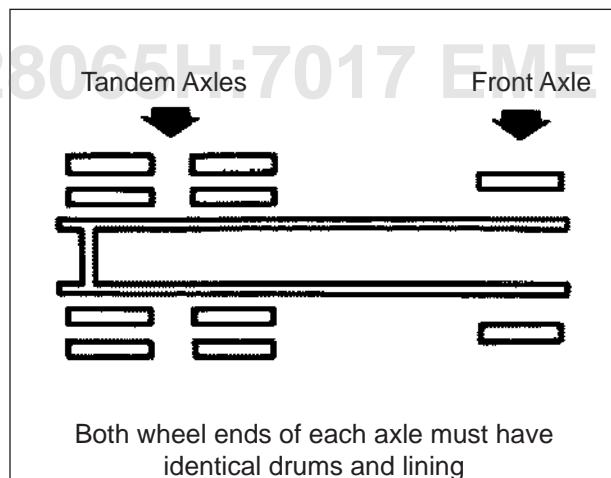
Linings should be checked for wear and gap as mentioned in the Maintenance Schedule.



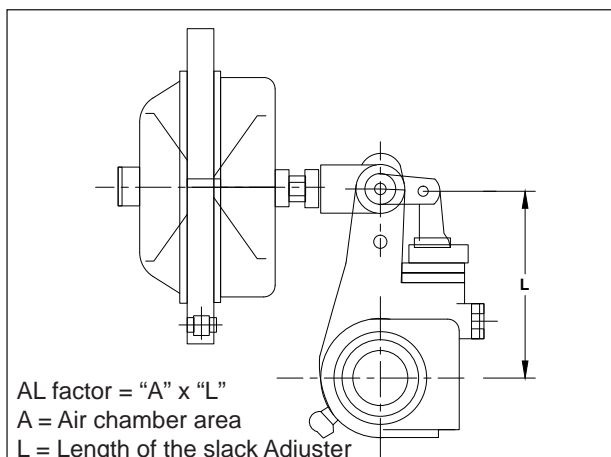
In order to ensure efficient operation, all four brakes must be kept properly adjusted. Excessive travel of the brake chamber push rod indicates the need for brake adjustment i.e. if the angle between the brake chamber push rod and the centre line of slack adjuster is less than 90° in the brakes applied condition, the brakes should be adjusted.

For safe operating conditions and longer components life, make these visual inspections before the vehicle is put into service.

- Check the complete air system for worn hoses and connectors. With air pressure at 100 PSI, brakes released and engine off loss of tractor air pressure must not exceed two psi a minute. Total tractor & trailer loss must not exceed three psi per minute.
- Air system pressure must rise to approximately 100 psi in two minutes.
- The governor must be checked and set to the specifications.
- Both tractor & trailer air system must match the specifications.



- Both wheel ends of each axle must have the same linings and drums. All four-wheel ends of tandem axles also must have the same linings and drum. It is not necessary for the front axle brake to be same as the rear driving axle brakes.
- Always follow the specifications supplied by the vehicle for the correct lining to be used. Vehicle brake system must have correct friction material and these requirements can be changed from vehicle to vehicle.
- Return spring must retract the shoes completely when the brakes are released. Replace the return springs each time the brakes are relined. The spring brake must retract completely when they are released.



- The "AL" factor is air chamber area multiplied by slack length. The AL factor must be equal for both ends of an axle and all four ends of a tandem axle.

### 55.14.7 Major and Minor Inspections

#### Brake Adjustment

1. When air chamber stroke exceeds the limit adjust the brakes.

Maximum stroke at which brakes must be adjusted @ 80-90 PSI Air pressure in the Air chamber. Clamp Type Air Chamber.

Chamber Type (Size)	Stroke Length: not to exceed
9	34.9 mm
12	34.9 mm
16	44.4 mm
20	44.4 mm
24	44.4 mm
30	50.8 mm
36	57.1 mm

The adjusting bolt on manual slack adjuster can reach the limit of its adjustment before the linings are completely worn out. To get additional adjustment, do the following:

- Completely retract the brakes.
- Remove the slack adjuster
- Turn the camshaft to force the brake shoes apart. Install the slack adjuster so that its arm is one spline closer to the yoke than before.
- Adjust the brake



**Brake adjustments should be made only by means of the adjuster screw on the slack adjuster.**

Jack up the wheels clear off the ground. Release the hand brake and check for free rotation of the wheel.

Position a box spanner or a ring spanner (14 mm A/F) over the adjuster hexagon by depressing the locking

sleeve turn the adjuster screw clockwise (while facing the adjuster screw) until the shoe begins to bind the drum. Then turn the adjuster screw anti-clockwise until the wheel rotates freely. Release the locking sleeve.



**Ensure that the locking sleeve engages with the hexagon head of the adjuster screw.**

It is possible to check the clearance between the drum and lining by using a feeler gauge through the inspection hole after removing the rubber grommet from the dust cover. The recommended running clearance is 0.25 mm.

#### 2. Lubrication

- Lubricate the brakes and slack adjuster according to the schedule mention in lubrication schedule.

#### 3. Minor inspection (during every lubrication schedule).

- Check for Spider mounting bolts. Complete retraction of return springs, Left over lining thickness.

#### 4. Brake reline

- Replace the lining when found worn out to the level of wear indicator (built in the sidewall of the linings at 4.5 mm thickness).

Drums to be checked while relining.

#### 5. Major inspection (during every relining)

- During major Overhaul, the following parts must be carefully checked and replaced with genuine replacement parts if required.
  - Brakes spider for distortion and loose mounting bolts,
  - Anchor pins and rollers for wear,
  - Brake shoes for wear and cracks,
  - Camshaft seals for leak and damage.
  - Drums for cracks, scratches and scoring.
  - Ensure same type air chamber and slack adjuster are used on both sides of the axle.
  - Ensure equal stroke length on all wheels



**Do not let the brake linings wear to the point that the rivets touch the drums which will cause damage to the brake drum.**



**Correctly adjust the wheel bearings before adjusting the brake.**

Brakes must be cleaned inspected lubricated and adjusted every time the wheel hubs are removed.



A schedule for the periodic adjustment, cleaning, inspection and lubrication of the brakes equipment must be made according to experience and the type of operation.

Brakes must be adjusted as frequently as required for correct operation and safety. The adjustments must give correct clearance between linings & drum, correct push rod travel and correct balance between brakes.

#### 55.14.8 Cam brake tips

##### Return Spring

Replace cam brake return springs at every cam brake reline. The return spring is critical to alignment, Brake kits accurate return of the brake away from the drum and proper automatic slack adjustment.

##### Linings

Insist on same brand of quality OEM friction lining material to help ensure fewer reline and greater compatibility with your present system.

##### Hardware

When you service cam brakes, replace all the springs, anchor pins, bushings and rollers – not just the shoe return springs – to help ensure maximum braking performance.

##### Drums

To help ensure balanced braking, even lining and drum wear and proper function of the automatic slack adjuster, do not install a cast drum and centrifuse drum on the same axle.

A cast drum and centrifuse drum each absorbs and dissipates heat differently. When drum type and weight are mixed, different rates of heat absorption and dissipation occurs that can affect the brake system.

##### Air Chambers

To ensure proper brake balance, all the brake chambers on the same axle must be the same size and type to help ensure a balanced brake system and maximize lining wear and drum life.

##### Brake kits

Brake shoes, rollers, camshafts and shoe return springs are designed to perform as a system. Always install OEM specification level components during maintenance to help ensure proper brake performance and maximum lining life.

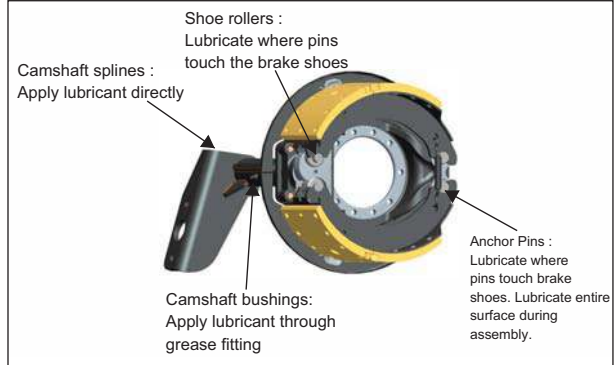
##### Cam heads

Cam heads can look the same, but that doesn't mean they will perform the same in your brake system. Two cam head profiles can appear to be identical, but very small difference in cam from different manufacturer can be significant enough to affect the performance of your brakes. To ensure a balanced brake system and optimum lining and drum life, always install the proper replacement cam

##### Cam Roller

To avoid flat spot, lubricate a cam roller directly in the web roller pocket and not at the cam to roller contact area. Flat spots can affect brake adjustment and result in premature brake wear or reduce braking performance.

#### 55.14.9 Lubrication



**When grease flows from the seal near the cam head, replace the seal. Remove any grease from the cam head, roller & linings. Grease on the lining can increase stopping distances. The use of an unapproved grease can damage components or shorten their useful life and void warranties. Not all approved greases are compatible with one another, and therefore should not be mixed.**

##### Cam Shaft Bushings

Install new camshaft bushings whenever you install a new camshaft or relined brake shoes.

- Off-Highway application: When seals are replaced or when brakes are relined. Lubricate more often for severe duty. Lubrication frequencies can be determined by inspecting the internal parts & lubricant every two weeks. At each inspection Look for hardened or contaminated grease or for the absence for the grease.
- Lubricate through the fitting on the bracket or the spider until new grease flows from the inboard seal

##### Brake spider Bush and Anchor Pins

- When the brake is disassembled or when necessary, lubricate the stainless steel bush, Anchor Pins & the spider where they touch the brake shoes.

##### Cam shaft splines

- Lubricate when the brake is disassembled or when necessary

##### Shoe Roller

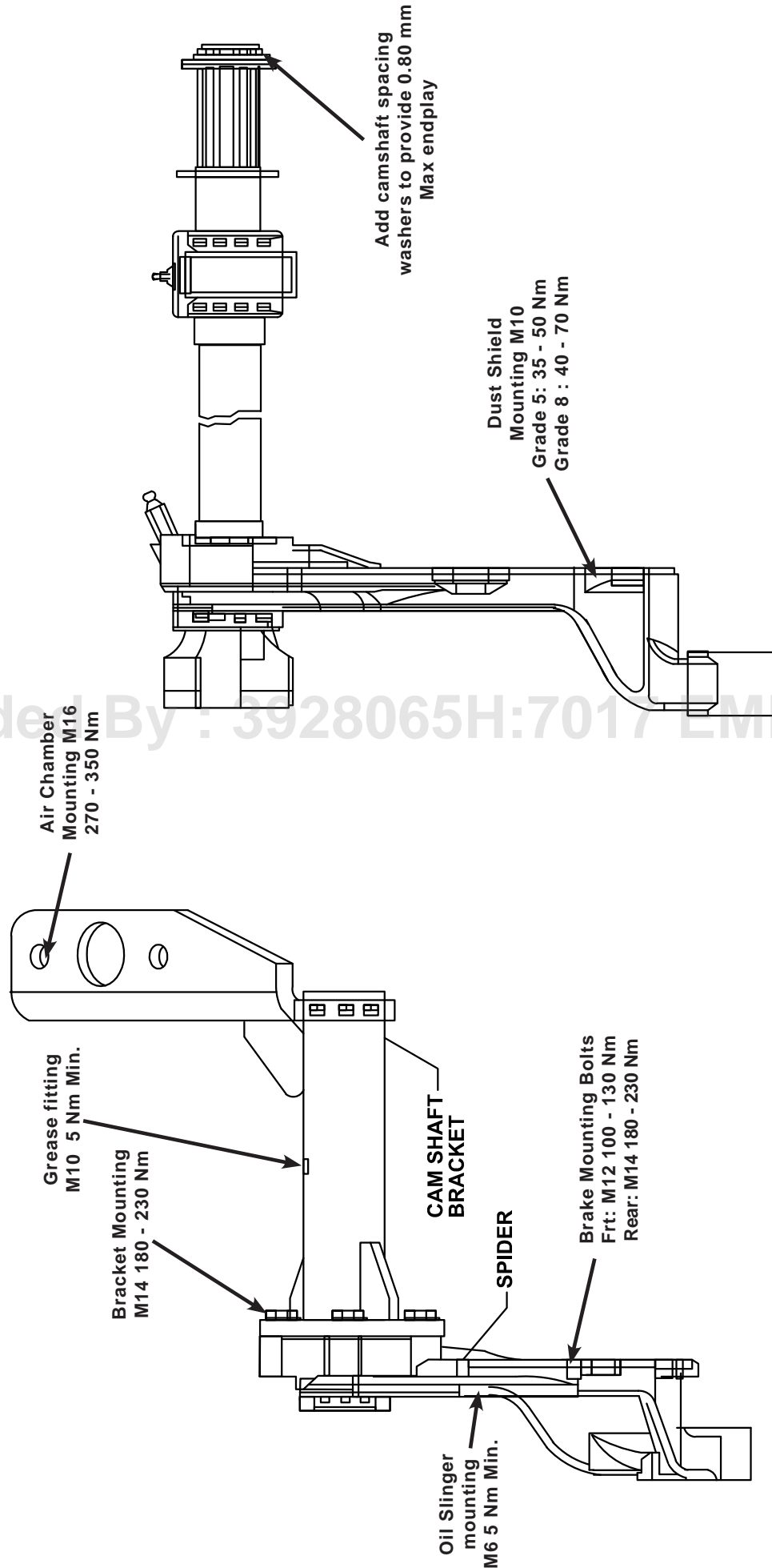
- When the brake is disassembled or when necessary, lubricate the rollers where they touch the brake shoes. Do not get grease on the part of the roller that touches the cam head

##### Slack Adjuster

- Use following schedule that gives the most frequent lubrication:
- Your Fleet's chassis lubrication schedule.
- The chassis manufacturer's chassis lubrication schedule.
- A minimum four times during the life of the linings.
- Lubricate through the fitting until new grease flows from the around the inboard splines, or from pawl assembly.



## 55.14.10 Torque Chart

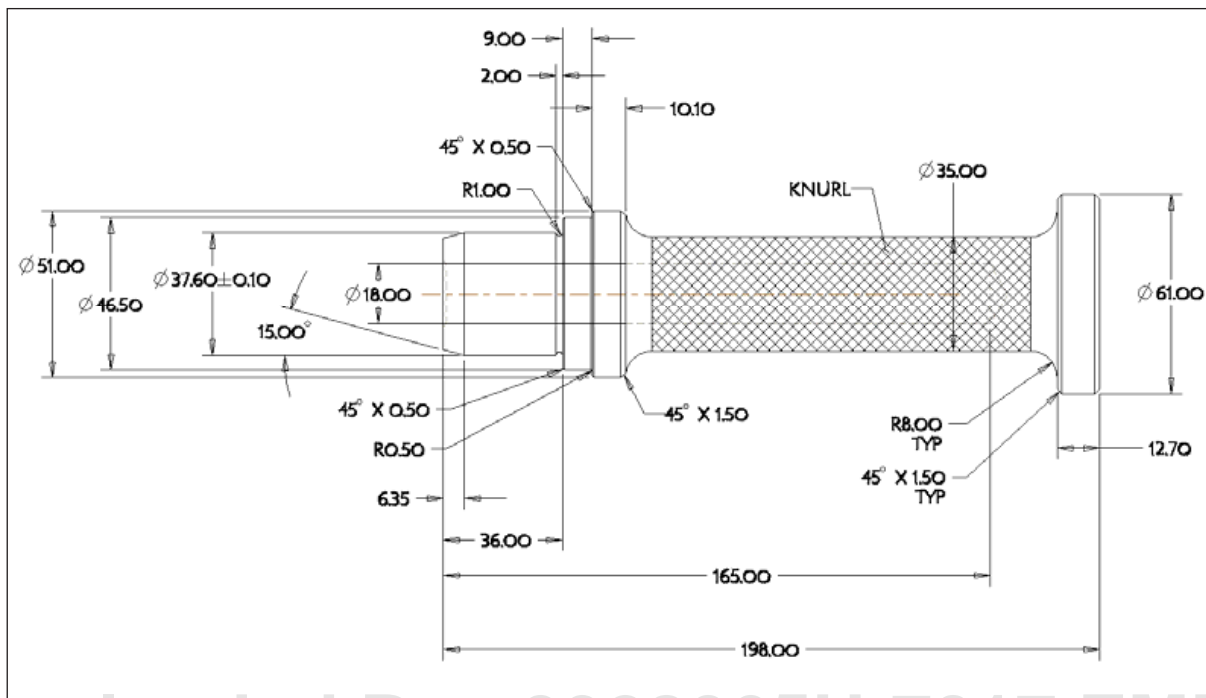




## 55.14.11 Special tools

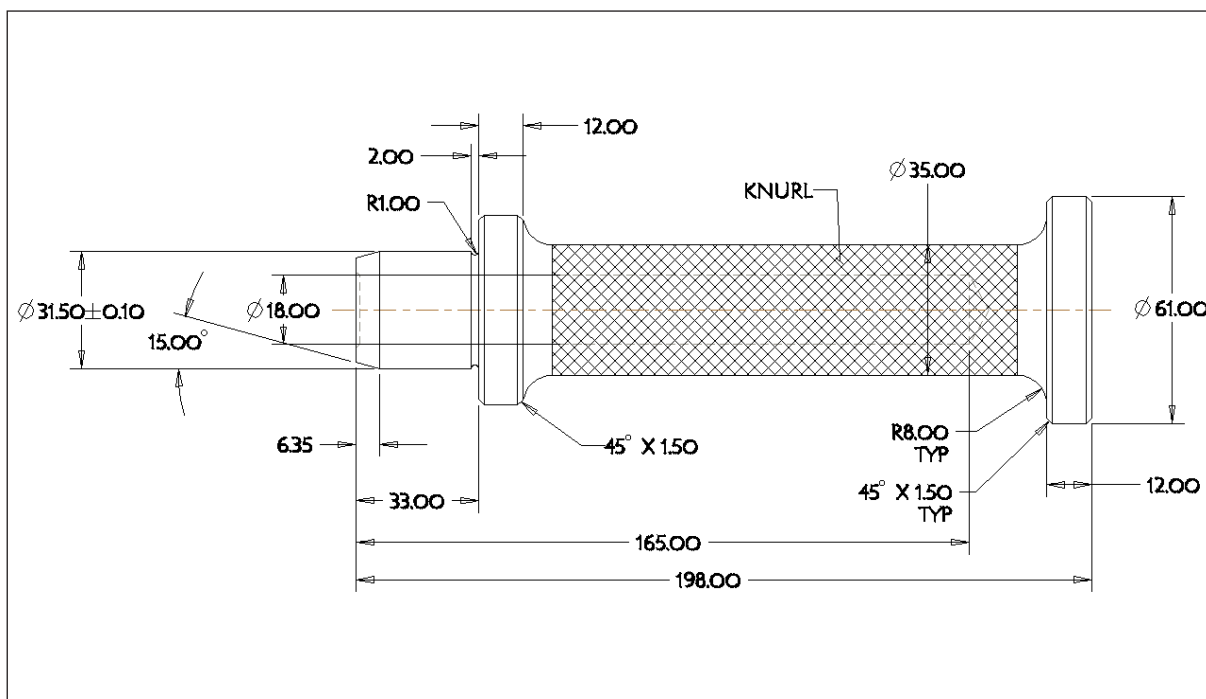
The below images outline the machining and construction techniques for producing tools necessary to aid in servicing cam brakes. All tools are within the capability of a reasonably equipped machine shop.

## Camshaft bushing and seal driver (slack adjuster end of bracket)



Material: SAE -01 Oil Hardened Tool Steel Hardened to Rock "C" 50-55 -8 grind

## Bush - anchor pin pressing tool (in brake spider)



Material: SAE -01 Oil Hardened Tool Steel Hardened to Rock "C" 50-55 -8 grind

**55.15 MANUAL SLACK ADJUSTER**

Item	Description	Qty	ItemDescription	Qty
1	Slack Adjuster Body	1	6 Bush	1
2	Rivet	5	7 Worm Shaft Lock	1
3	Cover Plate	2	8 Worm Shaft	1
4	Worm Wheel	1	9 Worm Shaft Spring	1
5	Worm	1	10 Grease Nipple	1

**55.15.0 Description**

Slack adjusters provide a quick, easy method of adjusting brakes to compensate for brake lining wear. Slack adjusters were designed to conform to the development of heavy-duty, two shoe foundation brakes.

The slack adjuster consists of a forged steel body which constitutes both the arm and spline housing in one piece. A worm gear with internal splines along with its driving worm on its shaft is housed in the body and the worm wound shaft turns tangentially to the worm gear and is plugged at one end and locked in position by a worm shaft lock at other end.

The worm and the worm shaft are press fit and run as single unit. The locking of the worm shaft is achieved by the spring loaded lock, looking on the hexagonal head of the shaft. The lock itself is prevented from rotating by a pin fixed to the body and running along a slot on the exterior of the lock. The whole unit is sealed by two-end of the arm contains a reamed hole with a sintered

bronze bush pressed in, wherein the operating lever is coupled for actuation. The mating parts are lubricated with grease fed through a grease nipple.

**55.15.1 Operation**

Slack Adjusters perform a two-fold function: (1) they serve as a lever during normal braking operation and (2) provide a quick and easy method of adjusting brakes.

**55.15.2 Braking**

In normal braking. The entire slack adjuster remains rigid as a unit and rotates bodily with the brake cam shaft as the brakes are applied or released. When the brakes are applied (a) air pressure actuates the brake chamber, (b) the brake chamber push rod rotates the slack adjuster, (c) the slack Adjuster rotates the cam shaft and cam thereby spreading the brake shoes, applying the brakes. When brakes are released, (d) the air pressure in the brake chamber is released, (e) the brake cam, cam shaft, slack adjuster and brake chamber push rod comes to the released position.

**55.15.3 Adjustment**

Brakes are adjusted by turning the adjusting screw of the Slack Adjuster with a common open end box or socket wrench, after releasing the worm gear. Turning adjusting screw rotates the worm gear. Turning the worm gear rotates the cam shaft and brake cam. The brake cam spreads the brake shoes and compensates for lining wear.

Brakes on a vehicle can be adjusted by merely turning the adjusting screw until brake shoes are against the brake drum with the brakes released. Back off the adjustment for the sufficient brake lining clearance.

After proper adjustment apply the brakes. The slack adjuster arm and brake chamber push rod should form an angle slightly greater than 90 degrees. All slack adjusters on the vehicles should be at the same angle.

**55.15.4 Removal**

- (a) Remove the clamp from the 'S' camshaft.
- (b) Disconnect the yoke/brake chamber push rod by removing the clevis/in
- (c) Withdraw the slack adjuster.

**55.13.5 Dismantling**

Remove rivets holding covers and gear in place.

Remove welch plug.

Press out worm shaft from worm by pressing on the end of the worm shaft opposite the adjusting screw nut.

Remove worm shaft, worm shaft lock and worm lock spring.

Remove worm and gear from slack adjuster body.

After slack adjuster is dismantled, clean all parts in cleaning solvent.

Carefully inspect body for cracks or distortion.

Check play in yoke pin holes.

If yoke pin is loose in hole, or if hole is out round, press bushing out and press in replacement.

Ream bushing after pressing in.

Check inside surface of body, especially the surface where the worm gear rotates in the body. This surface must be smooth and free of any heavy nicks or scratches. Make sure the grease holes in the body are open and clear.

Inspect worm gear for broken teeth or damaged spline. Replace gear if either is found.

Check worm for bent, broken or deeply scored threads and replace if any of these conditions prevail.

Check the worm shaft lock for wear. It should be replaced if worn excessively.

Inspect the worm shaft lock pin in the body, making sure it is rigidly installed. If loose remove it and install replacement, prick punching it to body.

The bores of all worms, are serrated to assure a rigid assembly with worm shaft. Repeated removal and installation of worm shaft in a serrated bore may make the shaft unfit for further use. Judgment must guide in most shaft be installed when rebuilding and slack adjuster.

**55.15.6 Assembly**

Place worm and gear in slack adjuster body.

Position and press the worm shaft, worm shaft lock and worm lock spring into the worm and slack adjuster body.

Be careful to press the worm shaft into the body to the proper dimension.

Be sure to line up the recess in the worm shaft lock within the pin in the slack adjuster body before pressing into position.

Replace old welch plug with new one and install.

Install covers and rivets and rivet securely.

**55.15.7 Fitment**

Provide clearance so that the slack adjusters can be rotated to the maximum stroke of the brake chamber.

Locate slack adjuster on camshaft so both the adjusting screw and grease fitting are accessible for servicing. Grease slack adjuster.

Test and make sure the proper adjustments are made to provide for these conditions when installing a slack adjuster.

**55.15.8 Tests**

Apply brakes and check to be sure slack adjusters rotate freely and without binding.

Release brakes and check to be sure slack adjuster return to the released position freely without binding.

With brakes released, check to be sure the angle formed by the slack adjuster arm and brakes chamber push rod is greater than 90 degrees. All slack adjusters should be set at this same angle.

With brakes applied, check to be sure the angle formed by the slack adjuster arm and brakes chamber push rod is still slightly greater than 90 degrees. All slack adjusters should be set at this same angle.



### 55.16 AUTOMATIC SLACK ADJUSTERS

The Slack Adjuster is a link between the brake chamber or actuator and the foundation brake camshaft. It transforms and multiplies the force developed by the chamber into a torque that applies the brakes via the brake camshaft. Slack adjusters provide a quick, easy method of adjusting brakes to compensate for brake lining wear.

The excess clearance between the brake lining and the brake drum (due to the wear of brake lining or brake drum) to be adjusted automatically to have effective braking. Automatic slack adjuster (ASA) works on the principle of clearance sensing and adjust for the excess clearance between the brake lining and brake drum automatically.

#### 55.16.0 Installation Procedure of Automatic Slack Adjuster on Front Axle.



1. Mount the Brake chamber.



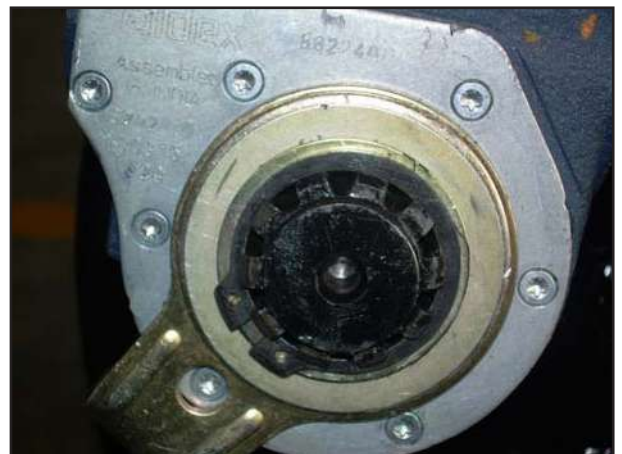
2. Add shim on the S camshaft.



3. Always install the Automatic Slack Adjuster (ASA) with **arrow indicated** in the direction of the brake actuation.



4. Install ASA, add shims to maintain axial play of 0.3 to 0.8 mm and finally put circlip.



5. Rotate control arm of ASA and match it on the 3<sup>rd</sup> mounting screw.





6. Rotate the adjusting hex nut by 12mm ring spanner clockwise till the ASA tail hole match fork pin's center hole.



7. Visually check the matching of both holes as shown.



8. Put the Pivot bolt & nut **without pulling pushrod fork**.



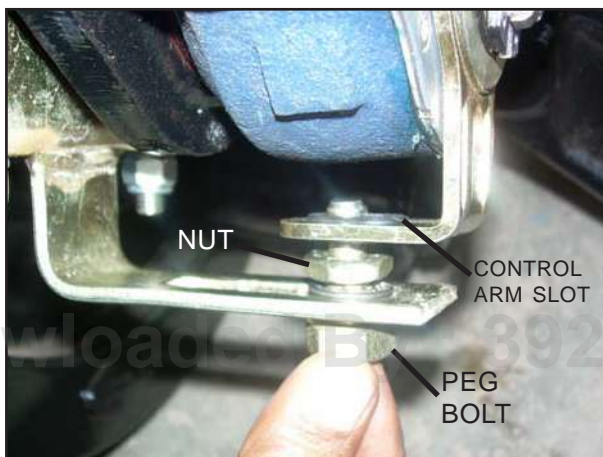
9. Place Anchor bracket's "U" bolt alone on S cam's housing.



10. Fix the remaining part of anchor bracket as shown & tighten the U bolt assembly.



11. Place the peg bolt in to the anchor bracket's slot as shown.



12. Match the Peg bolt & nut inline with ASA's control arm slot and tighten the nut.



13. Ensure minimum 2 mm projection of bolt above the control arm slot



14. Rotate the adjusting hex nut clockwise until the lining contacts the drum using 12mm spanner. **Don't use pneumatic gun.**



15. To set the clearance, back off the adjuster by turning the adjusting hex nut anti-clockwise (1/2 turn to aim 180°) Torque: Min 18 Nm). **Don't use pneumatic gun.**



**While turning the adjusting hex nut anti clockwise direction, much more effort is required than when turning clockwise and the action of the serrated clutch should be distinctly heard. Do not treat this as any failure.**

16. Operate the brake pedal for 15 applications to complete the automatic adjustment and stabilize at optimum lining clearance.



**Make sure that minimum of 7 bar pressure in the system, while doing the above operation. On release of every application, allow sufficient time for brake to fully retract. Same make of ASA should be used on both RH & LH sides.**



### 55.16.1 Installation Procedure of Automatic Slack Adjuster on Rear Axle.



1. Mount the Brake Actuator with Anchor bracket (loosen condition) - **Fig - 1. Ensure push rod is fully retracted as shown and don't proceed without this.**
2. Add shim on the S camshaft.



3. Always install the Automatic Slack Adjuster (ASA) with **arrow indicated** in the direction of the brake actuation.



4. Install ASA, Add shims to maintain axial play of 0.3 to 0.8 mm and finally put Circlip.



5. Rotate the adjusting hex nut by 12mm ring spanner clockwise till the ASA tail hole match fork pin's center hole.



6. Visually check the matching of both holes as shown.
7. Put the Pivot bolt & nut **without pulling pushrod fork.**





8. Align the control arm in the Anchor bracket slot



9. Fasten the Anchor Bracket along with actuator mounting bolt.



10. Tighten the hex nut, fastening Anchor Bracket with ASA control arm.



11. For brake setting, rotate the adjusting hex nut clockwise until the lining contacts the drum using 12 mm spanner. Don't use pneumatic gun.



12. To set the clearance, back off the adjuster by turning the adjusting hex nut anti-clockwise (1/2 turn to aim 180°) Torque: Min 18 Nm). **Don't use pneumatic gun.**



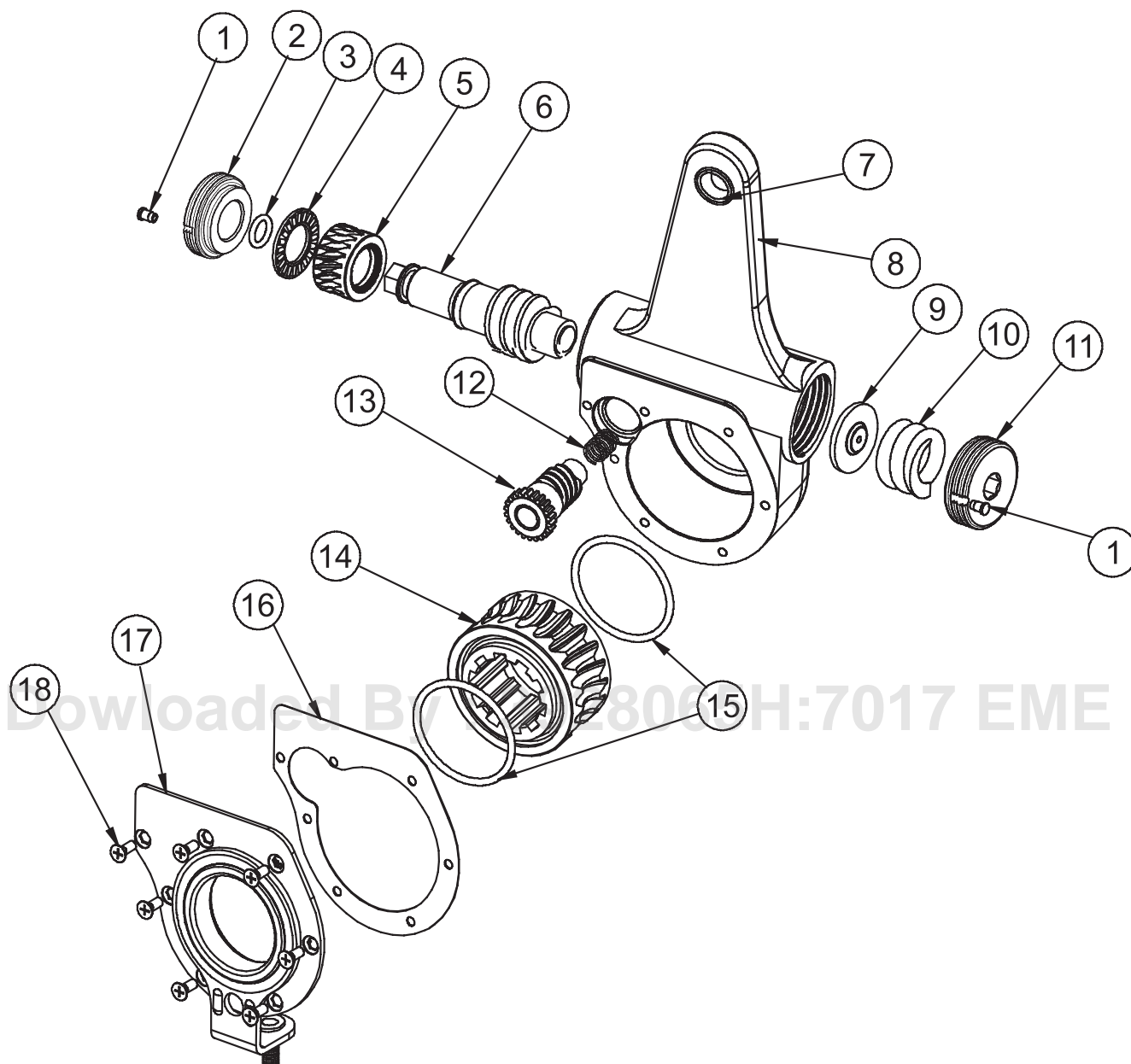
**While turning the adjusting hex nut anti-clockwise direction, much more effort is required than when turning clockwise and the action of the serrated clutch should be distinctly heard. Do not treat this as any failure.**

13. Operate the brake pedal for 15 applications to complete the automatic adjustment and stabilize at optimum lining clearance.



**Make sure that minimum of 7 bar pressure in the system, while doing the above operation. On release of every application, allow sufficient time for brake to fully retract. Same make of ASA should be used on both RH & LH sides.**

## SELF SETTING - AUTOMATIC SLACK ADJUSTER



1. Rivet
2. Bearing Retainer
3. Sealing Ring
4. Thrust Bearing
5. Clutch Worm Wheel
6. Worm Shaft
7. Bush (tail Hole)
8. Body
9. Spring Seat
10. Heavy Coil Spring
11. Spring Retainer
12. Retainer Spring
13. Pinion Assembly
14. Worm Wheel
15. Sealing Ring
16. Gasket
17. Cover Plate Assembly
18. C' Sunk Head Screw

**55.16.2 Function**

MEI Self Setting Automatic Slack Adjuster is a clearance-sensing Slack Adjuster, which maintains optimal clearance between lining and drum, in addition to working as a lever to move the brake shoe to the drum, through the S Cam.

**How it works**

When the brake is applied, Control arm fixed to the anchor bracket permits the mechanism to rotate through the clearance angle and shoe contacts the drum. On further application the torque increases and the worm shaft is moved axially, causing the heavy coil spring to compress and the disengagement of clutch wheel.

During brake release, the torque decreases and the clutch mechanism gets engaged and advances, reducing the sensed excess clearance by rotation of the worm shaft, in small increments. Full adjustment takes place after few brake applications and release.

This gradual adjustment is design feature, to eliminate over adjustment

**Service procedure****a) Inspection**

With the brake released, ensure that the angle between the slack adjuster arm and the Brake chamber push rod is greater than 90°. Ensure all the slack adjusters are with this same angle.

With brake applied, the angle formed between the slack adjuster arm and the Brake chamber push rod is 90° or more.

**b) Operating Tests**

Apply the brakes and check for free movement of the slack adjuster (with out binding).

Release the brake and check for free return of slack adjuster.

Inspect SASA for proper functioning.

- Close, drum to shoe clearance to '0' by rotating Adjusting hex Clockwise.
- De-adjust to approximately 180° to get nearly 1 mm gap by rotating adjusting hex counter clockwise. Healthy clicking sound with a torque of above 18 Nm is needed for a Good slack adjuster.

Apply service brake for few applications and observe whether adjusting hex rotating clockwise to assess functioning.

**c) Removing**

Block the wheels to prevent vehicle movement.

Keep the hand brake in released position (parking brake valve in 'OFF' position)

If SASA is fitted on a Spring brake actuator axle, spring brake to be released (to be mechanically wound off).

Remove clevis pin / bolt.

Remove Circlip from the camshaft along with washers and then the slack adjuster.

**Tools required****55.16.3 Dismantling**

Remove cover plate screws (18) with special screw driver.

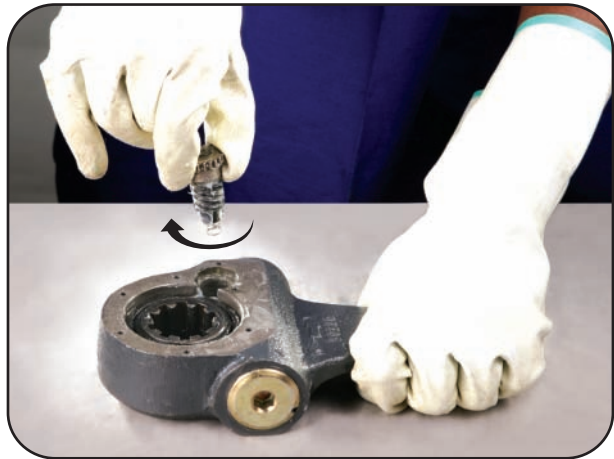


If tight, hammer and loosen.

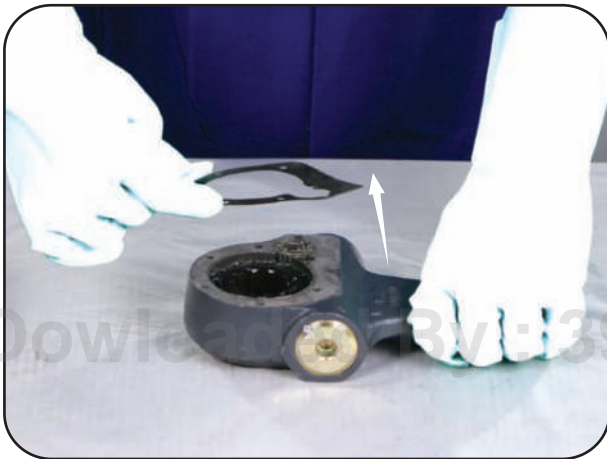




Remove cover plate assembly (17).



Remove pinion assembly (13)



Remove the gasket (16)



Remove rivet (1)



Use 12 mm A/F ring spanner



Remove bearing retainer (2)



Remove worm shaft assembly



Remove coil spring(10) & spring seat(9)



Detach sealing ring(3), thrust bearing(4) and clutch worm wheel (5)



Remove worm wheel (14)



Remove spring retainer(11) with 10 mm allen key



Remove sealing rings (15)





Body (8), sealing rings (15) and worm wheel (14)



Remove tail bush (7)

#### 55.16.4 Cleaning and inspection



Clean all the components with a cleaning solvent and blow dry with compressed air.

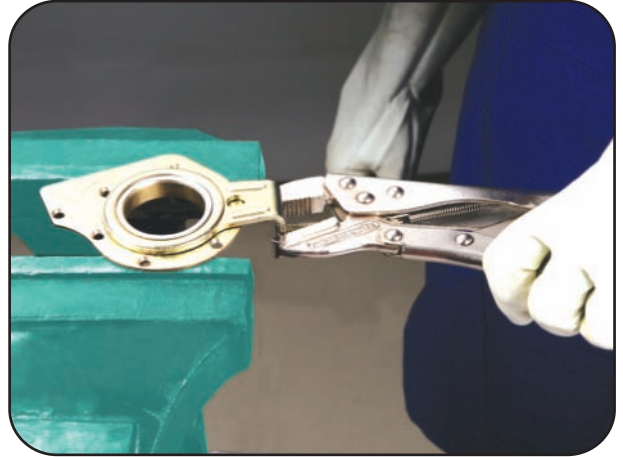
Ensure that no trace of solvent is present in the components during assembly.



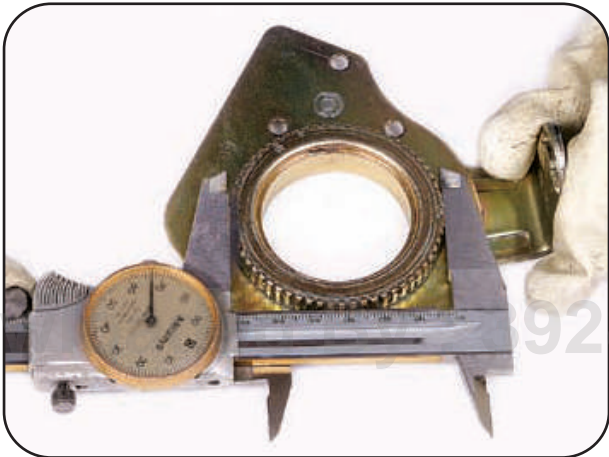
Check the body (8) bore for wear and change if dia is >62.2 mm.



Check ovality of the body. Permissible ovality: 0.25 mm.



Check control arm for 'O' shake by rotating horizontally.



Check control gear wheel for wear/ovality. Replace cover plate assembly if the gear dia. is < 61.50.



Check worm wheel for wear and replace if the dia is < 61.85.



Check control arm for bend/crack and replace cover plate assembly if necessary.



Check visually for wear / damage and replace if necessary



Check worm wheel for spline wear/chipping and replace if necessary.



Check worm shaft and worm wheel serration for wear.



**Scrap all components that are replaced with the ones supplied with the repair kit. Deface/damage the removed components.**

### 55.16.5 Reassembly



Use recommended minor repair kits during service.



Use recommended major repair kits when worn after long service.



Press new tail bush (7)





Use genuine grease supplied with the repair kit (2 sachets of 20 g each)



Lubricate with grease



Lubricate with grease

#### 55.16.6 Reassembly



Place worm wheel (14) in the body.



Assemble worm shaft (6)



Assemble clutch worm wheel (5) with serration facing worm shaft serration.



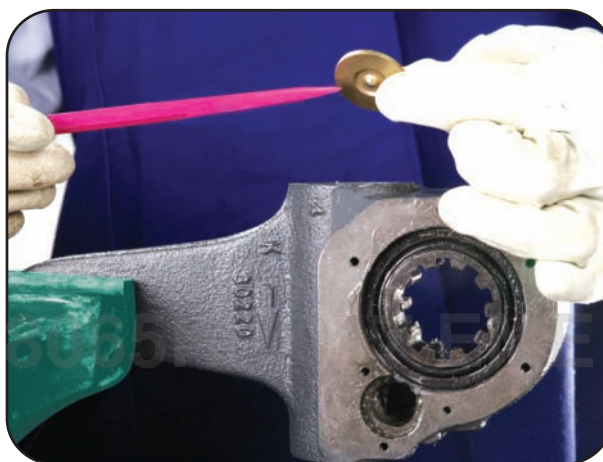
Assemble thrust bearing (4)



Tighten bearing retainer (2).



Assemble sealing ring (3)



Dimple of spring seat (9) to face worm shaft rear.



Assemble bearing retainer (2).



Assemble spring seat (9).

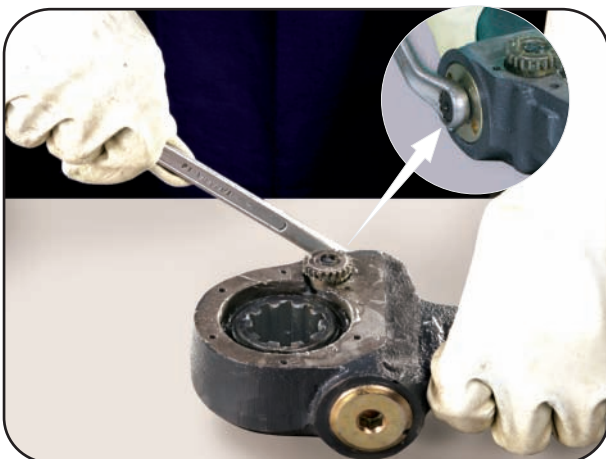




Assemble heavy coil spring (10)



Assemble spring retainer (11) Tighten spring retainer (11) with 1 to 1.5 mm projection above the body face.



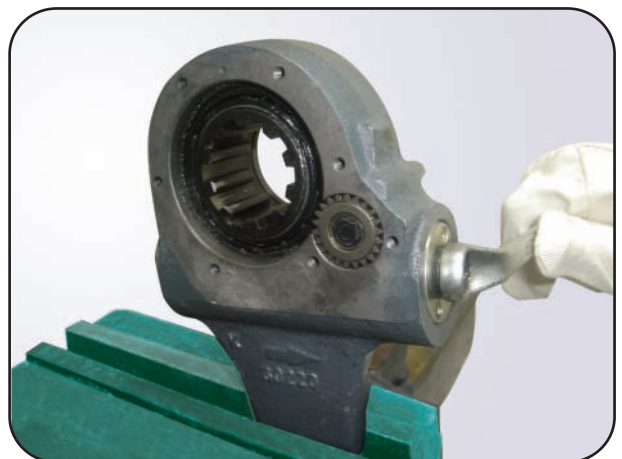
Assemble pinion assembly (13) with retainer spring (12)



Assemble gasket (16) after applying grease on both faces.

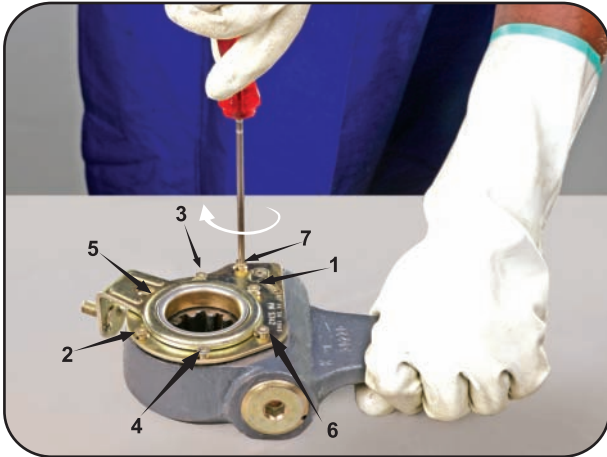


Assemble cover plate assembly (17)



Rotate worm shaft adjusting hexogen few times for free rotation of pinion assembly. (Do not use impact wrench).





Tighten cover plate assembly sequentially with c'sunk screws



Set clutch release force to  $375 \pm 15$  Nm



Install dial gauge and rotate worm gear either side to determine worm shaft end float. Permissible end float : 0.18 to 0.60



Fix rivets at both sides

#### 55.16.7 Replacing

Supply minimum 7 bar air pressure to spring brake chamber to ensure full retraction of push rod.

Fit anchor bracket loose after removing bottom/top brake chamber mounting nut, as applicable.

Fit the SASA with the arrow/12 mm adjusting Hex pointing away from the brake chamber.

Align slack adjuster tail hole with the clevis, by rotating the 12 mm adjusting hex.

Smear grease and fit the clevis pin/bolt and secure. Align control arm bolt to anchor bracket slot.

Secure the automatic slack adjuster on to the camshaft with circlip ensuring 0.5 mm axial play.

Tighten control arm to anchor bracket with washer and nut.



Check free movement of control arm. Check for clockwise rotation of Wormshaft.

**55.17 GENERAL SERVICE MAINTENANCE****Adjustment of Brake**

Jack up the vehicle till the wheels rotate freely.

Manually close the lining to brake drum gap to "0" by rotating 12 mm Adjusting Hex clockwise.

Deadadjust approximately 180° by rotating 12mm adjusting hex anticlockwise to achieve a gap of nearly 1 mm. (Do not use impact wrench).

Apply service brake (with 7 ksc air pressure) few times allowing full retraction during brake release. Observe clockwise rotation of Wormshaft.

Adjustment takes place in small increments and stabilizes once pre set clearance is achieved.

**Lubrication**

See vehicle manufacturer's recommendations for lube intervals.

MEI SASA prepacked with good quality long term grease and doesn't require lubrication except when overhauling.

Clevis pin should be lubricated at service intervals.

A light spray of oil is recommended around camshaft splines to reduce corrosion and seizure of adjuster where the adjuster is secured by a circlip.

**Brake Shoe Relining**

After relining brake shoes, carry out operations, explained under 'Adjustment of brakes'

**Fault Finding**

Check free stroke.

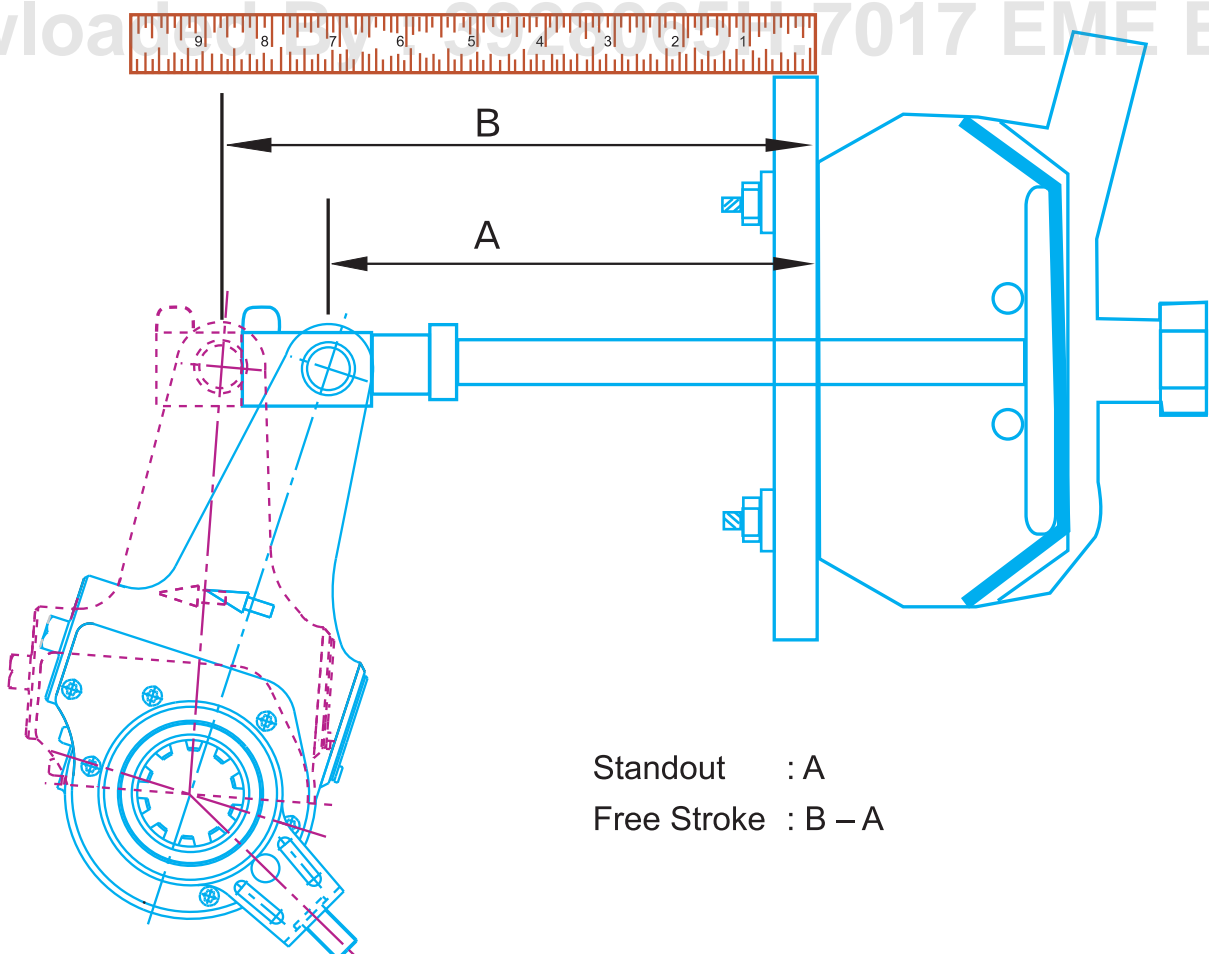
**FREE STROKE** to be checked by moving the tail of slack adjuster with a lever to touch the brake drum (just touch).

For 140 mm arm length - 21 mm max.

For 160 mm arm length - 26 mm max.

**Excessive Push Rod Travel/Poor Braking**

Check push rod is returning to full OFF position and camshaft is not sticky.



Check, there is no excess radial play or wear in camshaft, bushes, clevis pin, and control arm and anchorage attachments.

Check slack adjuster operations.

Insufficient Push Rod Travel/Binding of Brake.

Check, cam shaft is free with cam bush, cam bush in place without excess wear. Brake shoe rollers are without wear and brake shoe return springs not weak.

Where spring brake chambers are fitted, check sufficient air pressure available to keep parking brake to OFF position (min 7 bars).

### Operating Checks

See vehicle manufacturer's data for service intervals.

Ensure installation is secure and control arm and anchor bracket are tight. If not, tighten.

### Adjusting Function

#### Deadadjustment torque

Place a torque wrench on 12 mm adjusting hexagon and turn anti clockwise to check the torque. Torque to be more than 18 Nm (131bft) for a healthy slack adjuster. If torque is less or adjuster slips, assembly to be replaced.

Manual check of torque, in the absence of torque wrench. Deadadjusting brake, by at least one full turn, to give excess lining clearance and apply and release brake few times. Observe adjusting hexagon rotates clockwise at the end of every return stroke. If rotation is zero or anti clockwise, adjuster must be replaced immediately.

Leaving spanner on the adjusting hexagon, will enable, easy viewing of rotation/adjustment.



**When rotating 12 mm adjusting hexagon anticlockwise, much more effort is required than when turning clockwise and the action of serrated clutch should be heard distinctly. This also is an indication of satisfactory functioning.**

Sasa should not be adjusted manually once setting is done.

## 55.18 DO'S & DON'TS DURING INSTALLATION

### Do's



While fitting auto slack adjuster Check the Direction of ARROW/Adjusting HEX is pointing away from Brake chamber.



During checking the function, give one/two second interval after release of every brake application to enable auto adjustment.

Auto adjustment takes place only during brake release.

### Don'ts



Do not push slack adjuster or pull clevis to fit pin/bolt.

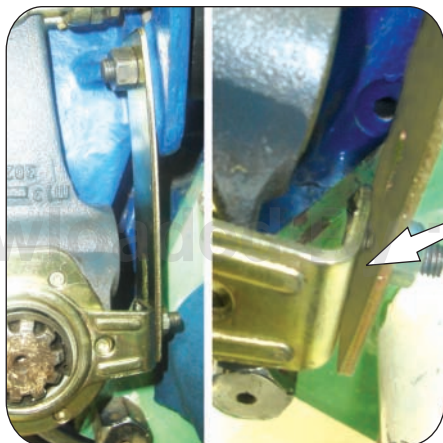
Rotate 12 mm Adjusting Hex for aligning adjuster to clevis





Do not Anchor control arm near adjustment Hex.

Preferred to anchor near brake chamber. If anchored at adjusting hex side, care should be taken to anchor within 45 deg from center axis of slack adjuster to avoid fouling.



Do not bend anchor bracket while fastening to control arm. Bent control arm will deter proper functioning of slack adjuster.

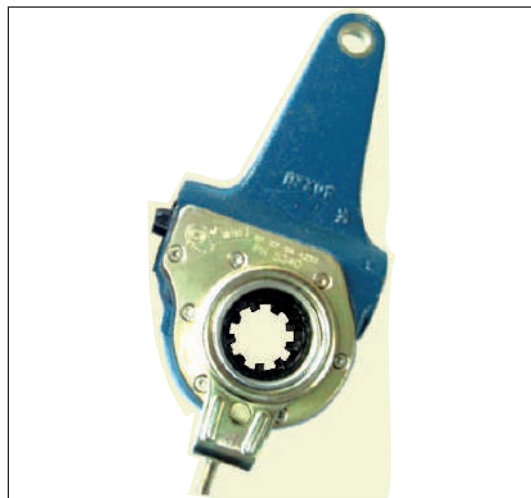
If gap observed, use required washers.



Do not use power wrenches to close the drum gap or during de-adjusting to 180 deg, while setting.

Use only hand tools (Ring spanner)

#### Advantages of using automatic slack adjuster



No need for periodical brake adjustments and vehicle downtime for brake adjustment is eliminated. Reduces the maintenance cost due to elimination of brake adjustments.

- Less consumption of air pressure during every brake application due to shorter stroke of actuators.
- Possibility of increase in lining life
- Increased safety of operation of vehicle since consistent stopping distance is maintained throughout the lining life
- Brake setting is required only during initial setting.

#### Need for automatic slack adjuster

- To ensure optimum effectiveness of the brake system, a minimum clearance is to be maintained between the lining and brake drum for free rotation of brake drum without brake grabbing.
- During regular operation of brakes, the lining clearance will increase due to wear of brake lining and brake drum leading to poor braking.
- To maintain the brake effectiveness, it is essential to adjust the brakes to have the normal working clearance.
- The interval of brake adjustment on a vehicle is likely to vary depending on the lining/brake drum wear which is determined by the following parameters:
  - a) Types of vehicles (Buses / Trucks),
  - b) Types of operation (City, Hilly, mining and coastal)
  - c) Speed and load conditions of vehicles.
- In case of manual slack adjuster the brake adjustment is to be carried out manually to ensure effective braking based on the driver complaint.
- Automatic slack adjuster takes care of this vital parameter in maintaining optimum lining clearance automatically to achieve effective braking on the vehicles.

**Need for retro fitment of automatic slack adjuster**

Considering the present vehicle operations at increased speed, higher loads and severe braking, the fitment of Automatic slack adjuster has become mandatory in place of Manual slack adjuster.

To achieve the advantages on safety & cost saving on vehicles with manual slack adjusters, Retro fitment of Automatic slack adjuster is recommended.

Retro fitment procedure described over leaf.

**Fitment of sasa in place of manual slack adjuster**

Manual slack adjuster



Remove clevis pin/bolt



Remove circlip



Remove manual slack adjuster



Initially fit anchor bracket loose at the brake chamber mounting bolt





Fit SASA with arrow/adjusting hex away from the brake chamber



Align & fix clevis pin/bolt by rotating 12 mm adjusting hex



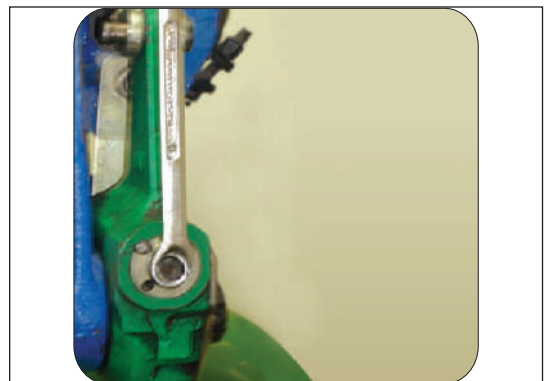
Fix circlip, ensuring 0.50 mm axial play on cam shaft.



Align control arm bolt to anchor bracket and tighten



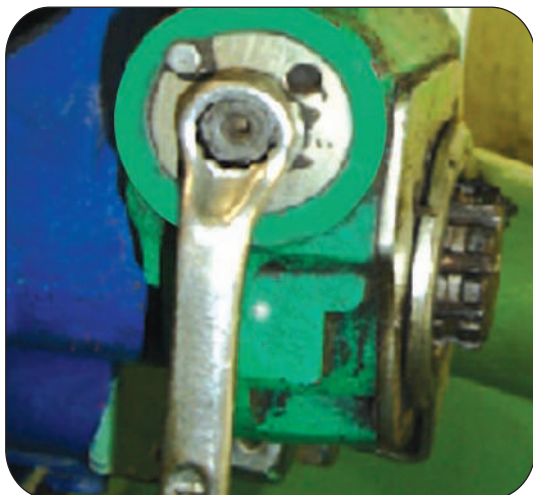
Tighten all fasteners



Close brake shoe clearance to drum to zero



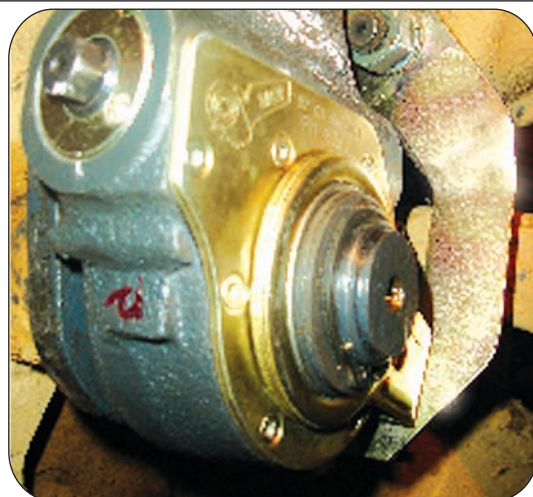
## Retro fitment



Deadjust 1800 by rotating 12 mm adjusting hex anticlockwise



Apply service brake few times with 7 ksc air pressure and observe clockwise rotation of adjusting Hex.



Cover plate faces out on RH side. On LH side cover plate faces in



Ensure Anchor bracket bolt is secured tight and aligned properly in the grommet. During routine check, look for grommet in control arm and replace with a new one if found dislodged..

## 55.19 RECOMMENDED LUBRICANTS

Aggregate	Minimum Ambient Temp. °C	Co-branded Lubricant	Approved Lubricant
		Gulf Oil India	Indian Oil Corporation
S cam shaft & Slack Adjuster	-20	Gulf MP Grease Max NLGI 2	Servo Grease ALT

NOTE : Do not mix lubricants of different brands/grades.



## 55.20 MAINTENANCE SCHEDULE

MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks
<b>A</b>	<b>General</b>					
1	Check foot brake operation. Remove stopper bolt to ensure full line pressure at the brake chambers	✓				
2	Check pneumatic hand brake for proper functioning		✓			
3	Check service brake for proper functioning & for air leakage and rectify if any		✓			
4	Check compressed air buildup on air gauge (8.25 kg/cm <sup>2</sup> )		✓			
5	Check brake pedal clearance over brake valve and adjust if required				40	
<b>B</b>	<b>Air Compressor</b>					
1	Clean compressor fins from oil sludge and dust				16	
2	Check for leakages in lub oil connection and rectify if any.				16	
3	Check compressor Inlet & delivery rubber hoses and pipes for deterioration and renew, if required				16	
4	Check & tighten cylinder head mounting bolts and end cover bolts for correct torque values.				16	
5	Check for leak through oil seal and rectify if any				16	
6	Remove cylinder head assembly and check for excessive carbon deposit and reed valve rivet loosening, decarbonize cylinder head and overhaul if necessary.	Every 96,000 km or 1 year whichever is earlier				
7	Check for carbon deposit in delivery pipe and clean.				96	
8	Overhaul the assembly	Every 1,60,000 km or 2 years whichever is earlier				
<b>C</b>	<b>DDU</b>					
1	Check for moisture/ water collection in the Reservoirs. If water collection is noticed, replace the Desiccant cartridge.	✓			8	
2	Check for performance. Pressure difference should not exceed 1.3 kg/cm <sup>2</sup> .				8	
3	Check for correct pressure setting (8.25 kg/cm <sup>2</sup> )		✓		16	
4	Remove inlet filter, clean and refit				48	
5	Check & tighten all screws in the assy for correct torque value				48	
6	Check rubber gaiter is in good condition and replace if required				8	
7	Overhaul the unit using recommended Repair Kit. Replace Desiccant Cartridge	First Overhaul at 2,40,000 km or three years whichever is earlier and thereafter every 1,60,000 km or 2 years whichever is earlier.				
<b>D</b>	<b>Graduated Hand Control Valve</b>					
1	Check rubber gaiter is in good condition and replace if required				8	
2	Operate the lever and check for proper functioning				8	
3	Remove exhaust filter, clean and refit				48	
4	Overhaul the assembly	Every 1,60,000 km or 2 years whichever is earlier				
<b>E</b>	<b>Dual brake valve</b>					
1	Check for free movement of pin in pedal & plunger.	✓			8	
2	Check & Tighten exhaust check screw				48	
3	Check boot for deterioration & change if required				48	
4	Overhaul the assembly	Every 1,60,000 km or 2 years whichever is earlier				



MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks
<b>F</b>	<b>Air Reservoir</b>					
1	Drain condensate		✓			
2	Check drain valve and replace if required				48	
3	Check air tank mounting, pipe clamps and tighten if necessary				8	
<b>G</b>	<b>Air Filter</b>					
1	Remove serviceable filter element, clean & refit				48	
2	Overhaul the assembly	Every 1,60,000 km or 2 years whichever is earlier				
<b>H</b>	<b>Front Brake Chamber</b>					
1	Check the travel of push rod and adjust the brake with minimum travel				8	
2	Check clamp ring bolt and mounting bolt tightness for its correct torque value				48	
3	Dismantle and clean. Change diaphragm and seal assembly on all chambers	Every 1,60,000 km or 2 years whichever is earlier				
<b>I</b>	<b>Slack adjuster</b>					
1	Lubricate the slack adjuster/S cam shaft	✓		✓		
2	Check worm shaft lock is functioning properly				8	
3	Overhaul the assembly	Every 96,000 km or 1 year whichever is earlier				
<b>J</b>	<b>Automatic Slack adjuster</b>					
1	Lubricate the S cam shaft	✓		✓		
2	Lubricate the slack adjuster with grease - <b>For Haldex make ASA once in 10,000 km and for MEI make ASA at the time of overhauling.</b>					
3	Check S cam bush play and replace the bush if required (Clearance should not exceed 0.5 mm)				16	
4	Check the tightness of anchor brackets and retighten to specification if necessary				16	
5	Check plastic insert & Peg Bolt for wear & replace if necessary				16	
6	Check peg bolt tightness				16	
7	Check for correct axial play (0.3 to 0.8 mm) of adjuster on S cam and adjust if necessary				16	
8	Overhaul the unit	When De- adjustment Torque Falls Below 18 Nm				
<b>K</b>	<b>Spring Brake Actuator</b>					
1	Check the travel of push rod and adjust the brake with minimum travel				8	
2	Check clamp ring bolt and mounting bolt tightness for its correct torque value				48	
3	Overhaul the assy with recommended repair kit	Every 1,60,000 km or 2 years whichever is earlier				
<b>L</b>	<b>Brake Shoes</b>					
1	Check brake shoe clearance (0.010") and adjust slack adjuster if necessary (Only manual slack adjusters)			✓	8	
2	Check brake lining for wear and replace if necessary, During replacement check brake drum and rectify defects if any.				8	
3	Check & tighten brake carrier mounting bolts for correct torque values				8	
4	Check S cam shaft / bushes, replace defective items, if any				16	
<b>M</b>	<b>Exhaust Brake</b>					
1	Check pipe connections & tighten if necessary				16	
2	Check mounting bolts & tighten if necessary				16	
3	Check pressure setting and adjust if necessary				48	
4	Overhaul the unit	Every 1,60,000 km or 2 years whichever is earlier				
<b>N</b>	<b>TC-2 Valve</b>					
1	Lubricate 'O' ring of head				16	
2	Lubricate cam and piston				48	
3	Check for correct graduated delivery of air pressure and adjust if required				48	
4	Overhaul the unit	Every 1,60,000 km or 2 years whichever is earlier				



MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks
<b>O</b>	<b>Quick Release Valve</b>					
1	Check for uniform exhaust by applying and releasing brakes				8	
2	Overhaul the unit	Every 1,60,000 km or 2 years whichever is earlier				
<b>P</b>	<b>Stop Light Switch</b>					
1	Check for electrical connection				8	
2	Check for correct operation by applying brakes. Replace if found defective				8	
<b>Q</b>	<b>Low Pressure Warning Switch</b>					
1	Check all electrical connections				8	
2	Check operation of the switch by depleting the air and replace if necessary				8	
3	Overhaul the assembly	Every 1,60,000 km or 2 years whichever is earlier				
<b>R</b>	<b>Shut off cock</b>					
1	Check for proper function				48	
2	Overhaul the unit	Every 1,60,000 km or 2 years whichever is earlier				
<b>S</b>	<b>Palm coupling/Dummy coupling</b>					
1	Replace sealing ring of coupling	Every 96,000 km or 1 year whichever is earlier				
<b>T</b>	<b>Unloader valve with tyre inflator</b>					
1	Check for correct pressure setting (8.25 kg/cm <sup>2</sup> ) and adjust if required		✓		16	
2	Remove inlet filter, clean and refit				48	
3	Check & tighten all screws in the assy for correct torque value				48	
4	Overhaul the assembly	Every 96,000 km or 1 year whichever is earlier				
<b>U</b>	<b>Air Dryer</b>					
1	Check for moisture/ water collection in the Reservoirs. If water collection is noticed, replace the Desiccant cartridge.	✓				
2	Check for performance. Pressure difference should not exceed 1.3 kg/cm <sup>2</sup> .				8	
3	Check for correct pressure setting (8.25 kg/cm <sup>2</sup> )		✓		16	
4	Remove inlet filter, clean and refit				48	
5	Check & tighten all screws in the assy for correct torque value				48	
6	Overhaul the unit using recommended Repair Kit. Replace Desiccant Cartridge	First Overhaul at 240000 km or three years whichever is earlier and thereafter every 160000 km or 2 years whichever is earlier.				
<b>V</b>	<b>Quadruple System Protection Valve</b>					
1	Check rubber gaiter is in good condition and replace if required				8	
2	Drain Sensing Reservoir and watch for any pressure drop in the gauge to detect Non Return Valve leak. If pressure drop is noticed, clean and reassemble the Non Return Valve of respective element. Check for joint leaks.		✓		8	
3	Overhaul the assembly	Every 1,60,000 km or 2 years whichever is earlier				
<b>W</b>	<b>Relay valve</b>					
1	Apply & release the brake and check for free exhaust and replace if required				16	
2	Check for proper function, remove & clean filter				48	
3	Overhaul the unit	Every 1,60,000 km or 2 years whichever is earlier				



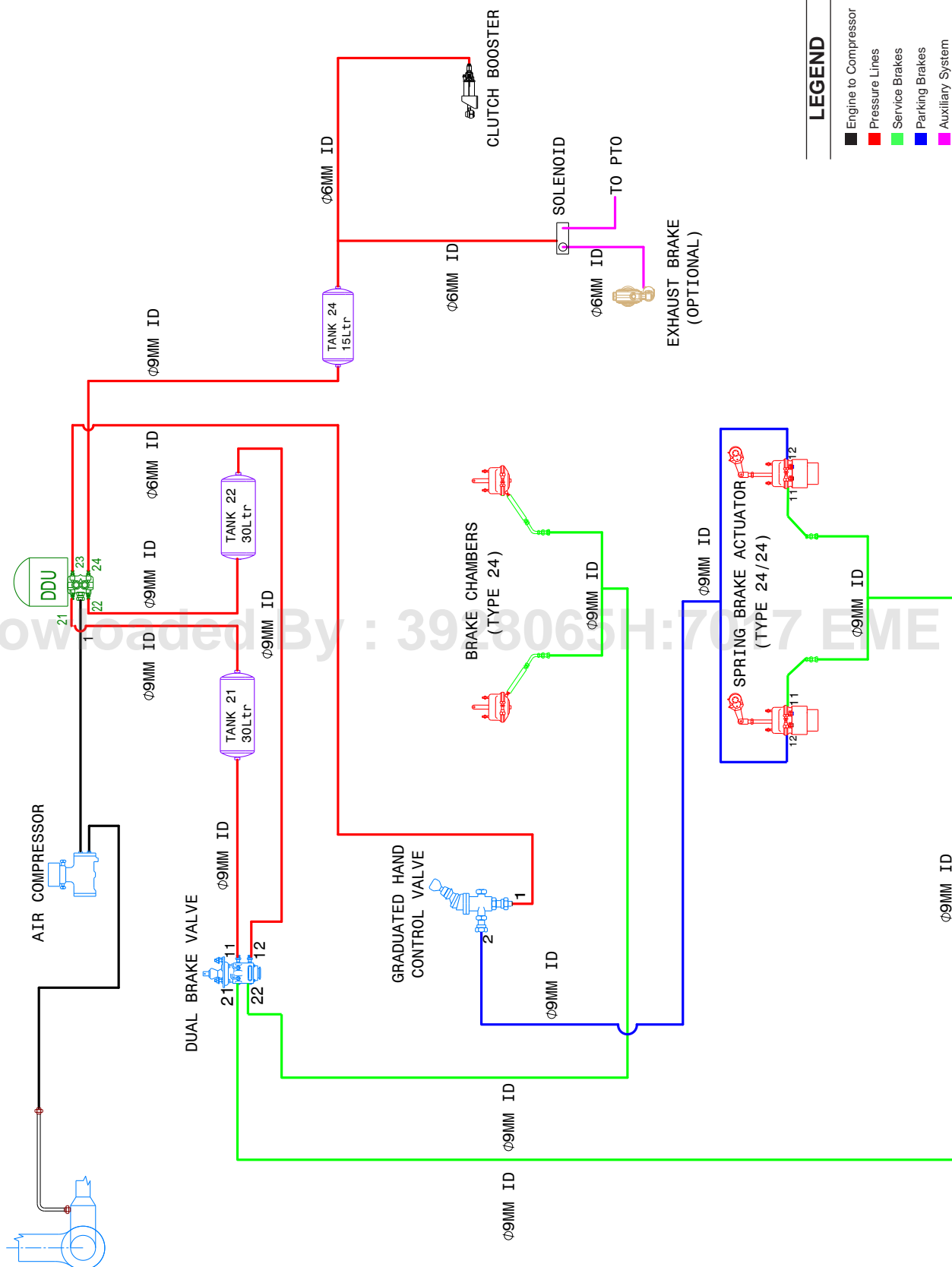
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# ANNEXURE

## AIR PIPING LAYOUT



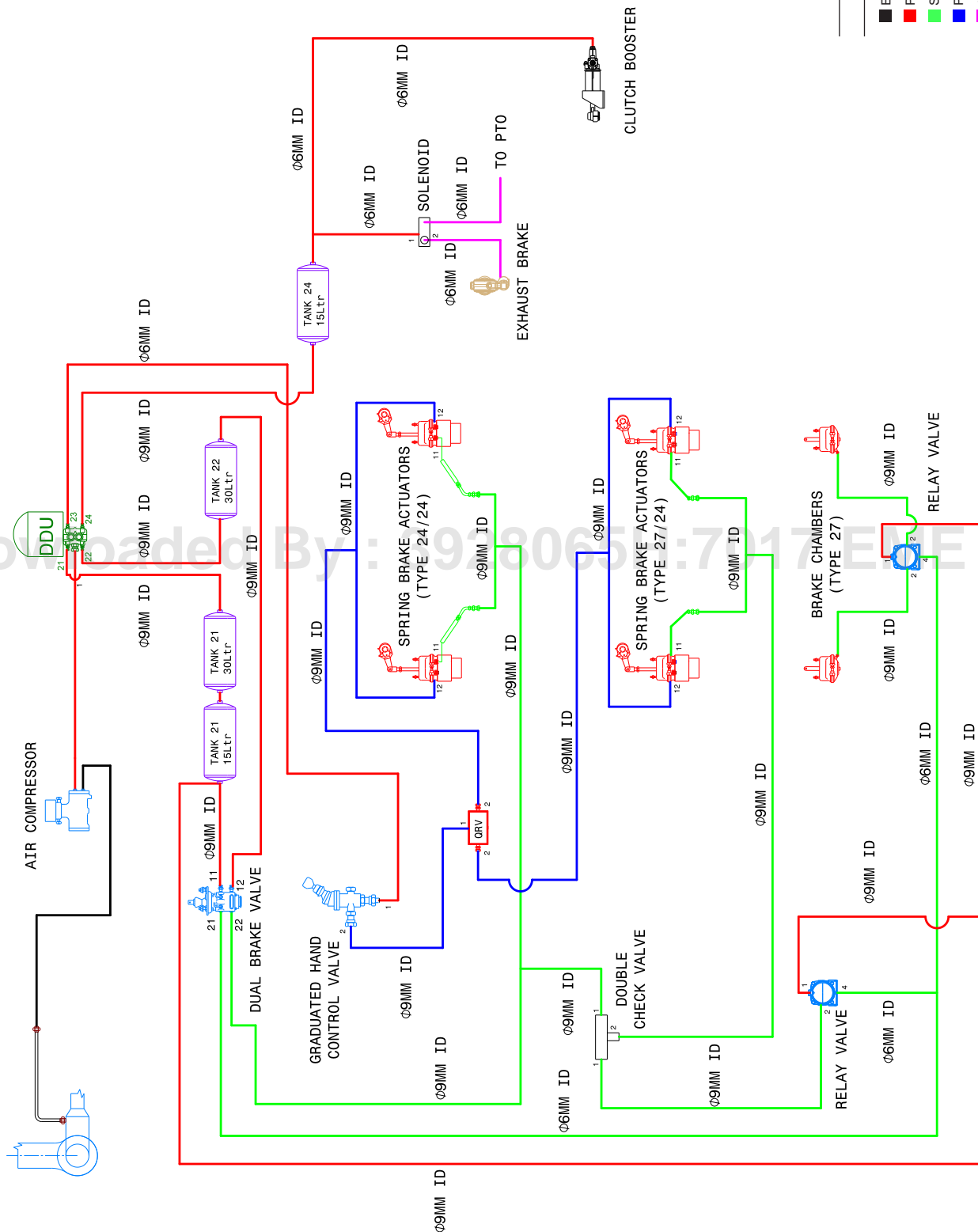
**BRAKES AND AIR PIPING LAYOUT FOR U-1616, U-1616T, U-1616T/1 & U-1618, U-1618T**



[illegible]

- Engine to Compressor
- Pressure Lines
- Service Brakes
- Parking Brakes
- Auxiliary System

**BRAKES AND AIR PIPING LAYOUT FOR U-2523 T**



**LEGEND**

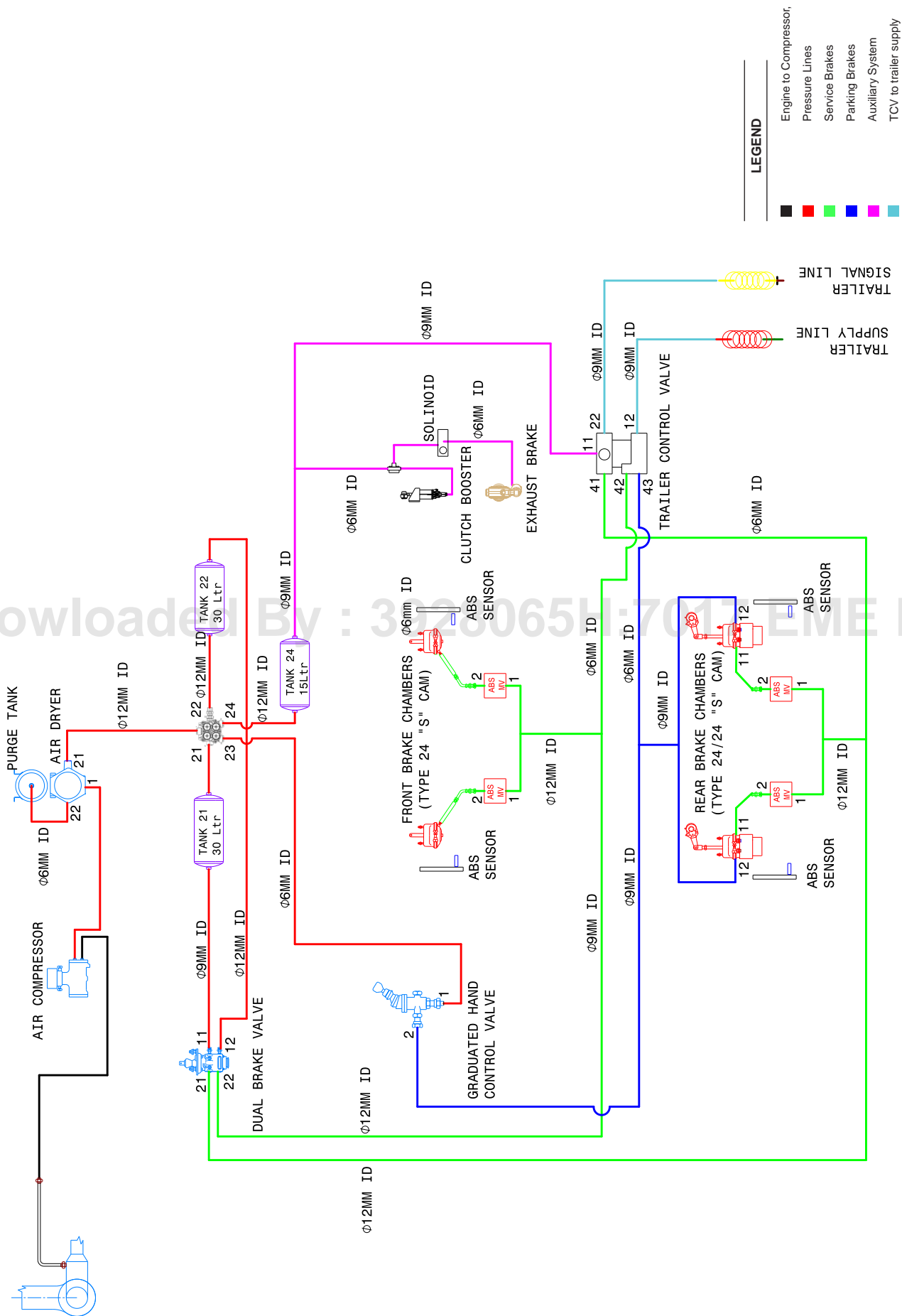
- Engine to Compressor
- Pressure Lines
- Service Brakes
- Parking Brakes
- Auxiliary System

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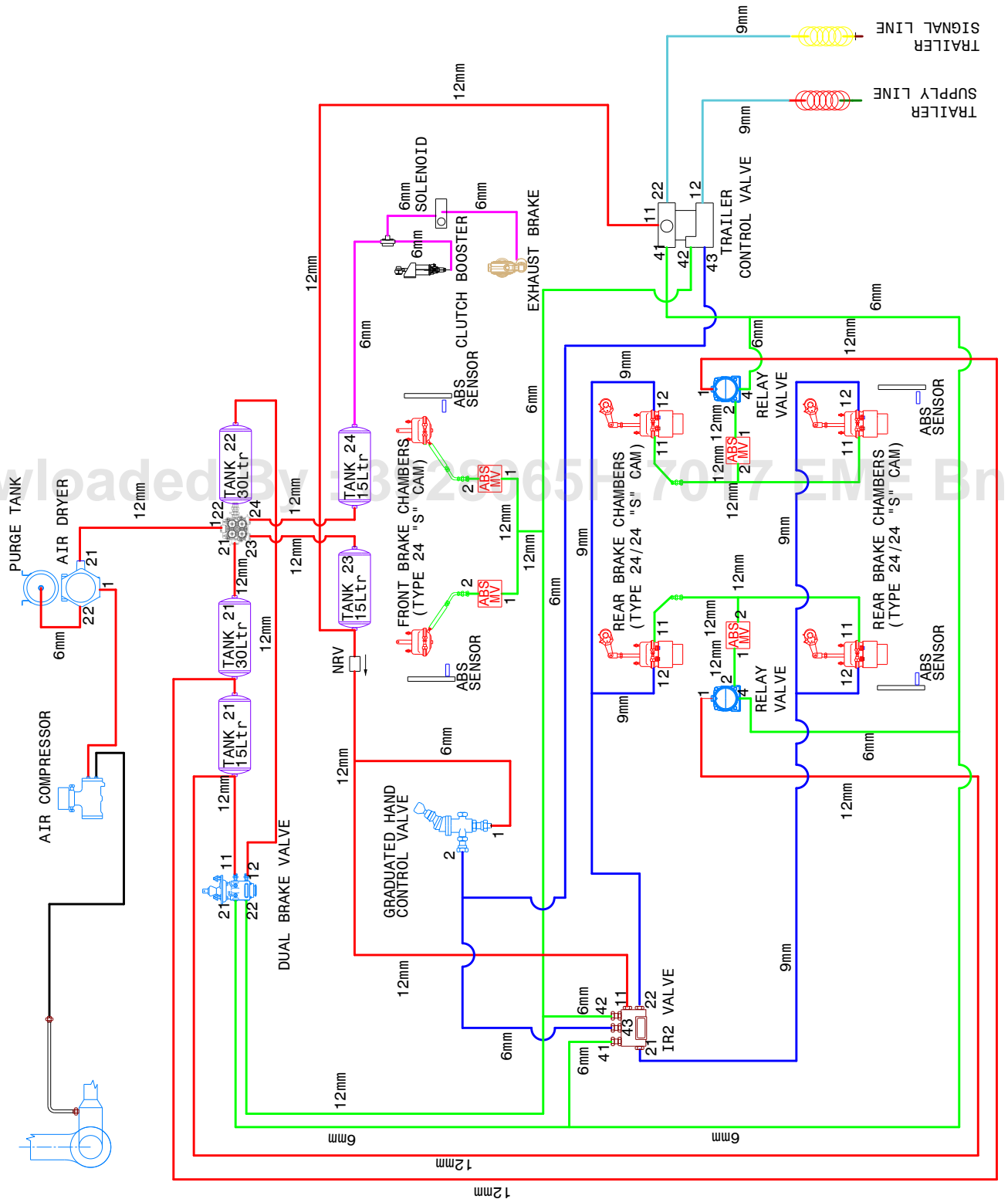


- Engine to Compressor
- Pressure Lines
- Service Brakes
- Parking Brakes
- Auxiliary System

**BRAKES AND AIR PIPING LAYOUT - U-3518 TT & U-4023 TT**

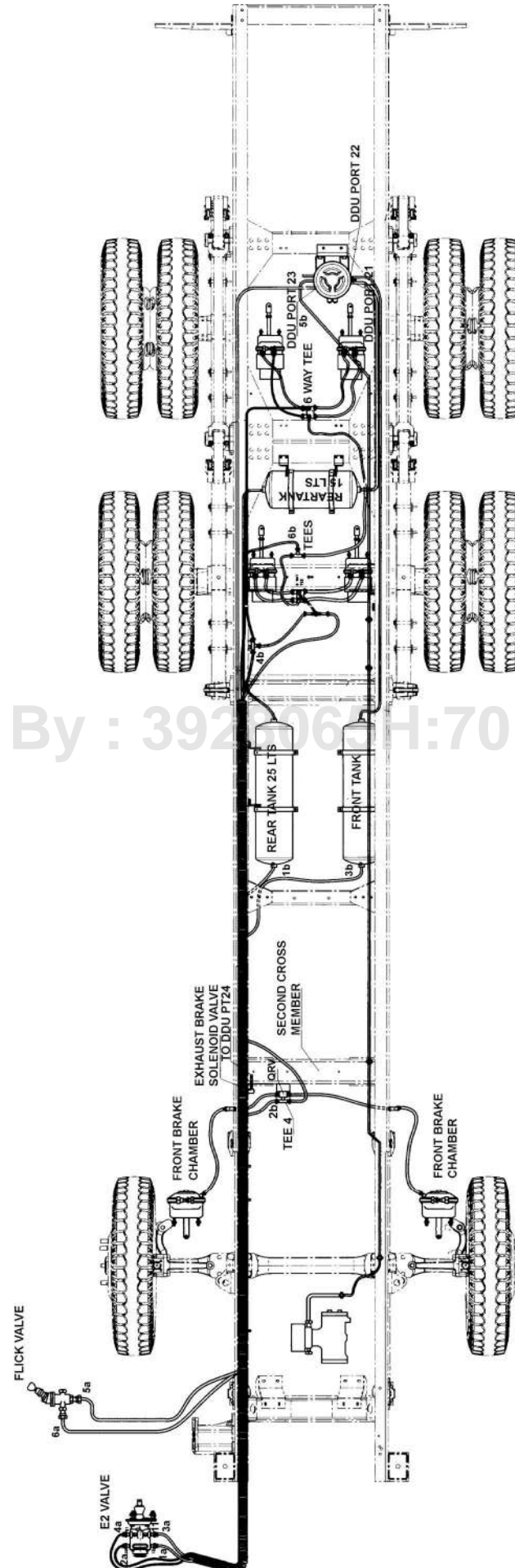


**BRAKES AND AIR PIPING LAYOUT U-4923 TT (NRS & BOGIE)**



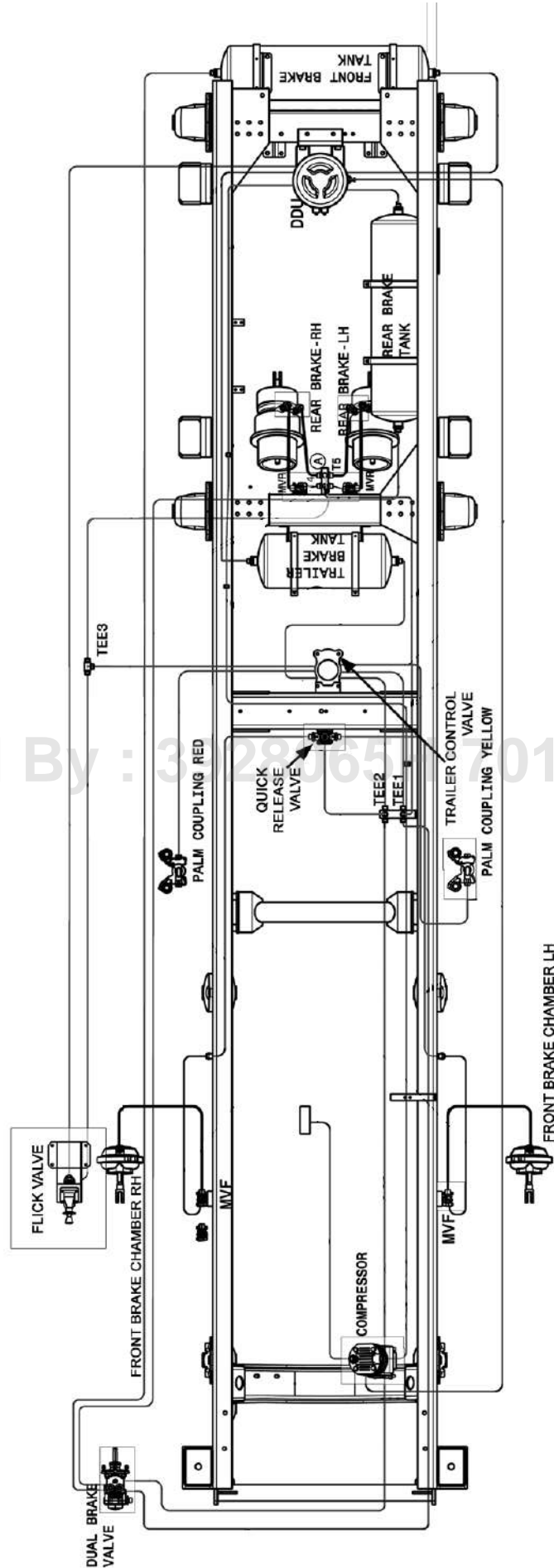


# **AIR PIPING LAYOUT OF 2516H/3**

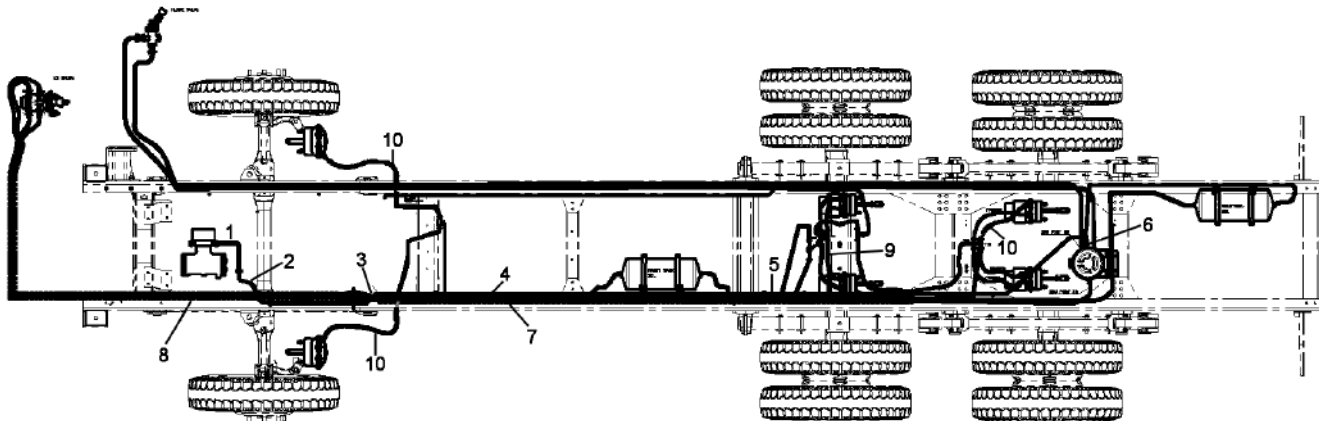


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AIR PIPING LAYOUT FOR 4019TT

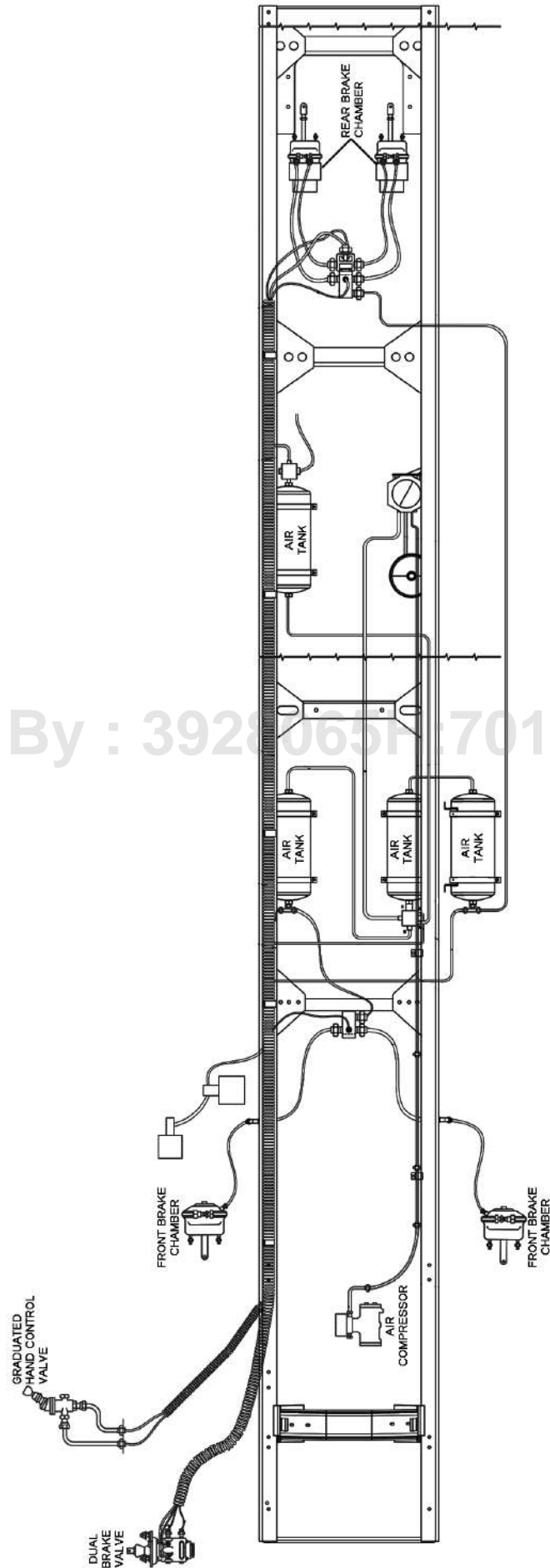


**AIR PIPING LAYOUT FOR 2516S (BS II)**

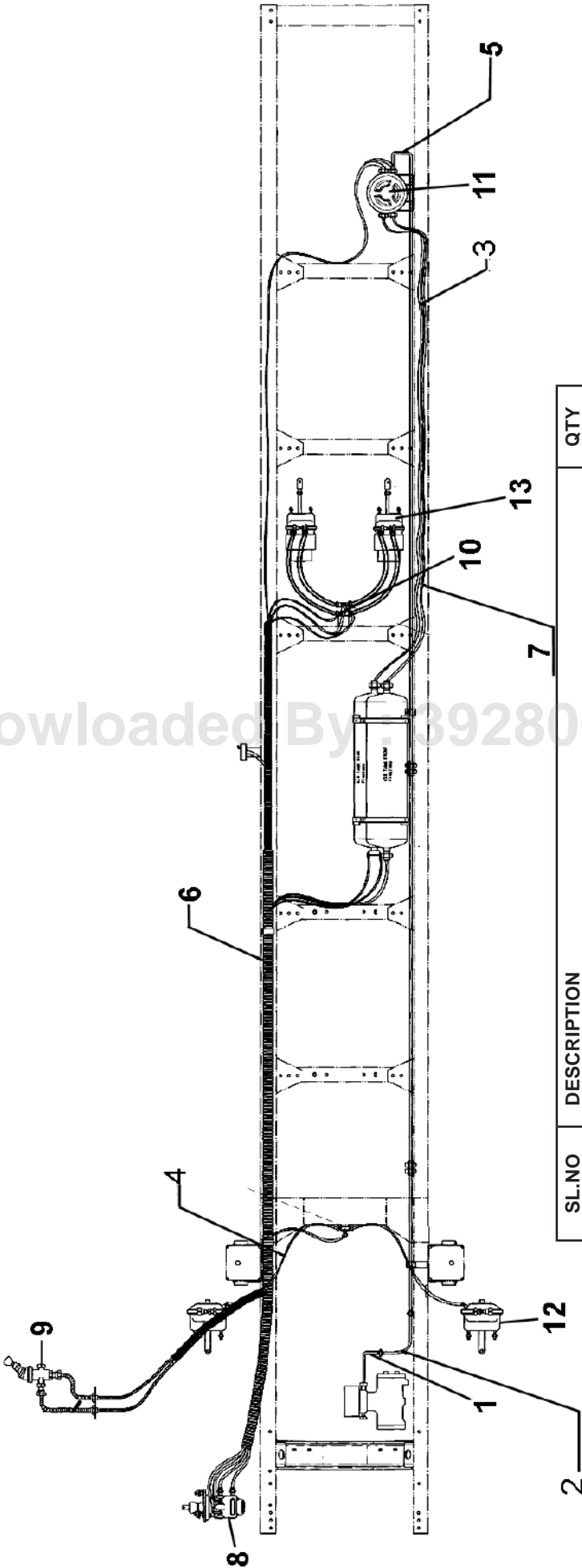


ILL NO	DESCRIPTION	QTY
1	S/A OF PIPE 5/8"	1
2	HOSE ASSY	1
3	S/A OF PIPE	1
4	S/A OF PIPE	1
5	S/A PIPE 5/8"DIA ST 18" LONG	1
6	S/A OF PIPE - PIPE TO DDU INLET	1
7	S/A OF MODULAR HOSE - CHASSIS SIDE	1
8	S/A OF MODULAR HOSE - CAB SIDE	1
9	HOSE ASSY	4
10	HOSE ASSY	4

# **AIR PIPING LAYOUT OF ALPSV4/86**

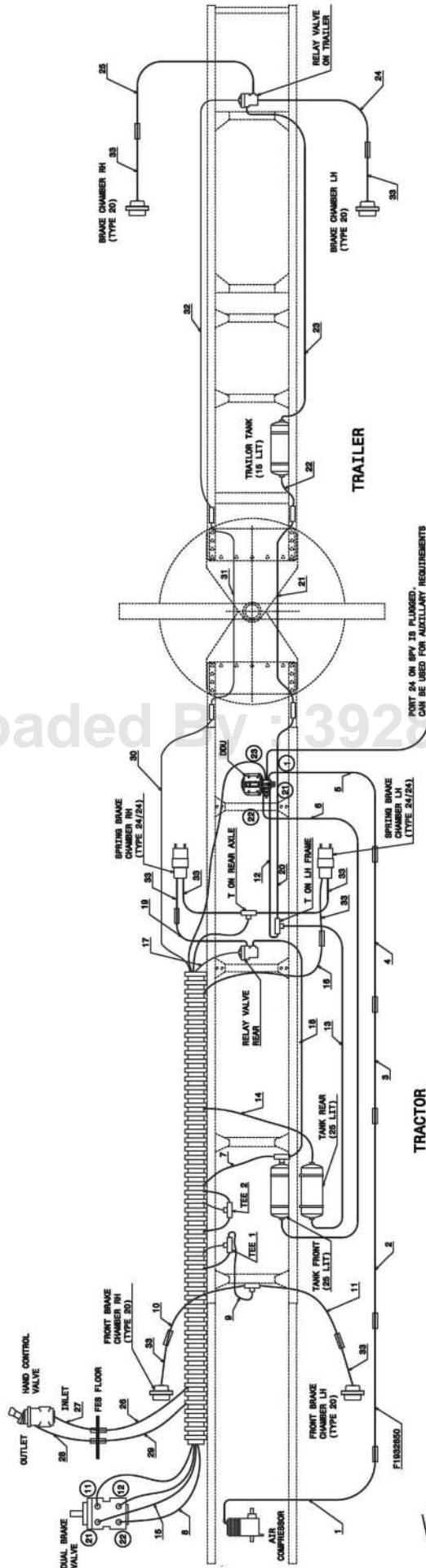


AIR PIPING LAYOUT FOR PASSENGER CNG (BS III)



SL.NO	DESCRIPTION	QTY
1	S/A OF 5/8" AIR PIPE	1
2	HOSE ASSY (BETWEEN COMP.OUTLET TO FIRST 5/8 PIPE )	1
3	S/A OF NYLON PIPE 12 DIA	1
4	S/A NYLON PIPE	2
5	S/A OF 5/8" PIPE- TO DDU INPUT	1
6	MODULAR HOSE KIT-AIR PIPING	1
7	S/A NYLON HOSE 12 DIA	1
8	DUAL BRAKE VALVE	1
9	GRADUATED HAND CONTROL VALVE	1
10	RELAY VALVE	1
11	DRYING AND DISTRIBUTION UNIT	1
12	FRONT BRAKE ACTUATOR	2
13	REAR BRAKE ACTUATOR	2

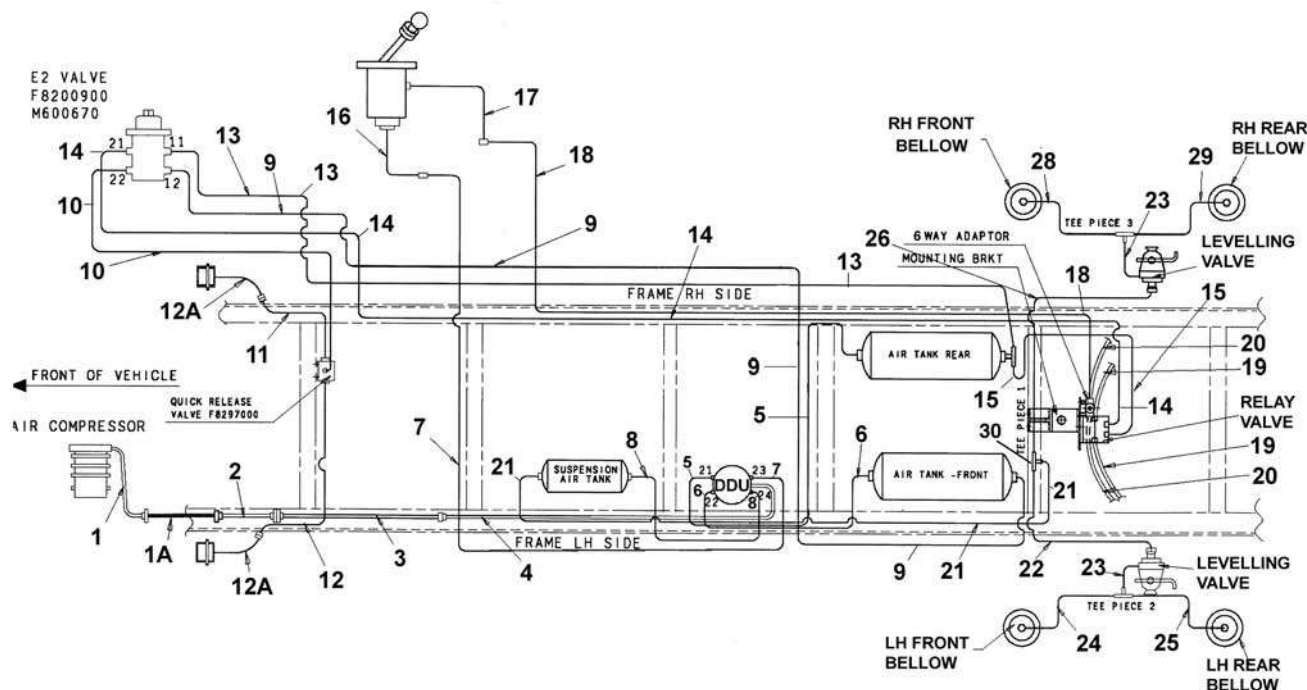
**AIR PIPING LAYOUT FOR VESTIBULE BUS**



III. No.	DESCRIPTION	QTY	III. No.	DESCRIPTION	QTY
1	PIPE-COMPRESSOR OUTLET TO HOSE	1	15	PIPE-REAR BR. TANK TO RELAY VALVE BOTTOM(4900mm)	1
1A	HOSE-COMPRESSOR OUTLET	1	16	PIPE- FLICK VAL. INLET TO ADAPTOR (600mm)	1
2	PIPE-COMPRESSOR HOSE TO UNION	1	17	PIPE- FLICK VAL. OUTLET TO ADAPTOR (600mm)	1
3	PIPE-UNION TO UNION	1	18	PIPE-FLICK VAL. OUTLET TO 6 WAY CONNECTOR (8050MM)	1
4	PIPE-UNION TO DDU	1	19	HOSE-REAR SERVICE BRAKE	2
5	PIPE-DDU PORT21 TO REAR BRAKE TANK (1200mm)	1	20	HOSE-REAR SPRING BRAKE	2
6	PIPE-DDU PORT22 TO FRONT BRAKE TANK (1800mm)	1	21	PIPE-AIR SUSPN TANK TO T-PIECE-1	1
7	PIPE-DDU PORT 23 TO FLICK VALVE INLET (5250)	1	22	HOSE - T PIECE- LH LV	1
8	PIPE-DDU PORT 24 TO AUX.AIR TANK	1	23	PIPE - LEV.VALV OUTLET TO T-PIECE	2
9	PIPE-E2 VALVE PORT12 TO FR. TANK (6300)	1	24	HOSE -T PIECE -LH FRONT BELLOW	1
10	PIPE-E2 VALVE PORT 22 TO FRONT BRAKE QRV (3050MM)	1	25	HOSE-T PIECE-LH REAR BELLOW	1
11	PIPE FR. BRAKE QRV TO RH. BR. CHAMBER (720mm)	1	26	AIR SUSPN HOSE	1
12	PIPE FR. BRAKE QRV TO LH. BR. CHAMBER (1000mm)	1	28	HOSE- T PIECE-RH FRT BELLOW	1
12A	HOSE-FRONT BRAKE	2	29	HOSE-T PIECE - RH REAR BELLOW	1
13	PIPE - E2VALVE PORT-11 TO REAR BR. TANK (5550MM)	1	30	3 WAY ADAPTOR	1
14	PIPE - E2 VALVE PORT21 TO RELAY VALVE (8900MM)	1			

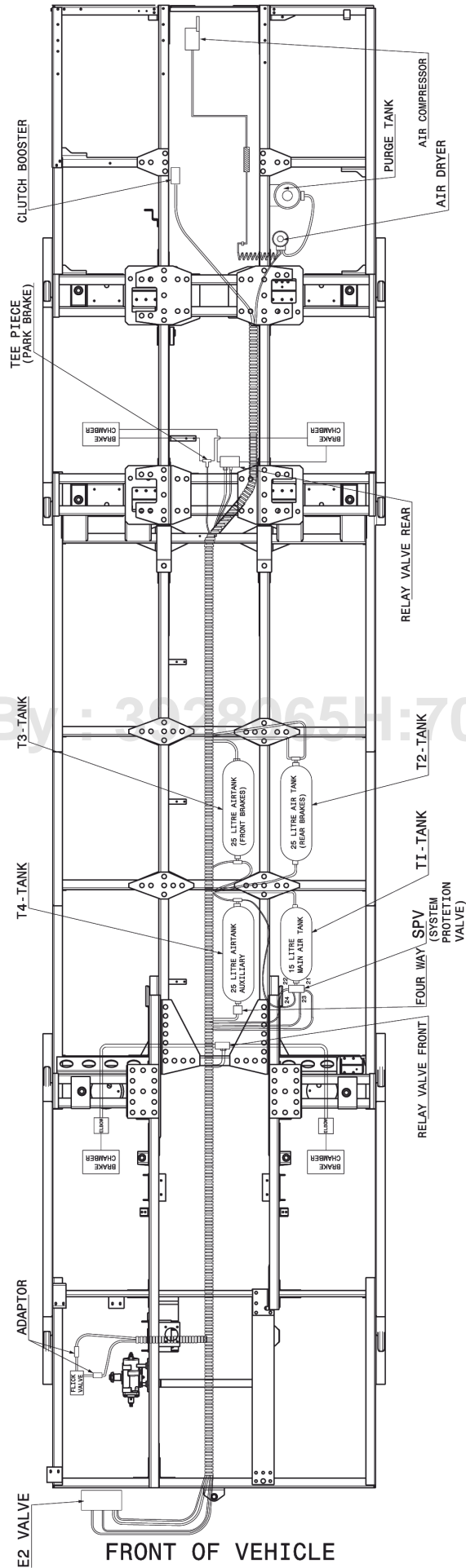


**AIR PIPING LAYOUT FOR 222" WB VIKING SLF (BSIII)**

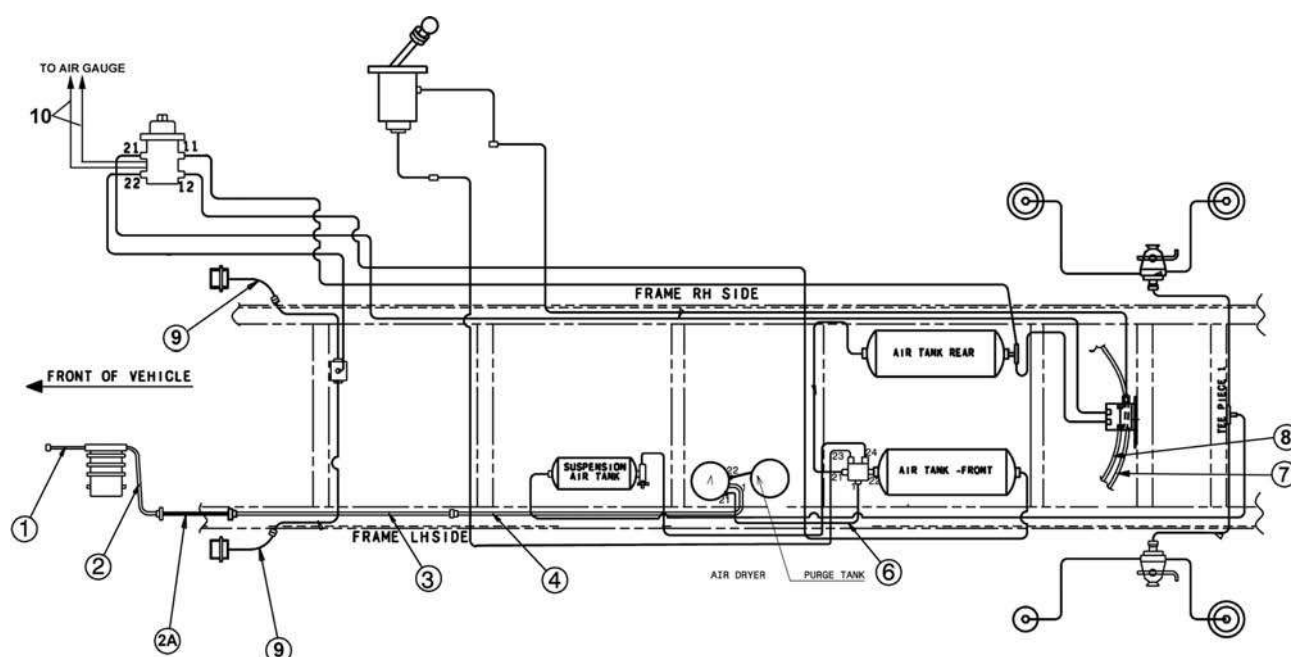


ILL NO	DESCRIPTION	QTY
1	S/A OF PIPE-COMPRESSOR OUTLET TO HOSE	1
1A	HOSE-COMPRESSOR OUTLET	1
2	S/A OF PIPE-COMPRESSOR HOSE TO UNION	1
3	S/A OF PIPE-UNION TO UNION	1
4	S/A OF PIPE-UNION TO DDU	1
5	S/A NYLON PIPE-DDU PORT21 TO REAR BRAKE TANK (1200mm)	1
6	S/A NYLON PIPE-DDU PORT22 TO FRONT BRAKE TANK (1800mm)	1
7	S/A NYLON PIPE-DDU PORT 23 TO FLICK VALVE INLET (5250)	1
8	S/A NYLON PIPE-DDU PORT 24 TO AUX.AIR TANK	1
9	S/A NYLON PIPE-E2 VALVE PORT12 TO FR. BR. TANK (6300)	1
10	S/A NYLON PIPE-E2 VALVE PORT 22 TO FRONT BRAKE QRV (3050MM)	1
11	S/A OF PIPE FR. BRAKE QRV TO RH. BR. CHAMBER (720mm)	1
12	S/A OF PIPE FR. BRAKE QRV TO LH. BR. CHAMBER (1000mm)	1
12A	HOSE-FRONT BRAKE	2
13	S/A NYLON PIPE - E2VALVE PORT-11 TO REAR BR. TANK (5550MM)	1
14	NYLON PIPE - E2 VALVE PORT21 TO RELAY VALVE (8900MM)	1
15	S/A NYLON PIPE-REAR BR. TANK TO RELAY VALVE BOTTOM(4900mm)	1
16	S/A NYLON PIPE- FLICK VAL. INLET TO ADAPTOR (600mm)	1
17	S/A NYLON PIPE- FLICK VAL. OUTLET TO ADAPTOR (600mm)	1
18	S/A NYLONPIPE-FLICK VAL. OUTLET TO 6 WAY CONNECTOR (8050MM)	1
19	HOSE-REAR SERVICE BRAKE	2
20	HOSE-REAR SPRING BRAKE	2
<b>AIR SUSPENSION NYLON PIPES</b>		
21	S/A NYLON PIPE-AIR SUSPN TANK TO T-PIECE-1	1
22	S/A HOSE -T PIECE- LH LV	1
23	S/A NYLON PIPE - LEV.VALV OUTLET TO T-PIECE	2
24	S/A HOSE -T PIECE -LH FRONT BELLOW	1
25	S/A HOSE-T PIECE-LH REAR BELLOW	1
26	S/A AIR SUSPN HOSE	1
28	S/A HOSE- T PIECE-RH FRT BELLOW	1
29	S/A HOSE-T PIECE - RH REAR BELLOW	1
30	3 WAY ADAPTOR	1

**AIR PIPING LAYOUT FOR RESLF**

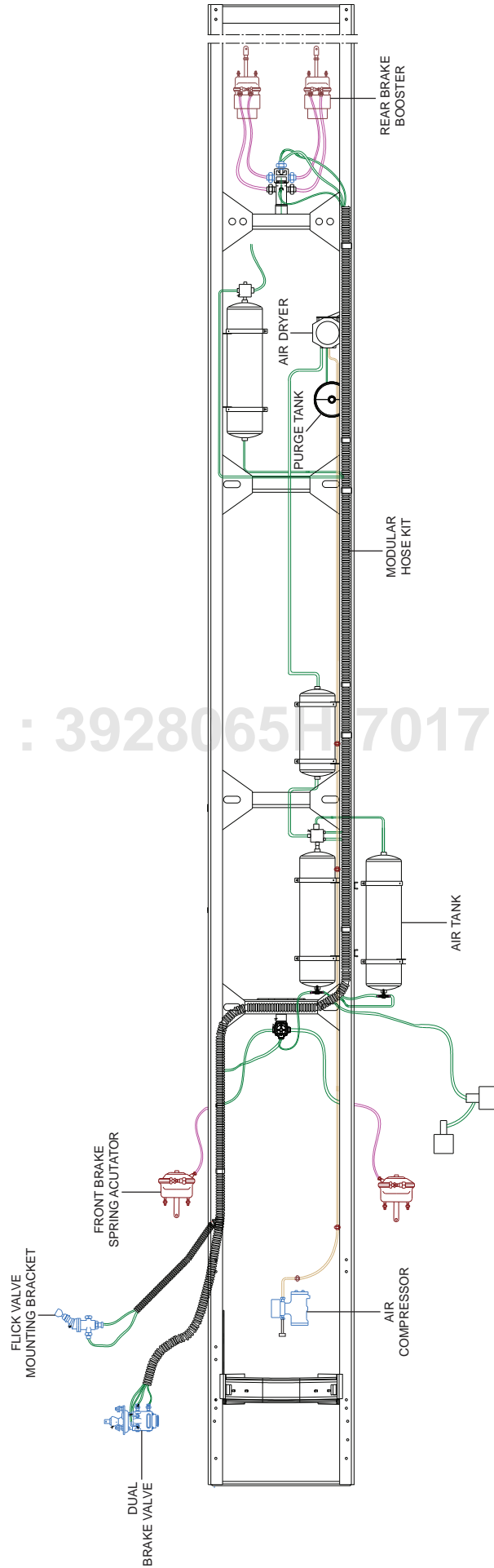


**AIR PIPING LAYOUT FOR 222" WB FESLF CNG BUS (BSIII)**



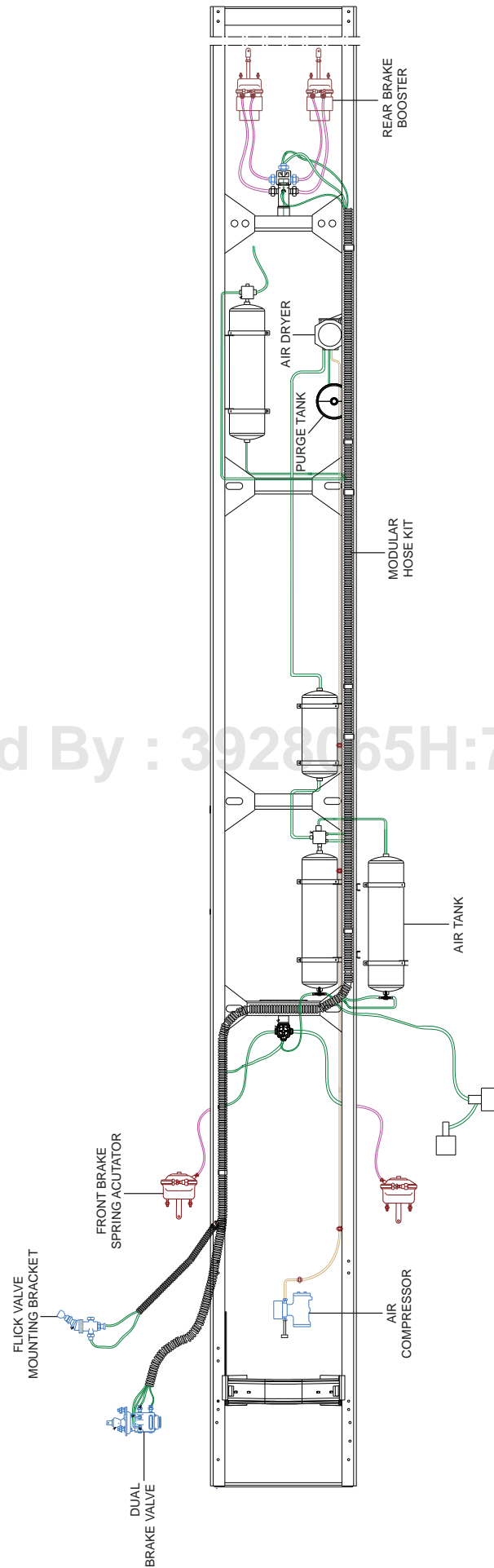
ILL NO	DESCRIPTION	QTY
1	S/A OF PIPE -AIP TO HOSE	1
2	S/A OF PIPE - HOSE TO COMPRESSOR INLET	1
2A	S/A OF PIPE - COMPRESSOR OUTLET TO HOSE	1
2A	HOSE ASSY	1
3	S/A OF PIPE - HOSE TO AIR DRIER INLET	1
4	S/A OF PIPE - AIR DRIER INLET	1
6	S/A OF PIPE - AIR DRIER OUTLET TO SPV	1
	<b>S/A OF MODULAR HOSE COMPRISES OF ITEMS MARKED #</b>	1
#	HOSE ASSY -FVI TO SPV23	1
#	HOSE ASSY -FVO TO FVO 6 WAY CONNECTOR	1
#	HOSE ASSY -E2 PORT 21 TO E2 21 RVTOP	1
#	HOSE ASSY -E2 PORT 22 TO FBQRV	1
#	HOSE ASSY -E2 PORT 11 TO RBT	1
#	HOSE ASSY -E2 PORT 12TO FBT	1
#	HOSE ASSY -RBT TO RVB	1
	<b>S/A OF LOOSE HOSE KIT COMPRISES OF ITEMS MARKED @</b>	1
@	FVO TO FVOA	1
@	FVI TO FVIA	1
@	FBQRV TO RHC	1
@	FBQRV TO LCH	1
@	REAR TANK TO SPV21	1
@	AIR DRIER TO PURGE TANK	1
@	AIR DRIER TO SPV INLET	1
@	AIR SUSPENSION TANK TO SPV24	1
7	HOSE ASSY	2
8	HOSE ASSY	2
9	HOSE ASSY	2
10	S/A OF NYLON HOSE (6 DIA) -AIR GAUGE	2
	FLEXIBLE HOSE ASSY.	2

# **AIR PIPING LAYOUT FOR 12M BUS**

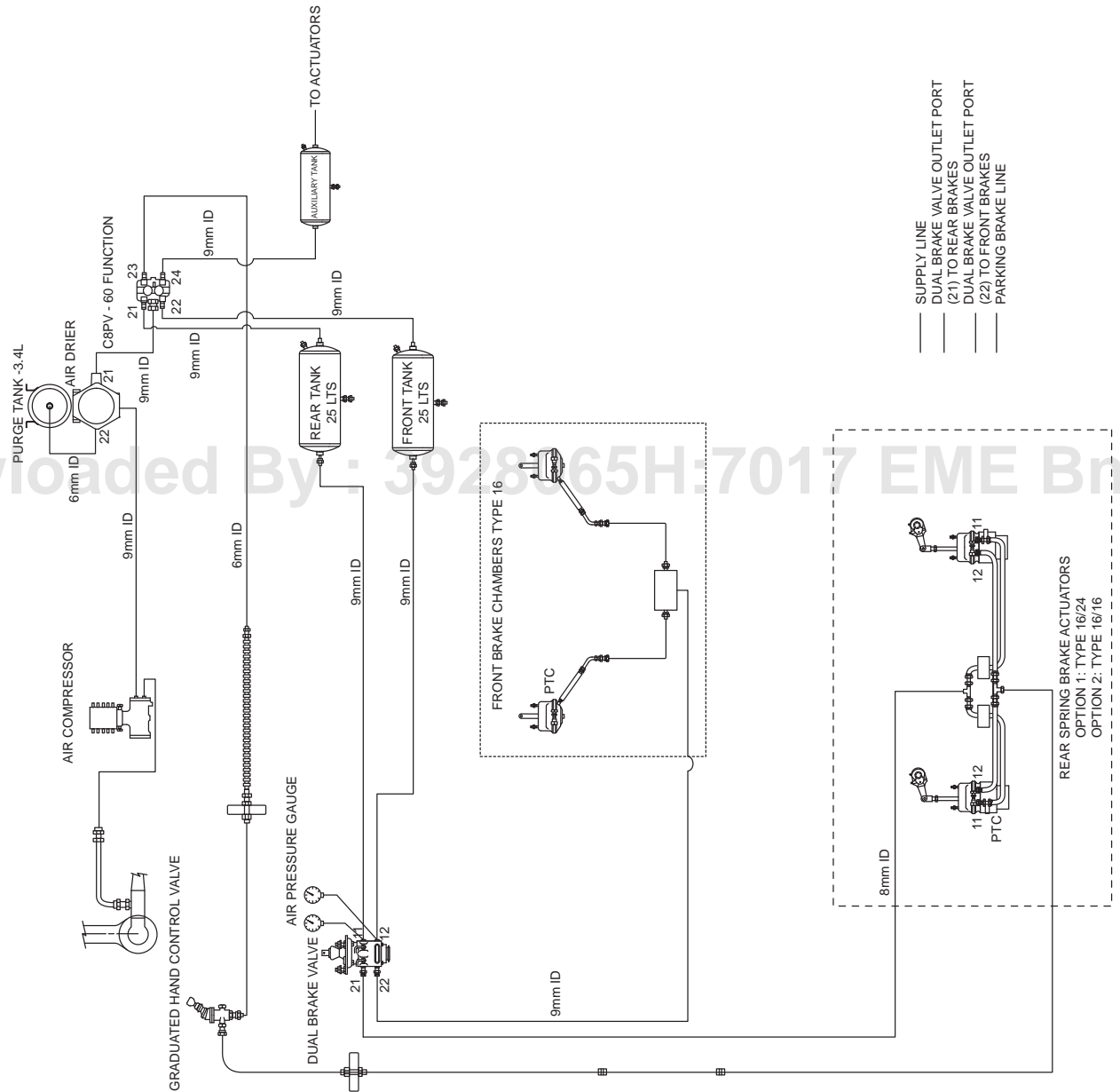


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**AIR PIPING LAYOUT FOR 210 VIKING**



**BRAKE SYSTEM LAYOUT FOR LYNX BSIV (DIESEL)**







# **SUSPENSION**



**ASHOK LEYLAND**



## CONTENTS

## GROUP - 45

## SUSPENSION

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45.2	To Remove and Refit Leaf Spring Assembly from Vehicle .....	45.04
45.3	To Overhaul Suspension (Regular Spring).....	45.05
45.4	Parabolic Spring .....	45.06
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**45.0 GENERAL****45.0.0 Design and Operation**

The front and rear springs are of the semi-elliptical laminated type with plain rolled eyes. The tension sides and edges of all spring leaves are shot-peened to increase their resistance to fatigue, thereby ensuring longer life.

The spring leaves are located by means of a bolt at the centre.

Rubber buffers are affixed to the top clamping plates immediately beneath the frame member, to prevent

damage through excessive axle bump, though for normal running, the front axle springing is controlled by telescopic type of shock absorber.

The rear springs are mounted on pads on the axle casing. Location of the spring leaves is by dimples at the centre of each leaf as already described for front springs.

The spring is fixed to the rear axle by U-bolts which pass over a clamp-block at the top and clamp-plates which partially encircle the axle casing at the bottom.

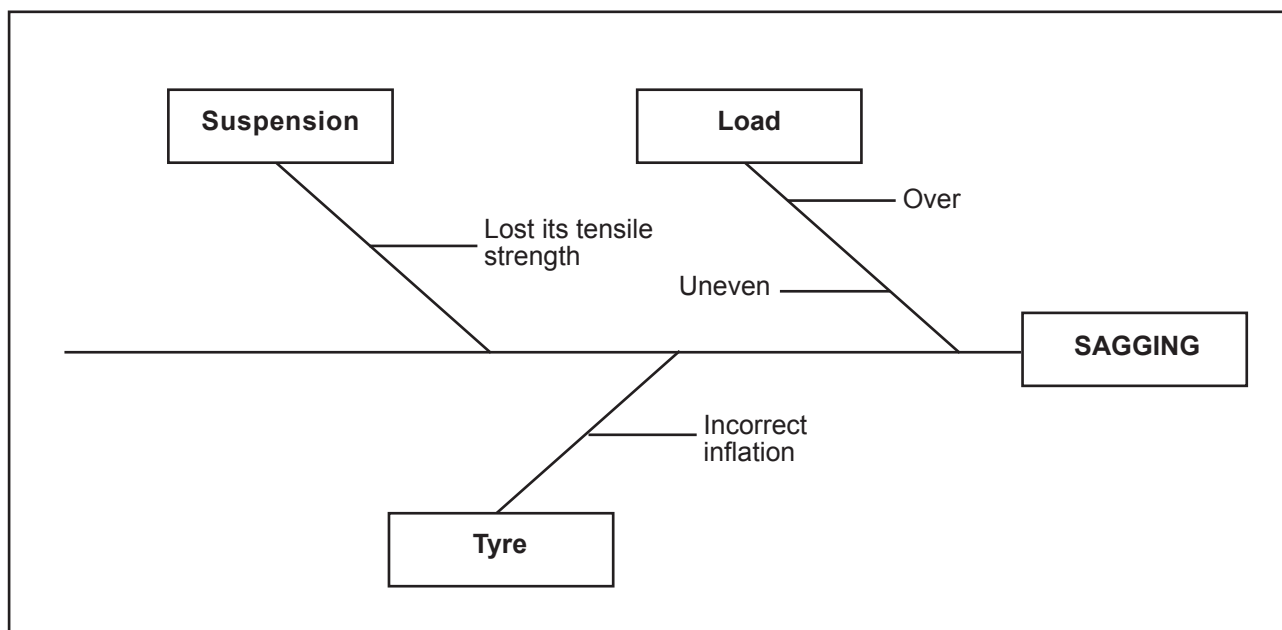
Helper springs are fitted to the rear axle of haulage chassis only.

**45.0.1 Description of Leading Components****Leaf Spring**

Quality Parameters	Leyparts Specifications	Resultant Advantage
Raw Material	EN 45A (Silicon - Manganese Steel) steel billets are specially manufactured at steel mills to Ashok Leyland's specifications	Provides requisite mechanical properties.
Roll Reduction Ratio	36 : 1 (Other manufacturers provides max. of 25 : 1 ratio only)	Improves mechanical properties and enhances life of springs. Eliminates surface defects.
Heat Treatment	Hardened and tempered	Provides proper toughness.
Hardness	375 - 444 BHN	Ensures safe operating tensile strength / stiffness.
Microstructure	Uniform tempered martensite.	Increases life of springs.
Peening	Shot peened on tension side and edges	Results in increased fatigue strength.

**45.0.2 Suspension Preliminary Checks**

It is mandatory to carry out few preliminary check on Suspension before dismounting from the vehicle. The following cause and effects can lead to overhauling decision.



Cause and Effect Diagram - Sagging

**45.1 Technical Data****REGULAR SPRING - FRONT**

Total No. of Spring	8
Free Camber	98 ± 6 mm
Laden Camber	20 ± 6 mm
Free Height	194 mm
Laden Height	116
Spring Rate	21.66 ± 7 %
Rated Load	1680 Kgf
DEF. at Rated Load	70mm
Max. Load	3228 Kgf

**REGULAR SPRING - REAR**

Total No. of Spring	10+4 PP
Free Camber	123 ± 6 mm
Laden Camber	27 ± 6mm
Free Height	290 mm
Laden Height	194 mm
Spring Rate	21.11 ± 7 % Kgf/mm
Rated Load	200 Kgf
DEF. at Rated Load	104 mm Kgf
Max. Load	4011 Kgf

**PARABOLIC FRONT SPRING**

Leaf Nos	Leaf Length			Thick	Width	Weight (Kgf)	Base Thick	End Thick
	Front	Rear	Total					
1	855	855	1710	22.5	76.2	15.84	22.5	13
	628	628	1256					
2	734	734	1468			13.72		10
	544	544	1088					

Value in ( ) shows Sheared Length

**PARABOLIC REAR SPRING**

Leaf Nos	Leaf Length			Center	End	Width	Weight (Kgf)			
	Front	Rear	Total							
1	890	890	1780	22.5	12	76.2	16.21			
	642	642	1284							
2	942	815	1757		11			15.69		
	645	598	1243							
3	777	777	1554							14.58
	577	577	1154							

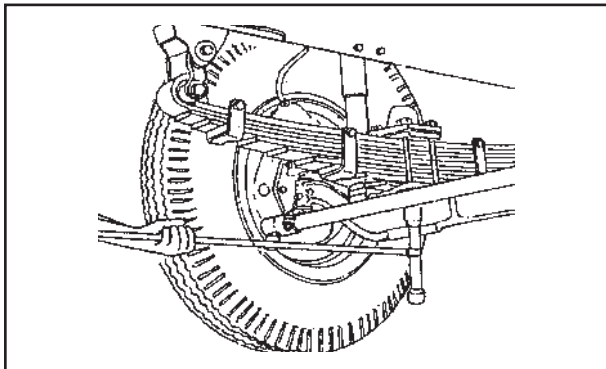
Value in ( ) shows Sheared Length

**45.2 TO REMOVE AND REFIT LEAF SPRING ASSEMBLY FROM VEHICLE****To Remove**

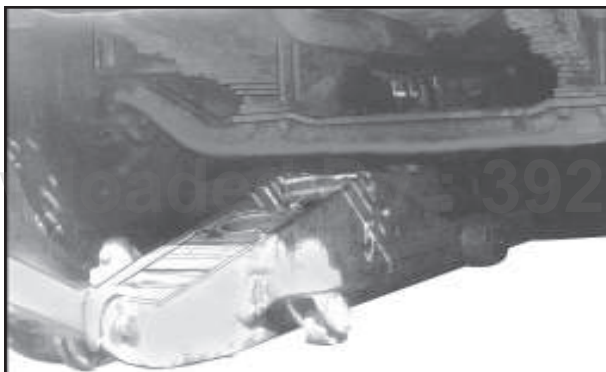
Jack up frame so that the road wheels just clear the ground.

Remove clamp-bolts from shackles.

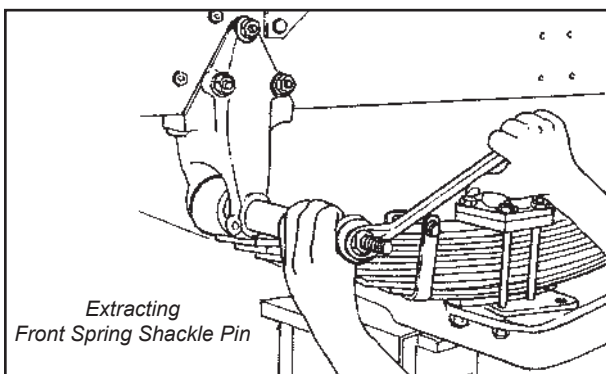
Remove the spring fixing bolts, using **Special Tool 0901002 - Socket Spring Clamp Nut**.



Take the weight of the spring by jacking up the axle slightly.



Using **Special Tool 0901001 - Extractor Shackle Pin**, pull out the shackle pin after removing the grease nipple.



The spring can now be removed from the vehicle.

**To Refit**

Place the spring perfectly on the spring saddle provided on the axles. Using a soft mallet, drive in the shackle pin after aligning the spring eye into the hanger brackets.

Fix and tighten the clamp bolts of the spring shackle and spring brackets. Fix and tighten slightly the U-clamp bolt/ clamp bolt nuts, using **Special Tool 0901002 - Socket Spring Clamp Nut**.

Release the jack.

Finally tighten the nuts of the clamp bolt/U-bolt nuts.

Fit back the grease nipple and lubricate.

**45.3 TO OVERHAUL SUSPENSION****Inspection**

The spring should be checked for camber on removal. To do this, place the spring in a press so that the weight of the spring eyes from the base plate is fixed. When the full load is applied, the camber will become negative. Therefore the spring eyes must be set at a higher plane on the press than the base plate. Measure the distance between the spring centre and the base plate. Apply the deflection load given under data at the centre of the spring and again measure the distance between the base plate and spring centre. The difference between the two readings will give the deflection of the spring. Reject the spring if it fails to conform to the details given in the data.

Separate the leaves, scrap well and clean with a thin oil, and dry. Examine both sides of each leaf carefully for cracks and if any found reject the faulty leaf. Assemble the spring, coating each leaf with graphited oil.

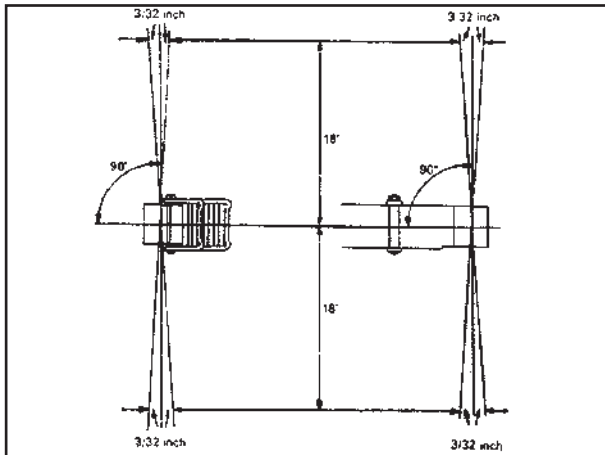
**Dismantling**

To dismantle a spring, grip the spring firmly in a vice. Remove the nuts from the spring clips. Carefully release the vice and the spring leaves will come apart. Replace any broken leaves, scrape and clean the remainder with thin oil and dry. Inspect the leaves very carefully on both sides for cracks and flaws. These are often made visible by the exudation of a little of the cleaning oil upon the dried surface along the line of the crack. These cracks commonly occur near the centre after long and arduous service. First, second or rebound leaves having the slightest indication of cracks should be replaced. If any other leaves are also cracked, a complete new spring must be fitted. The leaves should also be examined for physical wear, which occurs near the ends. Any "notches" which may have developed should be ground or filed away.

**Assembly**

Before re-assembly, each leaf should be coated with a mixture of graphite ground in oil or a graphited grease containing 10 per cent graphite. New bushes should be pressed into the front spring eyes and finished in position to 25.413 mm/25.384 mm (1.0005"/.99975") diameter. The clips should be cold straightened if distorted. Before finally fitting the clips, ensure that the spigot beneath each leaf fits into the dimple on the upperside of the next leaf. Then check the parallelism of the spring. Reject any first leaf which does not pass this test, otherwise the shackle pins cannot be inserted on assembly.





Finally fit the clips and tighten up the nuts dead tight.

#### 45.4 PARABOLIC SPRING

##### ADVANTAGES:

1. Improved Suspension
2. Light Weight
3. Long Fatigue Life

##### Pre-Installation Notes

1. Suspension is designed to operate within specific parameters. Operating the suspension outside the design parameters may result in improper performance.
2. In parabolic spring assembly the installer is responsible to ensure that the same designs of auxiliaries are fitted with parabolic spring assembly.
3. Welding and hammering is not permitted. The Installer is responsible to ensure that there is sufficient clearance for fitting of shock absorber so that it is properly located for correct load distribution.
4. Use standard fasteners (i.e. Center Bolt, U bolt, Clamp, Liner) providing good strength to the spring.
5. Ensure that all fasteners including center bolt, U Bolt are tightened to the proper torque values.

Basically a Parabolic Spring is a spring in which each leaf represents a complete spring in itself and will act as such. To enable this, the leaf is tapered, from the center (thick) to the outer ends (thin). This tapering is parabolic; it means that every centimeter (or inch) the thickness of the leaf decreases in an amount that relates to the square function of its length

Hence, the name parabolic refers only to the cross-section of the individual spring leaves. i.e, Rectangular cross section Vs Tapering cross section, from the center (thick) to the outer ends (thin)

This design is characterized by fewer leaves whose thickness varies from centre to ends following a parabolic curve. In this design, inter-leaf friction is eliminated, and therefore there is only contact between the springs at the ends and at the centre where the axle is connected. Spacers prevent contact at other points. Aside from a weight saving, the main advantage of parabolic springs is their greater flexibility, which translates into vehicle ride quality that approaches that of coil springs. The characteristic of parabolic springs is better riding comfort and not as "stiff" as conventional "multi-leaf springs".

The most important features of Parabolic springs:

**Improved flexibility:** Parabolic Springs will allow more axle movement due to their typical characteristics and lack of inter-leaf friction.

**Improved stability:** Parabolic Springs have a slightly higher spring rate and in combination with special shock absorbers it will give more stability to the vehicle at all speeds, on & off-road application.

**Better load carrying capacity:** Although parabolic springs are less in nos., each spring is designed to carry more loads as compared to conventional springs.

##### Do's and Don'ts

##### Do's

Replace broken leaf with correct part number leaf spring to avoid damage/breakage of other leaves.

1. Torque center bolt nut properly
2. Always use proper height & torque for U bolts

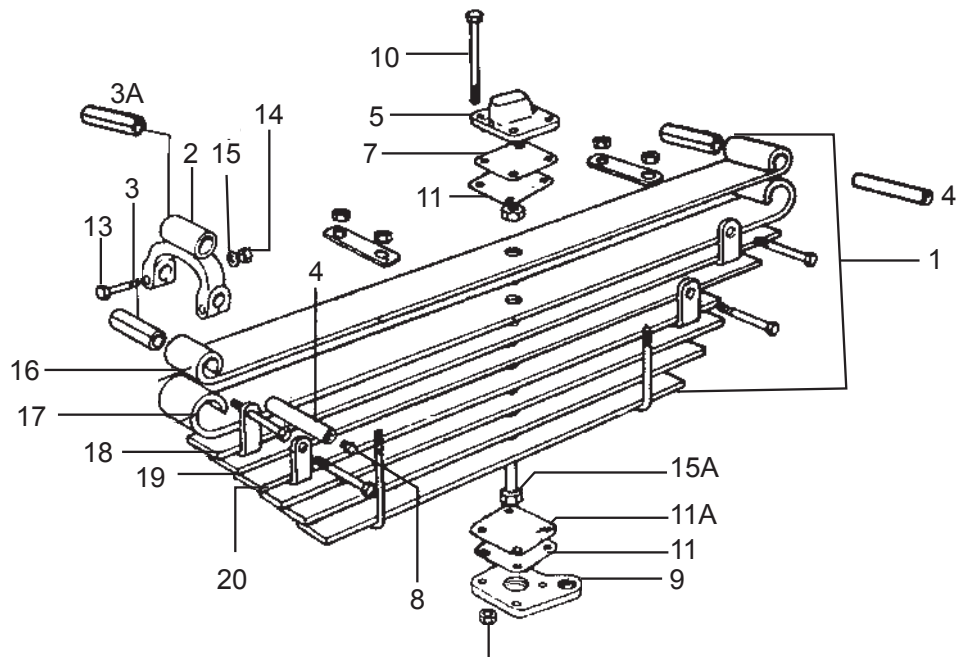
##### Don'ts

Do not remove the shock absorber as it results in more oscillations because of the friction between the springs is less.

Do not add semi-elliptic leaves

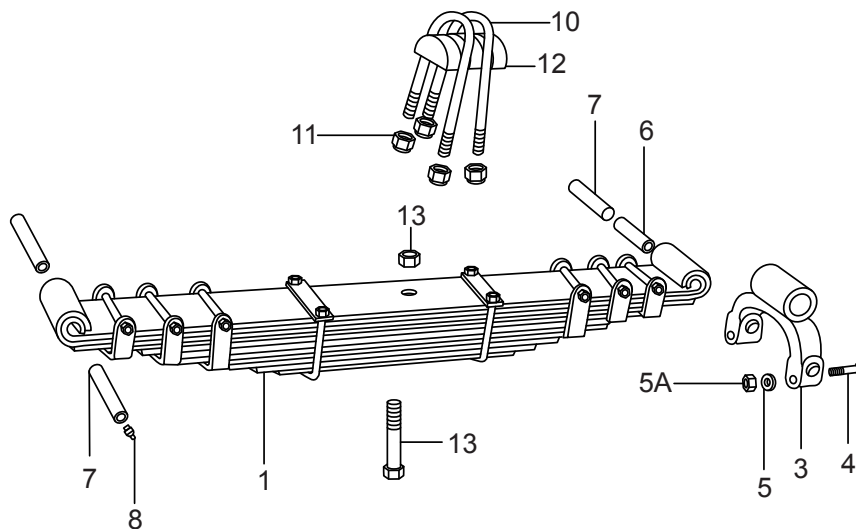
Do not re-camber the leaf spring

1. Don't remove center pads.
2. Don't add additional conventional leafs
3. Don't heat with gas welding torch or with any other means.



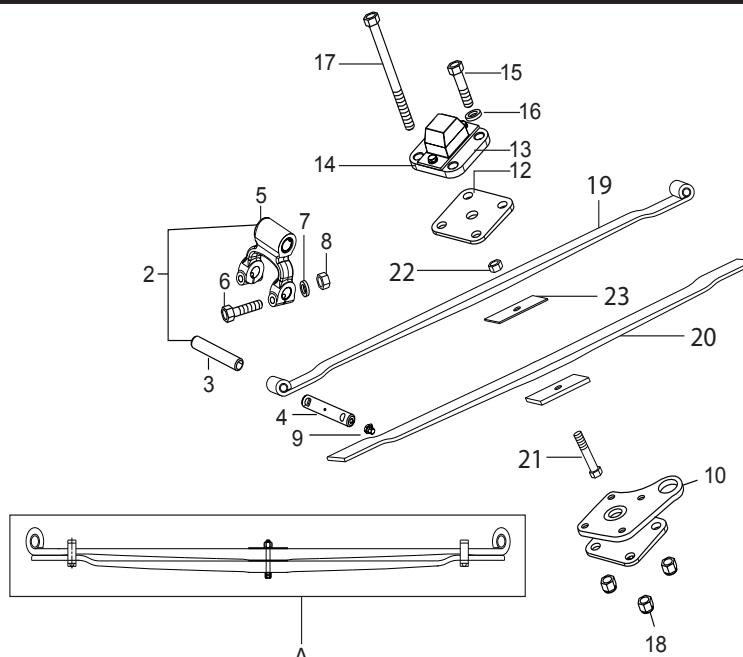
**Front Spring**

ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION
1,3	S/A Front Spring (With Bushes)	8	900 Grease Nipple	15	Washer Kolok 7/16"Dia
1	8 Leaves Front Leaf Spring	9	Shock Absorber Plate	15A	Spring Centre Bolt & Nut Kit
2,3A	Sub-Assy Of Spring Shackle	10	Front Eye Bolt	16	Main Leaf
2	Spring Shackle	11	Taper Packing	17	Second Leaf
3	Spring Eye Bush	11A	Packing Plate On Rhs Only	18	Third Leaf
3A	Spring Eye Bush	12	Nut Simmonds M16x2	19	Fourth Leaf
4	Shackle Pin	13	Bolt To Clamp Shackle Pins	20	Fifth Leaf
5	S/A Of Bump Stop	13	Bolt 7/16 X 2 3/4 Bsf		
7	Buffer Mounting Plate	14	Nut Plain 7/16"Bsf		



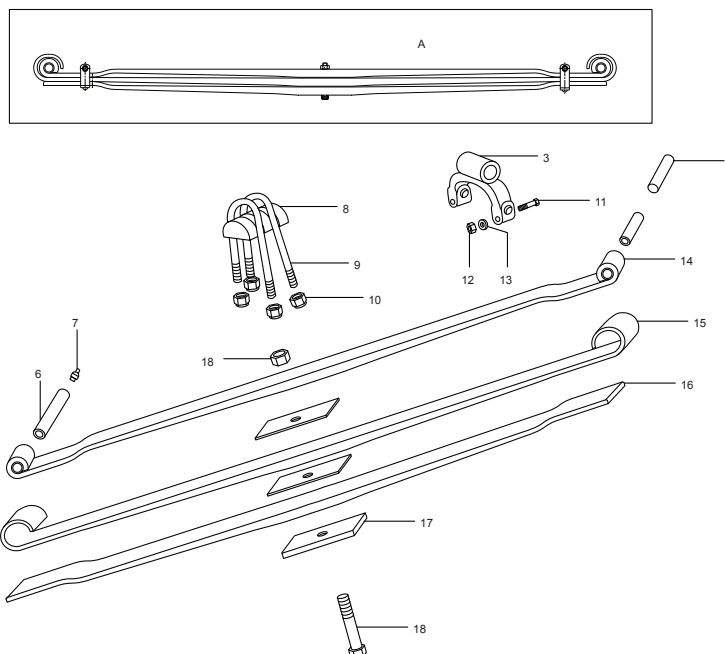
**Rear Spring**

ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION
1,6	S/A Rear Spring (With Bushes)	6	Spring Eye Bush
1	14 Leaves Rear Leaf Spring For Stag Bus	7	Shackle Pin
3,6	S/A Of Spring Shackle	8	900 Grease Nipple
3	Spring Shackle	11	Nut Simmonds M18x2
4	Bolt 7/16 X 2 5/8 Bsf Plated	12	Clamp Top
5	Sc Washer 7/16 Dia Inch Plated	13	U Blot
5A	Nut 7/16 X Pcp Bsf Plated		



**Parabolic Front Spring**

ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION
A	S/A Of Parabolic Front Spring	8	Nut 7/16 X Pcp Bsf Plated	17	Front Spring I Bolt 145 Mm
2	S/A Of Spring Shackle	9	Grease Nipple	17	Front Spring I Bolt 155 Mm
3	Spring Bush	10	Shock Absorber Bottom Plate	18	Nut - Nyloc Hex M16 X 2Cp X 20.8 Long X 0
3	Spring Bush	12	Packing Plate	19	1St Leaf
4	Snackle Pin	13	Buffer Mtg Plate	20	2Nd Leaf
5	Spring Shackle	14	Bump Stop Front Spring	23	Liner
6	Bolt 7/16 X 2 5/8 Bsf Plated	15	Screw M10 X 20 X 1.5 Cp Plated	21,22	Centre Bolt & Nut
7	Sc Washer 7/16 Dia Inch Plated	16	Sc Washer 10 Dia Plated		



**Parabolic Rear Spring**

ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION
A	S/A Of Parabolic Rear Spring	11	Bolt 7/16 X 2 5/8 Bsf Plated
2	Spring Bush	12	Nut 7/16 X Pcp Bsf Plated
4	Spring Shackle	13	Sc Washer 7/16 Dia Inch Plated
2,4	S/A Of Spring Shackle	14	1St Leaf
6	Snackle Pin	15	2Nd Leaf
7	Grease Nipple	16	3Rd Leaf
8	Top Clamp	17	Liner
9	U Bolt	18	Centre Bolt & Nut
10	Nut - Nyloc Hex M18 X 2.5- X 23.4 Long X 0		



45.5 TIGHTENING TORQUE	Kgm	lb.ft	Nm
Front spring 'I' bolts	24.8 - 30.4	180 - 220	244 - 299
Rear spring 'U' bolts	55.4 - 56.8	400 - 410	543 - 557
Spring Mounting bracket Bolts	12.5 - 15.2	90 - 110	122.5 - 149
- M10	5.5 - 6.2	40 - 45	54 - 61
- M12	8.3 - 11.0	60 - 80	81 - 108
- M14	12.5 - 15.2	90 - 110	122.5 - 149
Bump Rubber to bracket or Std. Nut	5.5 - 6.2	40 - 45	54 - 61
Shock absorber Mounting bracket to Chassis	8.3 - 11.0	60 - 80	81 - 108
Helper spring bracket bolt/Nut	8.3 - 11.0	60 - 80	81 - 108
Centre bolt nut - M12	12.1 - 13.1	88 - 95	119 - 128
- M14	15.5 - 17.3	112 - 125	152 - 170

#### 45.6 RECOMMENDED LUBRICANTS

		Co-branded Lubricant	Approved Lubricant
Aggregate	Ashok Leyland Specification	Gulf Oil India	Indian Oil Corporation
Suspension	IS 12203	MP Grease Max NLGI 2	Servo Grease ALT

#### 45.7 MAINTENANCE PROGRAMME

MAINTENANCE ACTIVITY	PDI	Daily	Weekly	Every km x 1000	REMARKS
1. Check "I" Bolts/"U" Bolts, Spring Clip fitment, Helper Spring brackets and Spring Shackle for tightness	✓			8	
2. Check & tighten shock absorber, rubber pads, mounting bracket bolts and nuts	✓			8	
3. Lubricate shackle pins - Regular suspension			✓		
Non-reactive suspension			✓		



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# **ELECTRICALS**



**ASHOK LEYLAND**





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**60.0 GENERAL DATA****a) Battery**

1. Make : EXIDE Industries Ltd.,
2. Capacity : 80 - 200 Ah
3. Voltage : 12 V x 2
4. Location : LH Frame

**b. Alternator - SA28 / SA23**

1. Make : Lucas TVS
2. Capacity : 55 A / 45 A
3. Voltage : 24 V

**c. Alternator - K1 Series**

1. Make : MICO
2. Capacity : 55 A
3. Voltage : 24 V

**d. Starter Motor - BS5 Axial Starter Motor / 7M14**

1. Make : Lucas TVS
2. Voltage : 24 V
3. Lock Torque : 6.2 kgf-m (Current - 1200 A)
4. Running Torque : 3.5 kgf-m (Current - 700 A)

**e. Starter Motor - DE 114 X**

1. Make : MICO
2. Voltage : 24 V
3. Lock Torque : 65 Nm (Current 1500 A) / 51 Nm (Current 1000 A max.)
4. Running Torque : 25 Nm (Current 650 A) / 25 Nm (Current 570 A max.)

**60.1 BATTERY (EXIDE)****60.1.0 Battery Capacity**

Batteries are rated in ampere-hour (Ah) at the 20 hour rate of discharge. This is referred to as C20. This is the number of amperes it will deliver in a specified time. Thus a 12 Volt battery with a C20 of 100 Ah will give a discharge of 5A for 20 hour at 27°C to an end Voltage of 10.50 volts, at a specific gravity of 1240 (27°C) when fully charged.

5 x 20h - 100 Ah.

**60.1.1 Battery Charging**

Batteries received charged should be given a freshening charge before installation. Check state of charge from specific gravities and put on charge at the normal rate till specific gravity and voltage readings are constant for two consecutive hour.

The freshening charge for unused wet batteries in stock should take about 6 to 12 hour according to state of charge.

**INSTALLING A NEW FULLY CHARGED BATTERY**

Clean battery cradle (or compartment) for dirt and oil. Take care of the battery terminals on cradle or compartment, so that correct terminal is presented to earth clamp.

Fasten battery hold-down, tightening both nuts evenly. Do not overtighten, because container may get damaged. Clean cable clamps, smear with vaseline and connect earthed cable last.

Connecting cables should be long enough, so that there is no strain on terminals. Cables should not foul with vent plugs or rub on hold down and other parts. Start engine - raise the engine rpm in neutral gear to check that the battery is being charged which is indicated on dash board indicator.

**MAINTENANCE**

The following simple instructions if observed will help you to obtain the long life built into battery.

**(i) Keep Clamps and Terminals Clean :**

Corrosion products have high resistance causing power loss and inturn prevents full charging back.

**(ii) Smear Terminals with Vaseline :**

Vaseline film prevents corrosion (grease is non-conductor)

**(iii) Top Up Regularly :**

Water is lost during charging as gas or by evaporation. Low levels of electrolyte will damage top of plates.

**(iv) Keep Vent Plugs Tight :**

To prevent electrolyte evaporation or splash.

**(v) Keep Battery Top Clean and Dry :**

Dirt and moisture cause surface current leaks between top metal, resulting in battery running down.

**(vi) Use Distilled or De-ionised Water only :**

Ionised water will cause self-discharge or attack plates due to the impurities present in it.

**(vii) Keep Cable Connections Tight :**

Because loose connection cause power loss.

**(viii) Keep Hold-downs clamps Firmly Secured :**

To prevent battery bouncing, container abrasion and damage.

**Battery Testing Chart**

In testing a battery, the age of the battery must be Borne in mind. The list of operations consists of :

1. A hydrometer test
2. High Rate Discharge Check
3. Sp. Gravity Drop over 7 days

**1. Hydro meter check**

Description	Battery Condition	Remedy or Action
Cell readings uniform 1210 - 1240	Probably good	Proceed to Check 2
Cell readings uniform (within 20 points) but below 1180	Questionable	Recharge, Repeat Check 1.
Cell readings vary by 30 points or more	a) Short circuit cell b) Premature failure or c) Contaminated electrolyte d) Cracked cell partition e) Electrolyte loss by leakage/excessive gassing.	Recharge, Repeat Check 1. If specific gravity of cells do not rise and differences of about 30 points persist, battery is probably unserviceable.

**2. High-rate discharge check**

Description	Battery Condition	Remedy or Action
Reading in green or GOOD ZONE	No action required	Probably good
Reading in red or FAILING ZONE. a) sp.gr.above 1210 b) sp.gr. below 1180	a) Replacement advisable b) Recharge and repeat checks 1 and 2.	a) Battery wearing out b) Questionable
Needle drops rapidly to Zero	Replace battery	Battery unserviceable

**3. Specific gravity drop over 7 days**

The results obtained in the first two checks should be confirmed when in doubt by charging the battery and allowing it to stand undisturbed for 7 days. The loss in capacity should not exceed a specific gravity drop of over 20 points. If the loss is not greater than 15 to 20 points and the battery is serviceable.

If the loss in any cell is greater than 20 points a replacement should be considered due.

**Trouble Shooting Chart**

Battery trouble can arise from different cause. The following chart will assist in diagnosing the most common trouble so that prompt corrective action can be taken.

Trouble	Diagnosis	Remedy
Low specific gravity in cells	Battery worn out	Replace after tests confirm diagnosis
	Infrequent driving	Charge by driving or by small bench charge periodically
	Loose fan belt	Tighten/replace belt
	Current leaks	Check, clean battery top
	Short circuit in wiring	Check wiring
	Regulator set low	Get regulator set correctly.
	Plates sulphated	Recover by sulphation
	Loose terminal lumps.	Clean terminals, tighten clamps
Abnormal rise in temperature during charge (generally with abnormal premature gassing)	Plates sulphated	Recover by sulphation treatment
	Short circuit in cells	Replace battery
	HIGH charge current	Lower to normal value.
Abnormal colour of separators bleached/darkened: white spots on top of plates	Contaminated electrolyte	Remove electrolyte refill and recharge
	Low electrolyte levels	Top-up
	Sulphonated plates	Recover by sulphation
Excessive topping required. (More than about 150 cc per battery every fortnight).	Over charging	Check, correct regulator setting

**Remedy for sulphation**

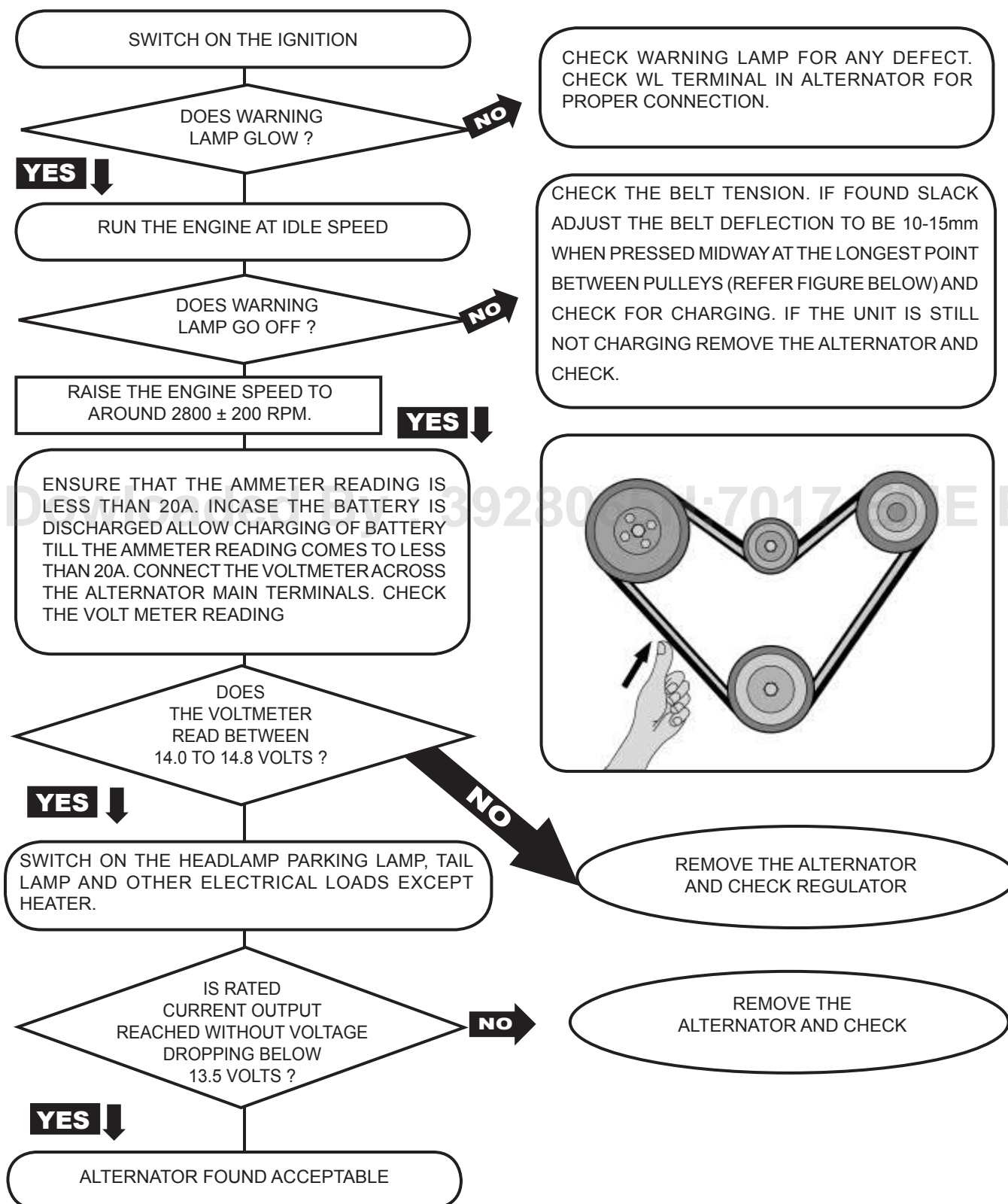
If plates are sulphated due to standing for long periods in a discharged state, the following treatment will often recover them:

1. Pour out electrolyte completely from all cells.
2. Fill with distilled water. stand for an hour.
3. Charge at a low current of the order of 1/2 ampere, so that the cells do not exceeds 2.3 volts. Do not let the temperature exceed 44°C.
4. Repeat steps 1 to 3.
5. When sp. gr. after prolonged charging does not rise further and cells are gassing, adjust to normal value (1240) by adding 1400 acid and giving it a gassing charge to mix.
6. Complete treatment by charging for 4 to 8 hour at the normal rate.

## 60.2 ALTERNATOR

## Alternator charging system checks on the vehicle

Before starting ensure the battery condition





**60.2.0 24V Alternator - SA28 - LUCAS TVS**

The SA28 24 V Alternator is intended for use on Commercial Vehicles. This alternator is suitable for negative earth systems.

**Technical Data**

1. Type	SA28
2. Rating	Continuous
3. Rated Output	12 V - 55 A
4. Ambient Temp. Range	-30° C to 105° C
5. Weight ( Without Pulley )	5.2 Kg.
6. Over Speed with Maximum Output	15000 R.P.M. for 0.5 Minute
7. Polarity	Negative Earth
8. Regulating System	Built-In Regulator
9. Reg. Set Voltage	14.6 ± 0.3 V
10. Direction of Rotation	Clock wise (Viewed from Pulley side)

**Salient Features**

- Delta connected 3-phase output winding wound on a laminated stator.
- 12-pole wound field rotor, carried on ball-race bearings in aluminium end brackets and belt driven from engine.
- Self-excited field (via three field diodes) at normal running speeds.
- Built - in rectifier provides rectification of generated A.C
- Voltage control is provided via a built-in electronic regulator.
- An RFI suppression capacitor is provided across the positive and negative terminals.
- A phase terminal can be made available if required (for RPM meter).

**Do's and Don'ts****Do's**

- Do ensure that all electrical connections are clean and secure.
- Do ensure that no electrical connection in the circuit including the battery is open.
- Do observe correct polarity. i.e. connect negative to negative and positive to positive. Otherwise, Alternator will be damaged.
- Disconnect all alternator terminals, while carrying out welding jobs on the vehicle.
- Disconnect the battery earth cable before removing the alternator.

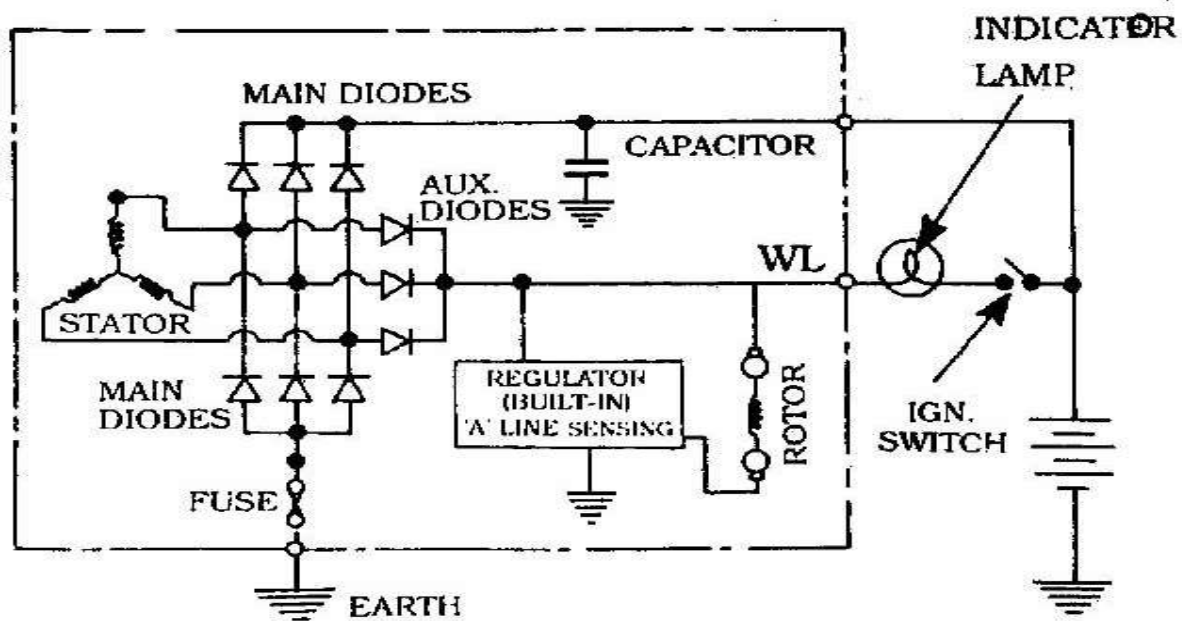
**Don'ts**

- Do not dis-assemble the alternator without removing the brush box assembly.
- Do not run the alternator with the battery disconnected.
- Do not disconnect any lead of Alternator/ Regulator with the engine in running condition.
- Do not disconnect battery cables while the engine is running.

**Routine Maintenance**

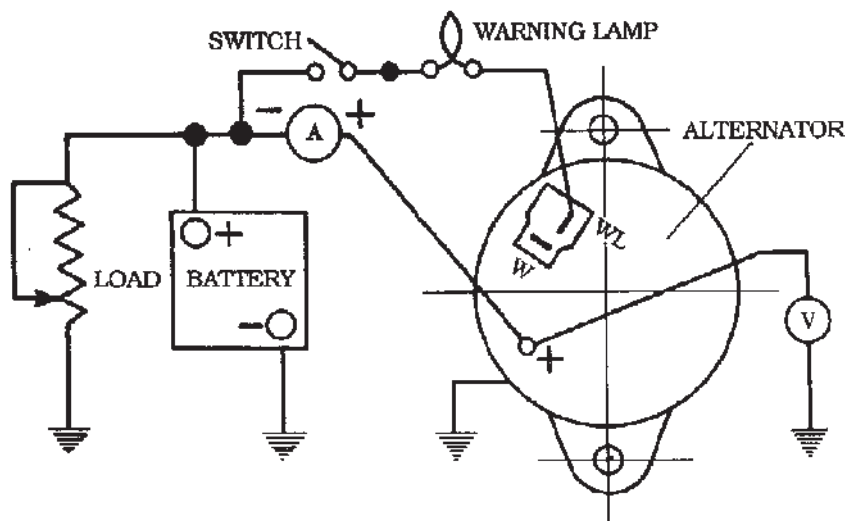
- Keep the alternator clean.
- Ensure that the ventilation slots are clear.
- Check and ensure that mounting bolts are tightened properly.
- Ensure that the belt on the alternator is in good condition.
- Check the belt tension and ensure that it is neither too slack nor too tight.
- Check the brush length after every 60,000 km.
- Ensure correct level of electrolyte in the battery.
- Check the general condition of the battery.
- Apply battery terminals with petroleum jelly.

## WIRING DIAGRAM

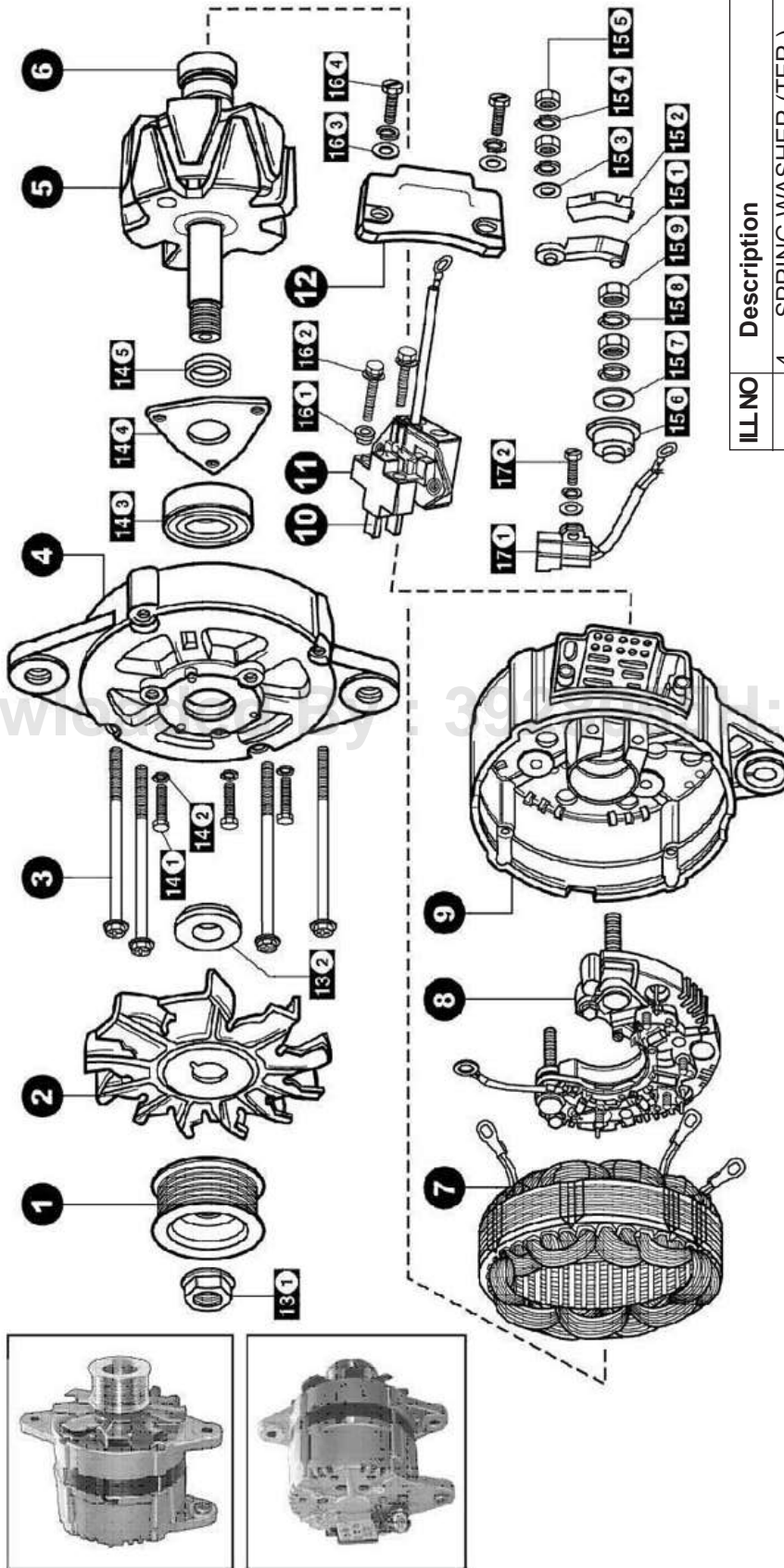


- Performance value to be taken after one hour heat run at 6000 RPM and 54 amps.
- Ambient temperature  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ .
- Cut-In speed at 13.0 Volt at terminals to be 1200 RPM (Cold)

## CHECKING AFTER RE-ASSEMBLY



1. Clamp the Alternator in a test rig.
2. Connect as shown in figure .
3. Observe correct polarity of battery.
4. Close the switch, warning lamp should glow.
5. Run the Alternator at 6000 RPM, WL should go off, and adjust the load so that terminal voltage is between 13.0 / 13.5 Volts. The Ammeter should read the rated output.



ILL NO	Description	Qty
4	SPRING WASHER (TER.)	2
5	NUT (TERMINAL)	2
6	INSUL CUP WASHER	1
7	PLAIN WASHER	1
8	SPRING WASHER	2
9	NUT	2
16	<b>BRUSH BOX ASSEMBLING KIT</b>	1
1	INSUL BUSH	1
2	CAPTIVE SCREW ASSY.	2
3	PLAIN WASHER	2
4	SCREW	2
17	<b>PLUG MOULDING ASSEMBLING KIT</b>	1
1	PLUG MOULDING ASSY.	1
2	SCREW (PLUG MOLG.)	1

ILL NO	Description	Qty
1	FLANGE NUT	1
2	BEARING COLLAR	1
14	<b>DE BEARING ASSEMBLING KIT</b>	1
1	SCREW (BEG. RET. FIX.)	3
2	SPRING WASHER	3
3	'DE' BALL BEARING	1
4	BEARING RETAINER	1
5	SPACING COLLAR	1
15	<b>RECTIFIER ASSEMBLING KIT</b>	1
1	TERMINAL MOULDING	1
2	COVER	1
3	PLAIN WASHER (TER.)	2

ILL NO	Description	Qty
1	PULLEY	1
2	ASYMMETRIC FAN THROUGH BOLT	1
3	"DE" BRACKET ASSEMBLY	4
4	ROTOR ASSEMBLY	1
5	"SRE" BALL BEARING	1
6	STATOR WINDING ASSEMBLY	1
7	RECTIFIER ASSEMBLY	1
8	SRE BRACKET ASSEMBLY	1
9	BRUSH SET	1
10	REGULATOR & BRUSH BOX ASSY.	2
11	COVER MOULDING	1
12	PULLEY ASSEMBLING KIT	1
13		1

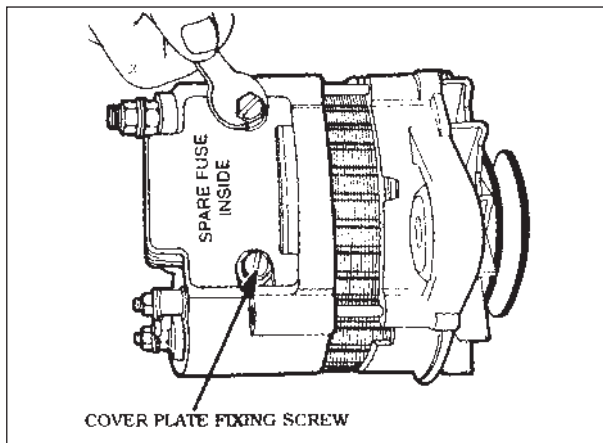
**Dismantling**

Before dismantling the parts, note down the position of various parts, in order to ensure their proper replacement on reassembly.

Follow the step by step procedure mentioned below :

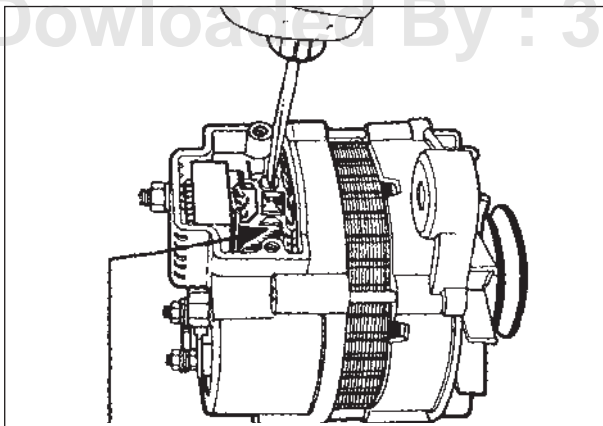


**Do not remove the rotor assembly without removing the brush box assembly. Otherwise, the brushes will break.**

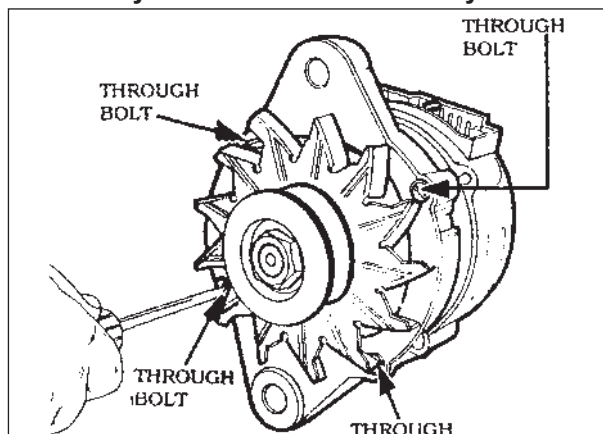
**Dismantling of Brush Box Assy**

Remove the cover plate fixing screws.

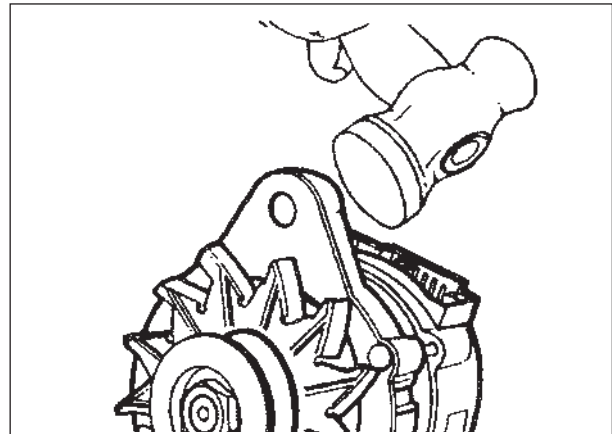
Remove the regulator cum brush box fixing screws.



Remove the regulator cum brush box assembly.

**Disassembly of SRE Bracket Assembly:**

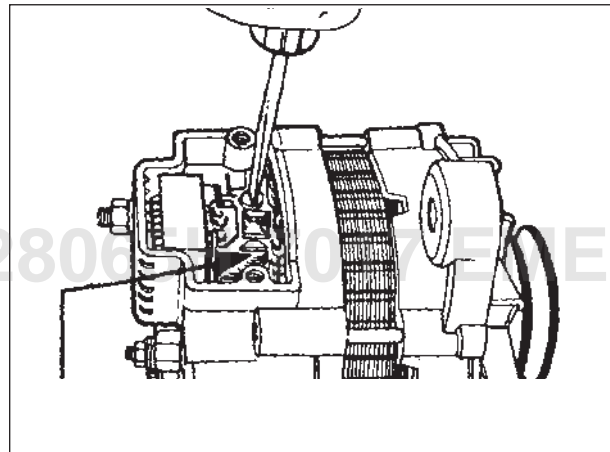
Remove the through bolts (4 Nos.) which secure the DE bracket and SRE bracket.



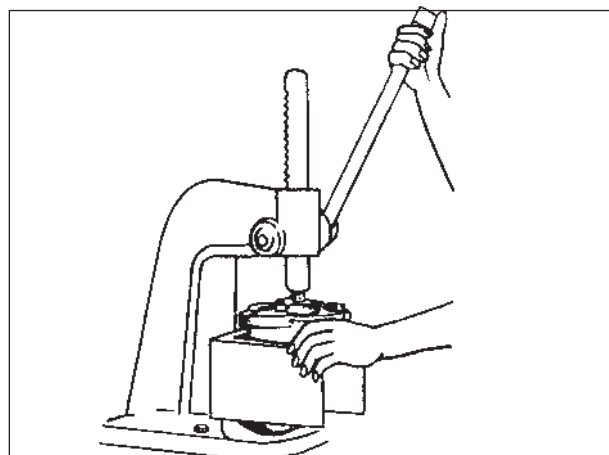
Separate the DE bracket assembly from the SRE bracket cum stator assembly using a wooden mallet.



**Place the SRE bracket assembly in a clean polythene cover.**

**Disassembly of DE bracket Assembly:**

Clamp the rotor assembly in a soft jaw and remove the pulley nut (Take care of Rotor claws from damage).



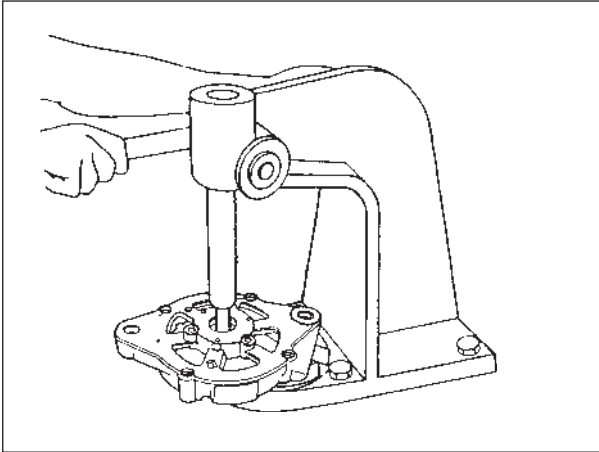
Push down the rotor assembly from the DE bracket using a fly press.



**Cover the slip ring with a suitable protective cap.**

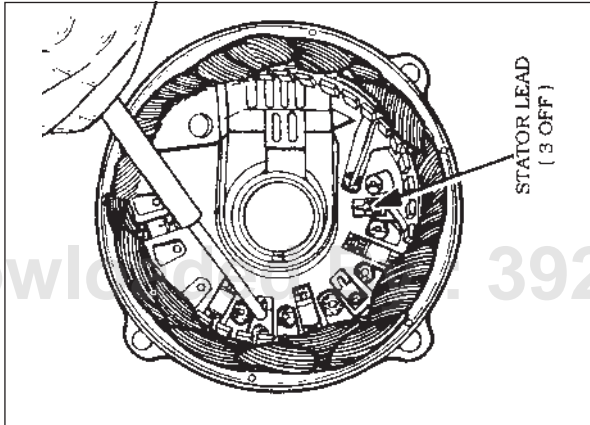


### Removal of D. E. Bearing:



Unscrew the retaining plate fixing screws and place the D. E. Bracket assembly in a fly press and press down the ball bearing from the D. E. Bracket.

### Disassembly of stator assembly from SRE bracket:

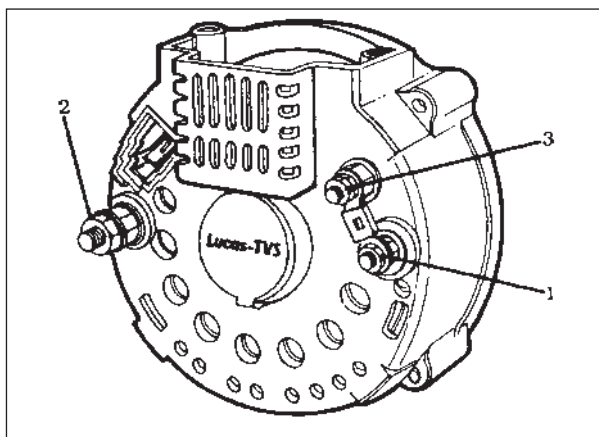


Note down the position of stator output leads.

De - solder the stator leads from the rectifier.

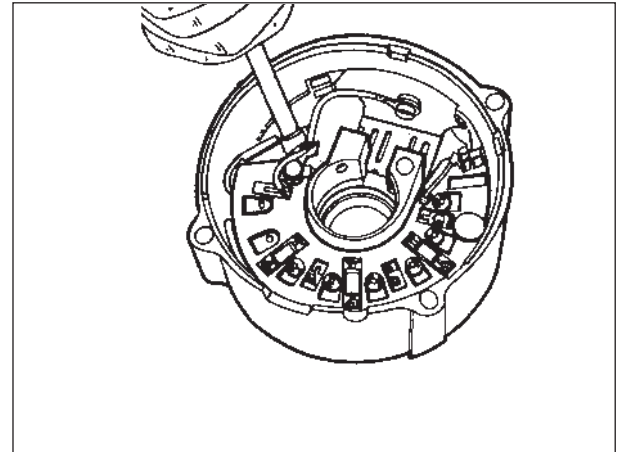
Remove the Stator assembly.

### Disassembly of rectifier assembly:



Remove the following:

1. Negative terminal nut
2. Positive terminal nut
3. Earth stud nut



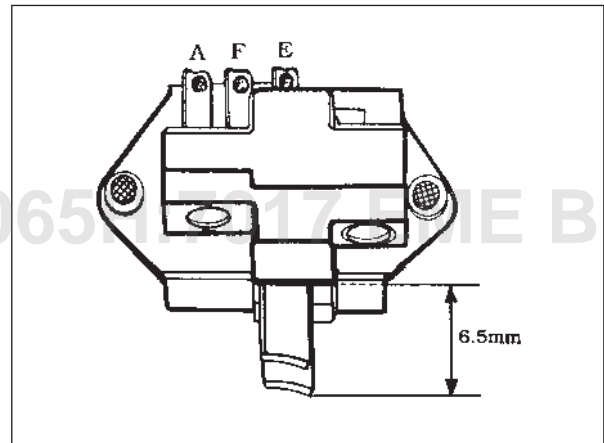
Remove the RFI capacitor fixing nut.

### Bench Inspection

Alternator:

On dismantling the unit conduct the following checks :

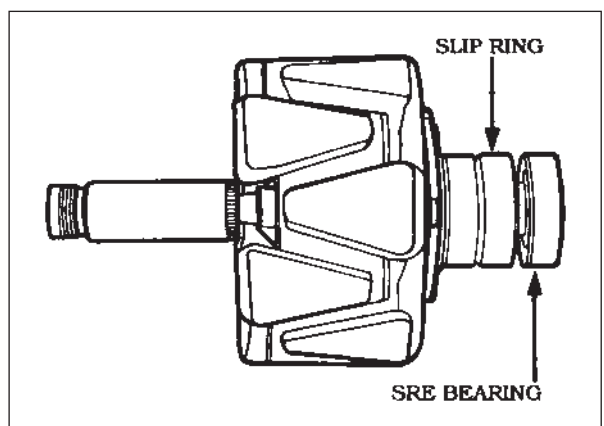
#### Brush check



Exposed brush length to be more than the minimum required length 6.5 mm.

If the brushes are below the minimum required length renew the brushes in sets not individually. De - solder the brush leads. Insert new brushes and solder to maintain the required brush length. Make sure that the brushes move freely inside the brush box.

#### Slip Ring Check:



Clean slip ring surface with a fine piece of cloth and ensure that the surface is smooth and clean.

If the surface is very rough and cannot be polished replace the rotor assembly. There should not be any trace of oil or grease on the slip ring surface.

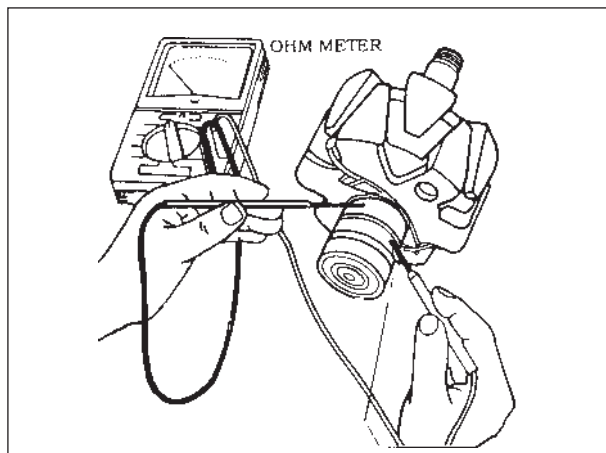
#### Bearing Check (Slip Ring End & Drive End):

Bearing should rotate freely without any excessive play.

If play is observed, the bearings should be replaced.

#### Rotor Assembly Check ;

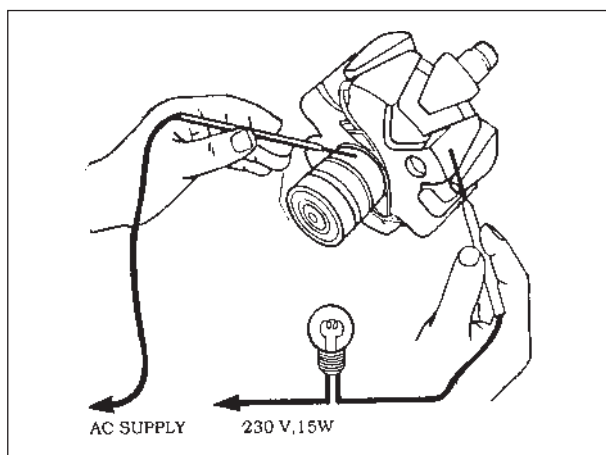
##### Resistance check:



Use Ohm meter 0 - 10 ohm range and connect.

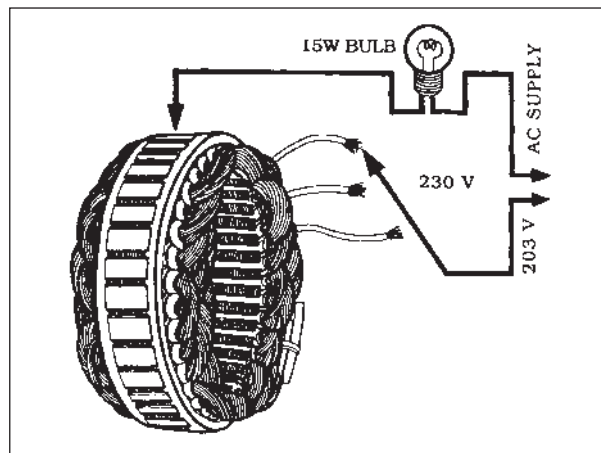
Connect the probes of the meter to the slip ring. The value should be between: 2.7 / 3.3 Ohms. If the value is outside this limit, change the Rotor Assembly.

##### Rotor ground test:



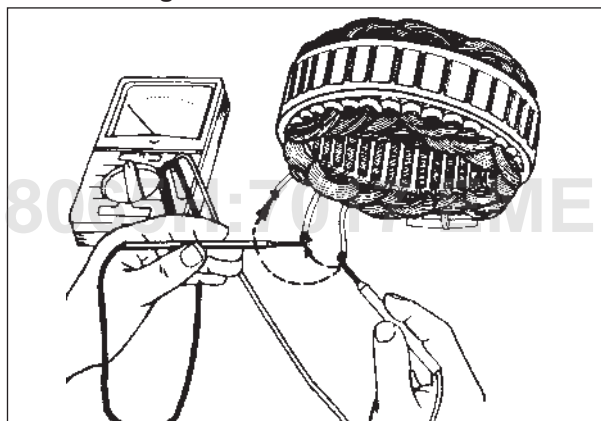
Using 230 volt AC main Supply, Connect a 15W bulb. Connect one of the probes to the slip ring and the other to the shaft. The lamp should not glow. If the lamp glows it indicates earthing. Replace the rotor assembly.

##### Stator Insulation Test:



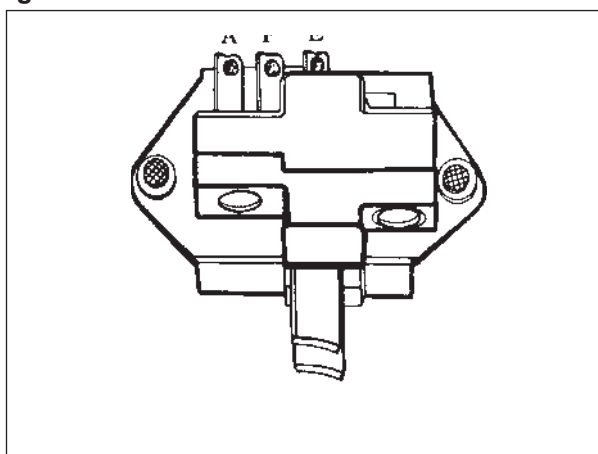
Using 230 volt AC main Supply, connect a 15W bulb. Connect one of the probes to any of the three leads and the other probe to the Stator core. The lamp should not glow. If the lamp glows it indicates poor insulation. Replace the stator assembly.

##### Stator winding resistance check :



Use ohm meter with two probes connect the probes between phases one by one. The value should read around 0.12 ohms

##### Regulator Check



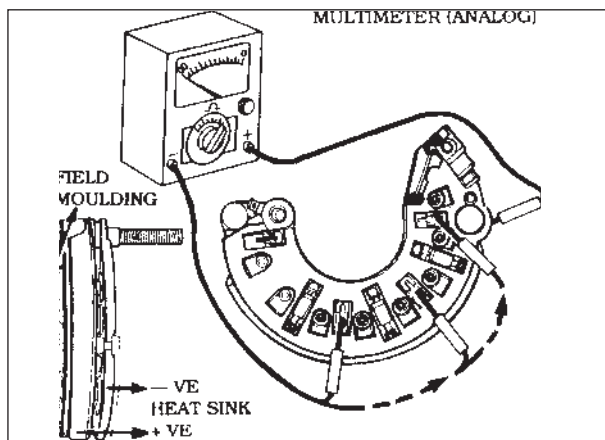
Use Lucas-TVS authorised test equipment for checking Regulators and test as per instructions given in the test equipment manual.

Connect the equipment as per the markings.

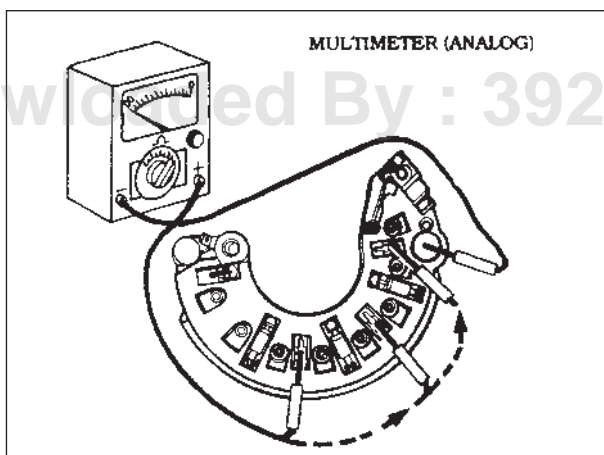


**Rectifier assembly check**

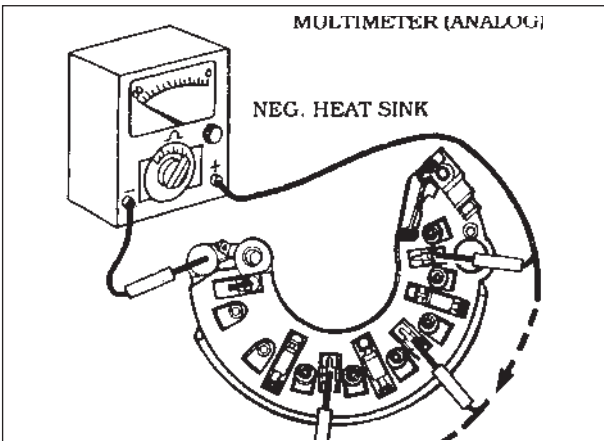
Remove the rectifier assembly from the unit and check as follows.

**Testing positive heat sink diodes (Short circuit check)**

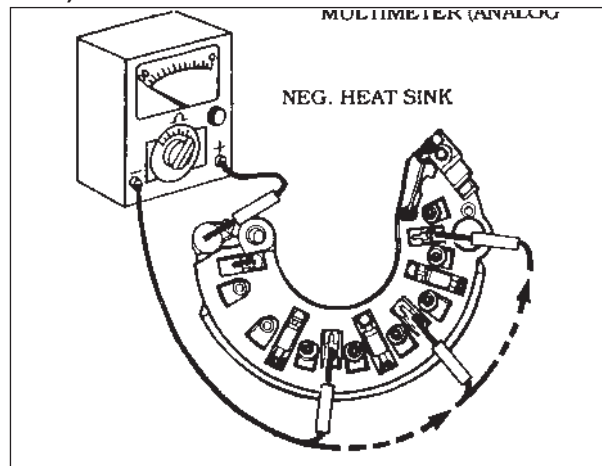
Connect as shown in figure. Use multimeter with two probes. Connect the positive probe of the multimeter to positive heat sink and negative probe to phase connecting points on the rectifier. It should not indicate continuity. If it indicates replace the rectifier assembly.

**Testing positive heat sink diodes (Continuity check)**

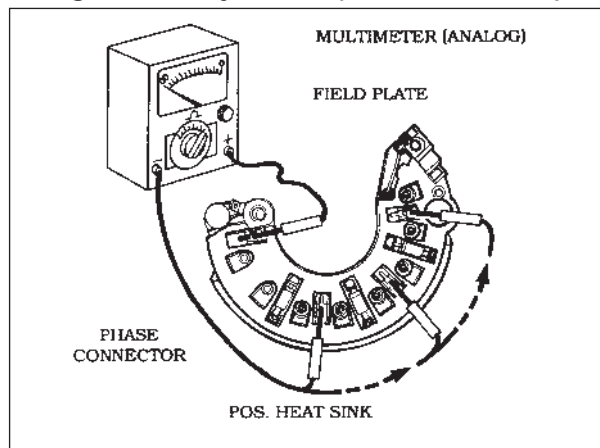
Connect as shown in Fig. Use multimeter with two probes positive probe to phase connector points and negative probe to positive heat sink of the rectifier assemblies. Meter should indicate continuity. If there is no continuity it indicates open circuit of diode. Replace the rectifier assembly.

**Testing of negative heat sink diodes (Short circuit check)**

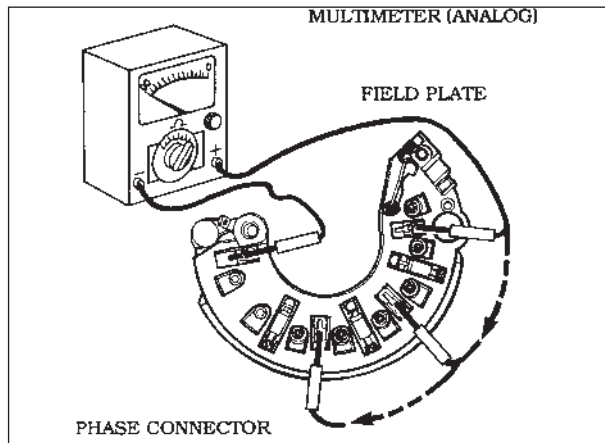
Connect as shown in Fig. Use the multimeter with two probes. Connect the positive probe of multimeter to phase connecting points and negative probe to rectifier body. Meter should not indicate continuity. If it indicates replace the rectifier assembly.

**Testing of negative heat sink diodes (Continuity check):**

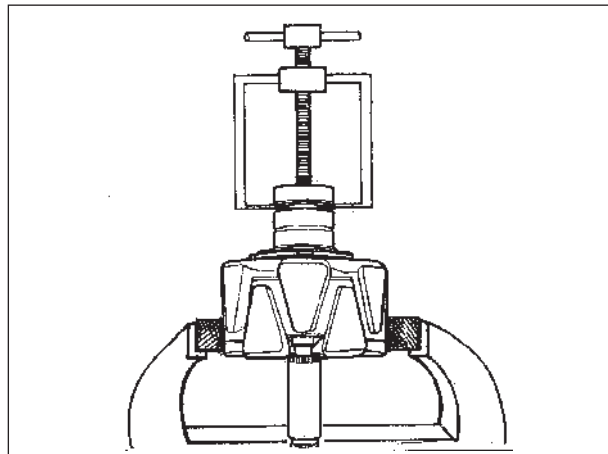
Connect as shown in Fig. Use a multimeter with two probes. Connect negative probe of multimeter to phase connecting points and positive probe to rectifier body. Meter should indicate continuity. If not, it indicates open circuit. Replace rectifier assembly.

**Testing of auxiliary diodes (Short circuit test):**

Connect as shown in Fig. Use a multimeter with two probes. Connect the positive probe of the multimeter to the field plate, and negative probe to the phase connection on the rectifier. Meter should not indicate continuity. If any diode indicates continuity replace the rectifier assembly.

**Testing of Auxiliary diodes (Continuity test):**

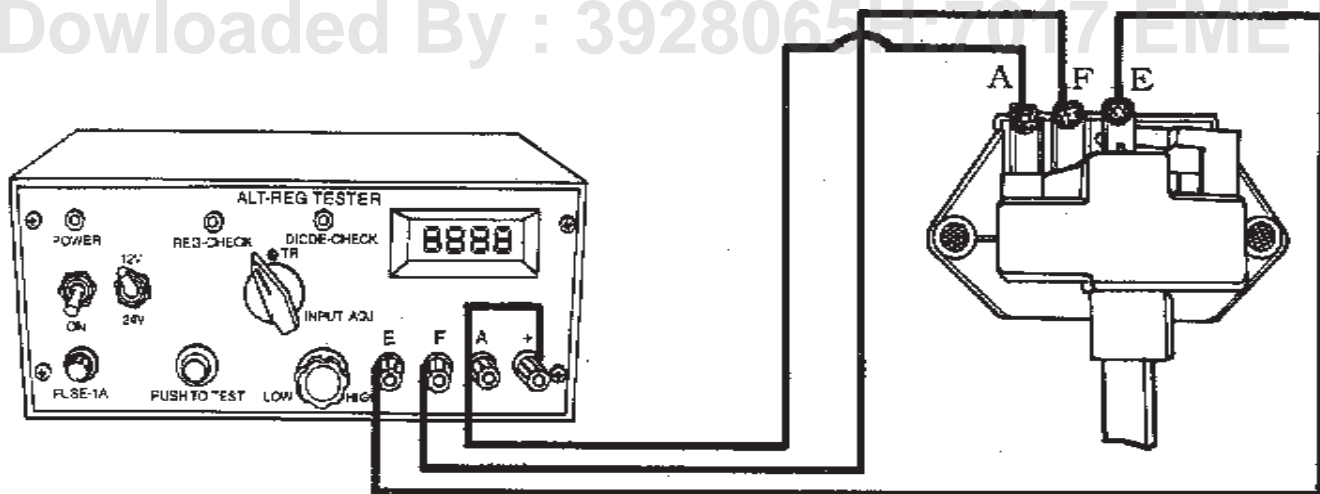
Connect as shown in Fig. Use a multimeter with two probes. Connect the negative probe of the multimeter with the field plate and the positive probe to the phase connecting leads. Meter should indicate continuity. If not, replace the rectifier assembly.

**SRE BEARING ASSY.**

Clamp the rotor assembly in a soft jaw. Place the puller in the bearing rear and remove it. (Take care of rotor claws from damage.)

**Regulator Check**

Use LTVS authorised test equipment for checking Regulators and test as per instructions given in the test equipment manual. Connect the negative to the equipment as per the markings on the Regulator.

**Reassembly**

It is a reverse order of dismantling procedure. Note the following precautions.

\*Use only 40 - 60 grade solder for soldering.

\*Use 50 watts soldering iron.

\*Ensure all through bolts and pulley shaft nut are tightened properly and driven home completely.

**Tightening Torque Chart:**

Shaft Nut (M16)	70 ± 5. Nm
Fixing Bolts (M5)	5.0 - 5.7 Nm
"+ Ve" Output Terminal Nut (M6)	3.9 - 5.1 Nm
"- Ve" & Fuse Link Terminal Nuts (M5)	2.0 - 2.9 Nm
Cover Moulding fixing Screw (M5)	2.5 - 3.0 Nm

**60.3 24V ALTERNATOR - SA23 - LUCAS TVS****Technical Data**

1. Type	SA23
2. Rating	Continuous
3. Battery Voltage	24 V
4. Nominal Output	24 V - 45 A
5. Weight	5.0 Kg. Approx. Without Pulley
6. Rated Maximum Output Speed	6000 R.P.M
7. Speed In Use	1000 ~ 13500 R.P.M.
8. No. Of Poles	12
9. Over Speed with Maximum Output	15000 R.P.M. for 0.5 Minute
10. Polarity	Negative Earth
11. Regulating System	Built-In Regulator
12. Reg. Set Voltage	27.5 $\pm$ 0.5 V
13. Dirgection of Rotation	Clock (Viewed from Pulley side)

**Salient Features**

- Star connected 3-phase output winding wound on a laminated stator.
- 12-pole wound field rotor, carried on ball-race bearings in aluminium end brackets and belt driven from engine.
- Self-excited field (via three field diodes) at normal running speeds.
- Built - in rectifier provides rectification of generated A.C
- Voltage control is provided via a built-in electronic regulator.
- An RFI suppression capacitor is provided across the positive and negative terminals.
- As a safeguard against accidental reverse battery connections, a fuse is provided.
- A spare fuse is also provided.
- A phase terminal can be made available if required (for RPM meter).

**Do's and Don'ts****Do's**

- Do ensure that all electrical connections are clean and secure.
- Do ensure that no electrical connection in the circuit including the battery is open.
- Do observe correct polarity. i.e. connect negative to negative and positive to positive. Otherwise, Alternator will be damaged.
- Disconnect all alternator terminals, while carrying out welding jobs on the vehicle.

- Disconnect the battery earth cable before removing the alternator.

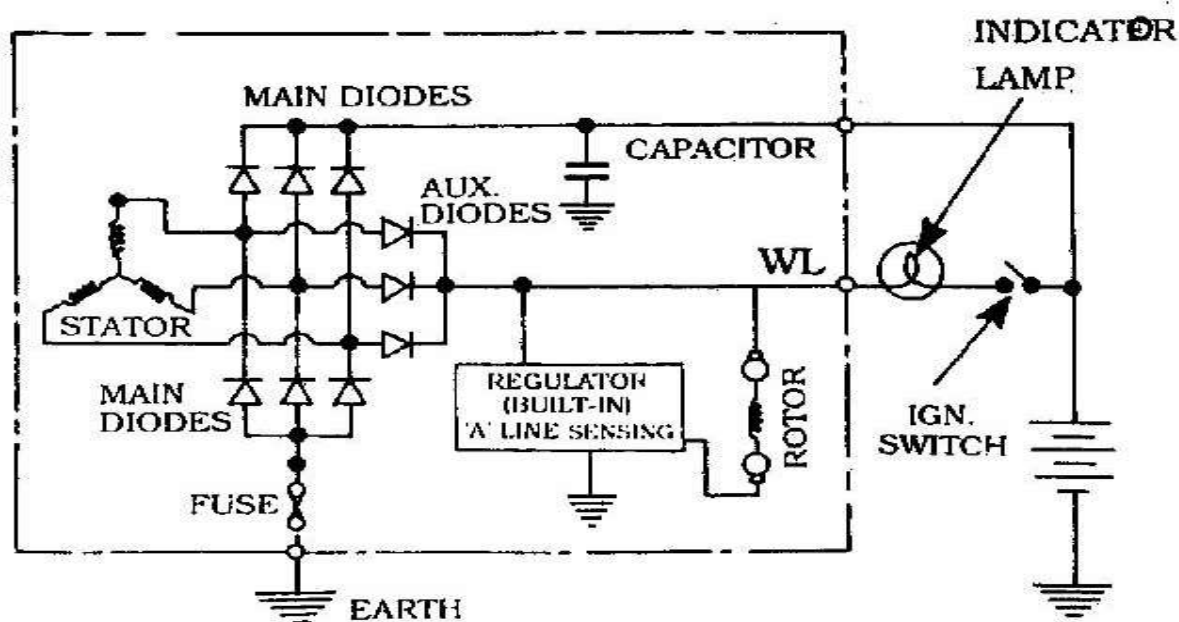
**Don'ts**

- DO NOT DIS-ASSEMBLE THE ALTERNATOR WITHOUT REMOVING THE BRUSH BOX ASSEMBLY.
- Do not run the alternator with the battery disconnected.
- Do not disconnect any lead of Alternator/Regulator with the engine in running condition.
- Do not disconnect battery cables while the engine is running.

**Routine Maintenance**

- Keep the alternator clean.
- Ensure that the ventilation slots are clear.
- Check and ensure that mounting bolts are tightened properly.
- Ensure that the belt on the alternator is in good condition.
- Check the belt tension and ensure that it is neither too slack nor too tight.
- Adjust the belt deflection to be 10-15mm at the longest point when pressed at midway between pulleys.
- Check the brush length (Ref. Fig 11) after every 60,000 km.
- Ensure correct level of electrolyte in the battery.
- Check the general condition of the battery.
- Apply petroleum jelly for battery terminals & posts.

## WIRING DIAGRAM FOR TESTING ALTERNATOR

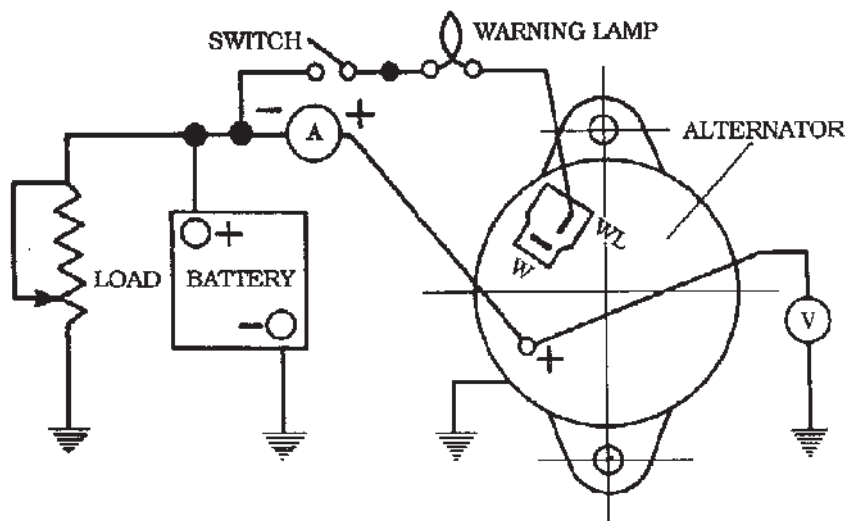


- Performance value to be taken after one hour heat run at 6000 RPM - 21Amps for 24V. (The heat run is to be conducted with regulator in circuit)

- Ambient temperature 27° C to 32° C.

- Cut-In speed at 27.0 Volt at terminals to be 1100 RPM (Cold)

## CHECKING AFTER RE-ASSEMBLY



1. Clamp the Alternator in a test rig.
2. Connect as shown in figure .
3. Observe correct polarity of battery.
4. Close the switch, warning lamp should glow.
5. Run the Alternator at 6000 RPM, WL should go off, apply minimum load and the terminal voltage is between 26.5 / 27.0 Volts. The Ammeter should read the output according to the applied load.

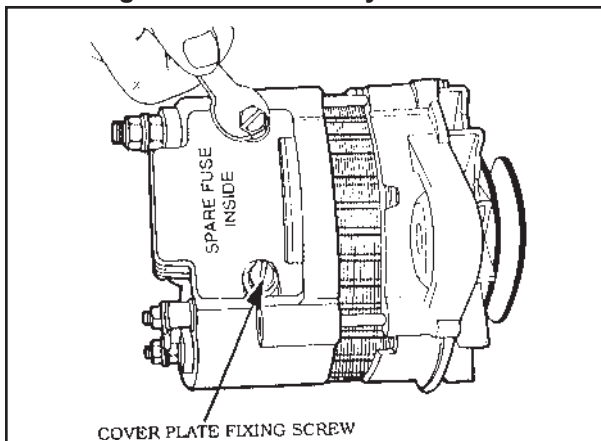
**Dismantling**

Before dismantling the parts, note down the position of various part, in order to ensure their proper replacement on reassembly.

Follow the step by step procedure mentioned below :

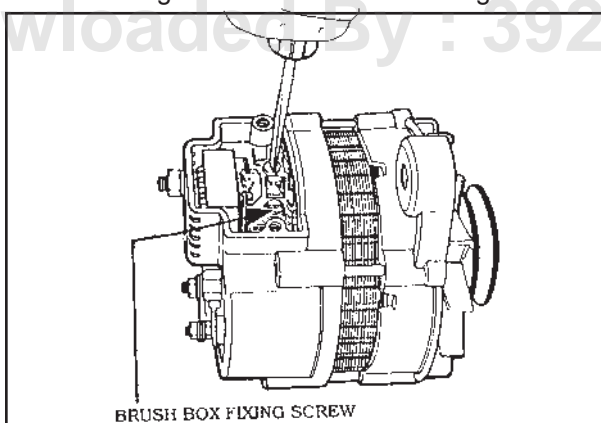


**Do not remove the rotor assembly without removing the brush box assembly. Otherwise, the brushes will break.**

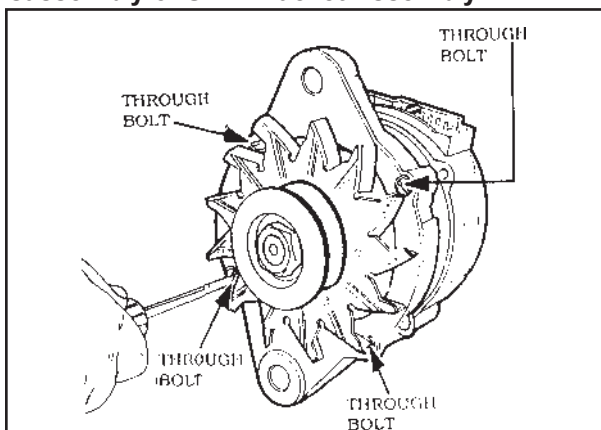
**Dismantling of Brush Box Assy**

Remove the cover plate fixing screws.

Remove the regulator cum brush box fixing screws.

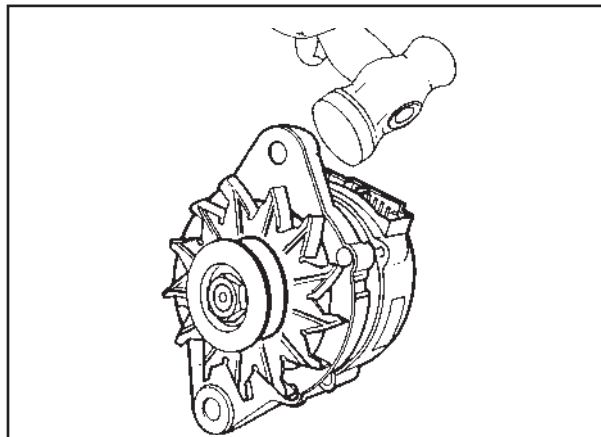


Lift the regulator cum brush box assembly.

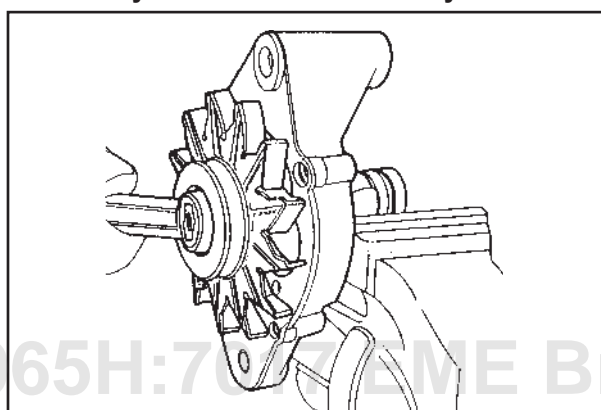
**Disassembly of SRE Bracket Assembly:**

Remove the through bolts (4 Nos.) which secure the DE bracket and SRE bracket.

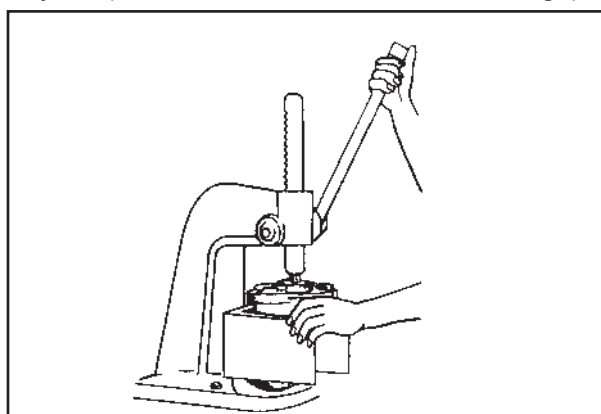
Separate the DE bracket assy. from the SRE bracket cum stator assembly using a wooden mallet.



Place the SRE bracket assembly in a clean polythene cover.

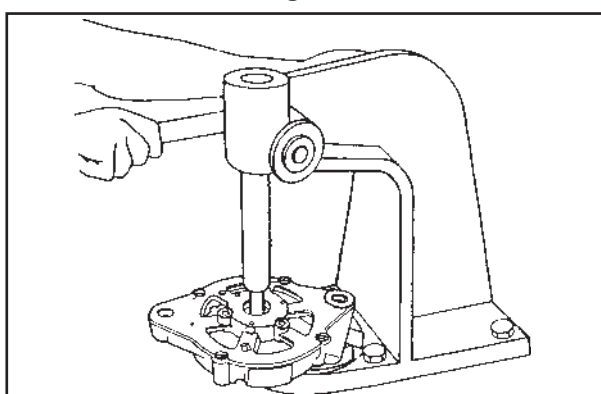
**Disassembly of DE bracket Assembly:**

Clamp the rotor assembly in a soft jaw and remove the pulley nut (Take care of Rotor claws from damage).



Push down the rotor assembly from the DE bracket using a fly press.

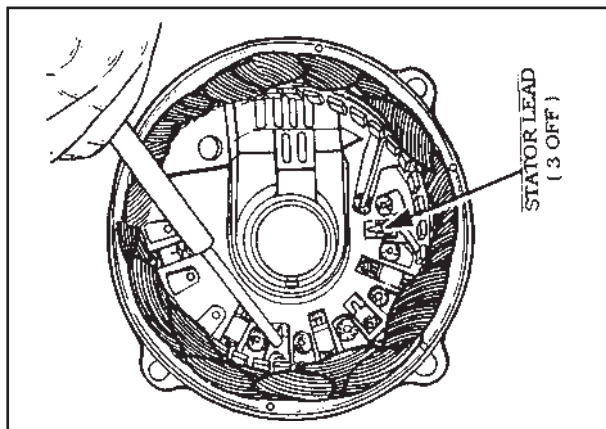
Cover the slip ring with a suitable protective cap.

**Removal of D. E. Bearing:**



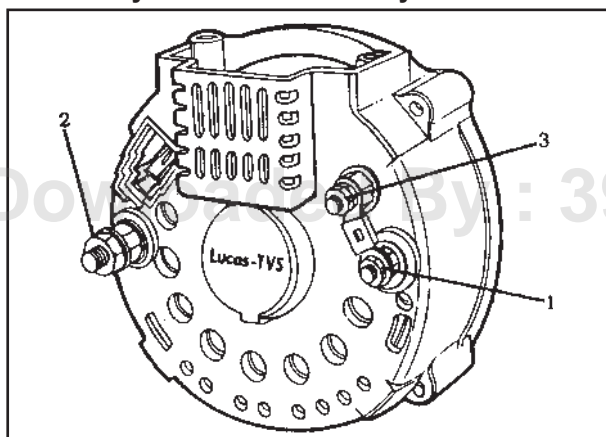
Unscrew the retaining plate fixing screws and place the D. E. Bracket assembly in a fly press and press down the ball bearing from the D. E. Bracket.

#### Disassembly of stator assembly from SRE bracket:



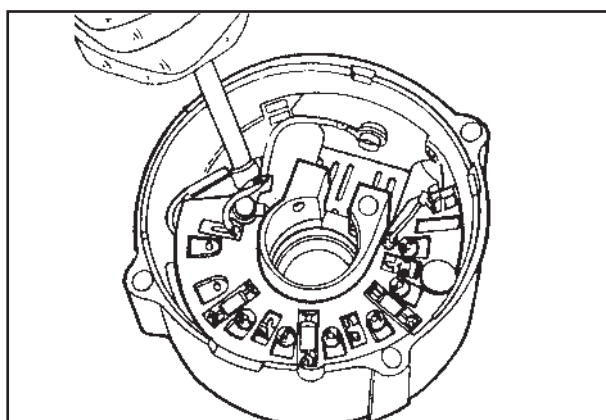
Note down the position of stator output leads.  
De - solder the stator leads from the rectifier.  
Remove the Stator assembly.

#### Disassembly of rectifier assembly:



Remove the following:

1. Negative terminal
2. Positive terminal
3. Earth stud nut



Remove the RFI capacitor fixing nut.

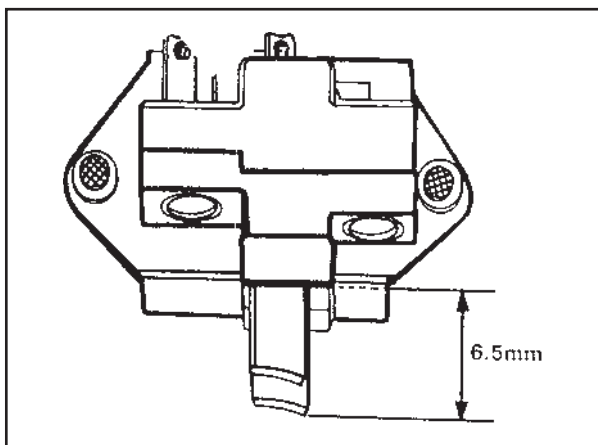
#### Bench Inspection

Alternator:

On dismantling the unit conduct the following checks :

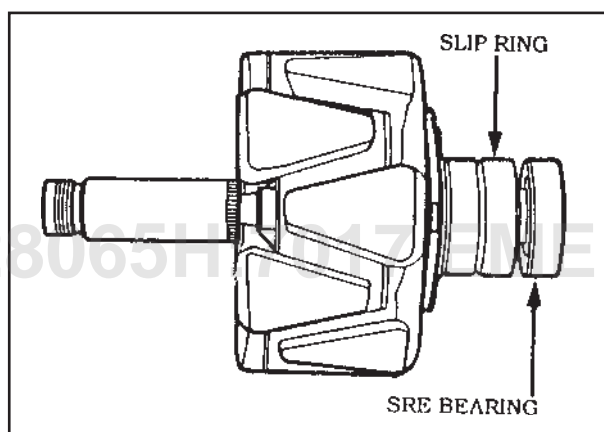
#### Brush check

Exposed brush length to be more than the minimum required length 6.5 mm.



If the brushes are below the minimum required length renew the brushes in sets not individually. De. solder the brush leads. Insert new brushes and solder to maintain the required brush length. Make sure that the brushes move freely inside the brush box.

#### Slip Ring Check:



Clean slip ring surface with a fine piece of cloth and ensure that the surface is smooth and clean.

If the surface is very rough and cannot be polished replace the rotor assembly. There should not be any trace of oil or grease on the slip ring surface.

#### Bearing Check (Slip Ring End & Drive End):

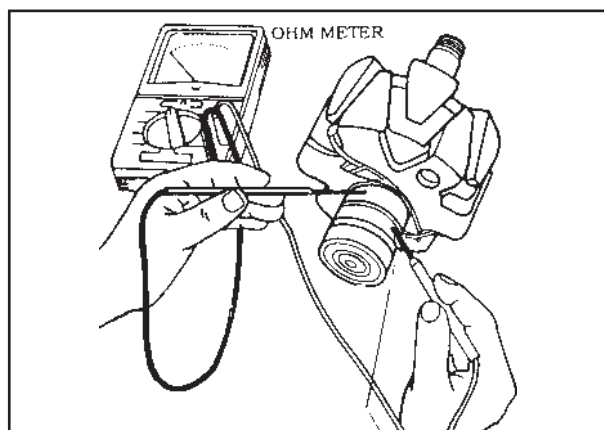
Bearing should rotate freely without any excessive play.

If play is observed, the bearings should be replaced.

#### Rotor Assembly Check ;

#### Resistance check:

Use Ohm meter 0 - 10 ohm range and connect.





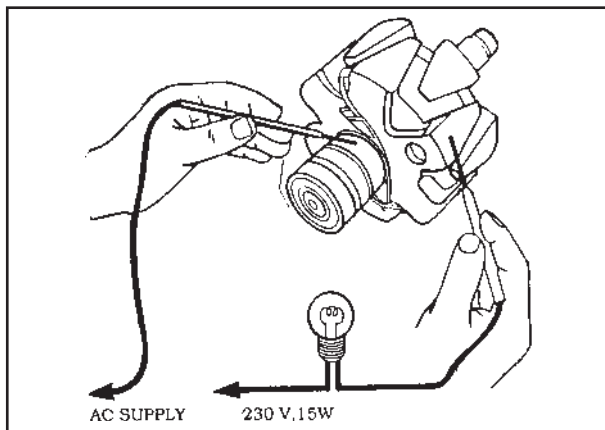


Connect the probes of the meter to the slip ring. The value should be between:

9.5 / 10.5 Ohms for 24V at 30°C

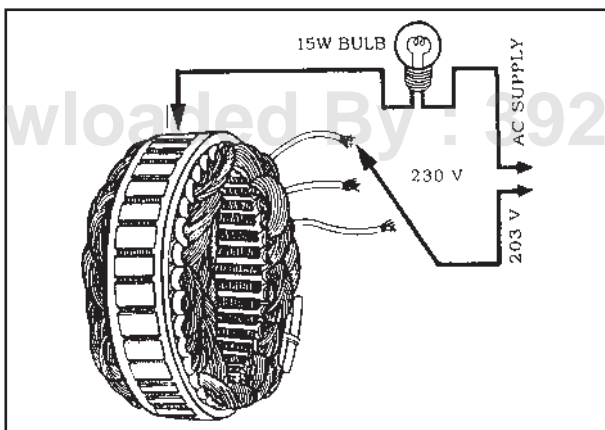
If the value is outside this limit, change the Rotor Assembly.

#### Rotor ground test:



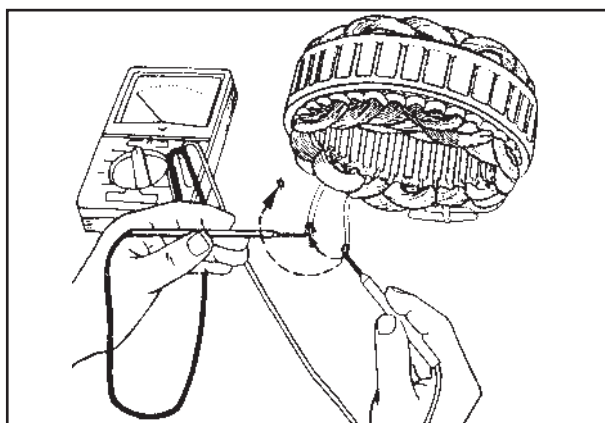
Using 230 volt AC main Supply, Connect a 15W bulb. Connect one of the probes to the slip ring and the other to the shaft. The lamp should not glow. If the lamp glows it indicates earthing. Replace the rotor assembly.

#### Stator Insulation Test:



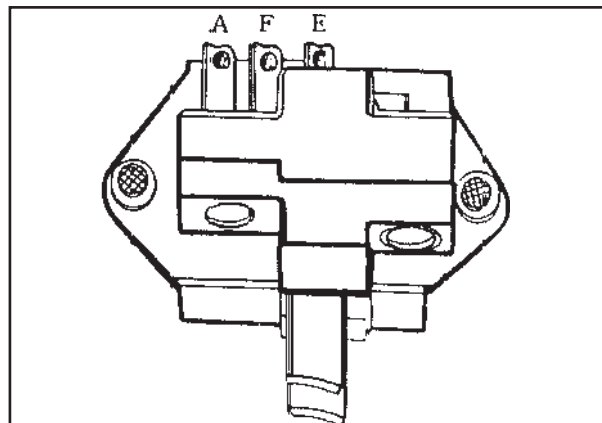
Using 230 volt AC main Supply, connect a 15W bulb. Connect one of the probes to the body. The lamp should not glow. If the lamp glows it indicates poor insulation. Replace the stator assembly.

#### Stator winding resistance check :



Use ohm meter with two probes connect between 1 and 2 leads. The value should read around 0.12 ohms at 20°C. Repeat it between 2 & 3 and 3 & 1 leads.

#### Regulator Check



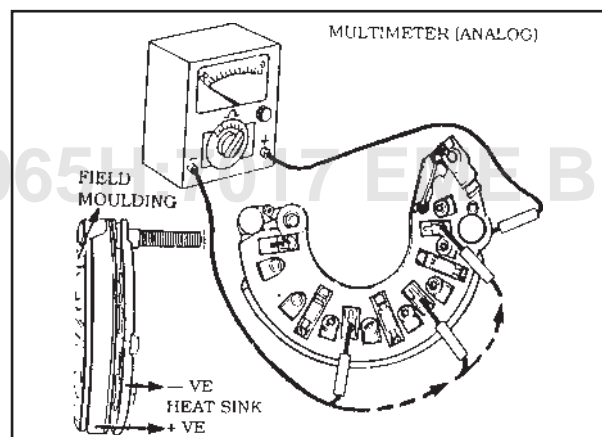
Use Lucas-TVS authorised test equipment for checking Regulators and test as per instructions given in the test equipment manual.

Connect the equipment as per the markings.

#### Rectifier assembly check

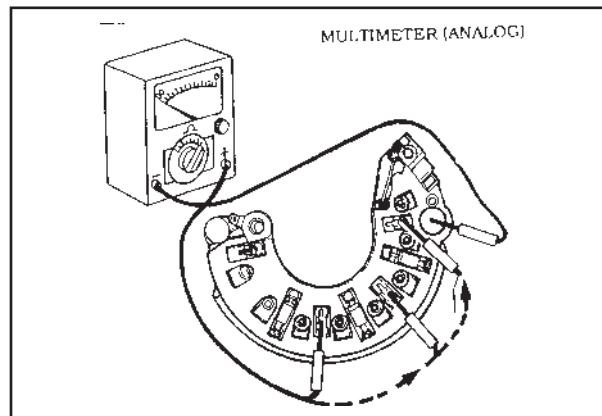
Remove the rectifier assembly from the unit and check as follows using a multimeter with two probes.

#### Testing positive heat sink diodes (Short circuit check)



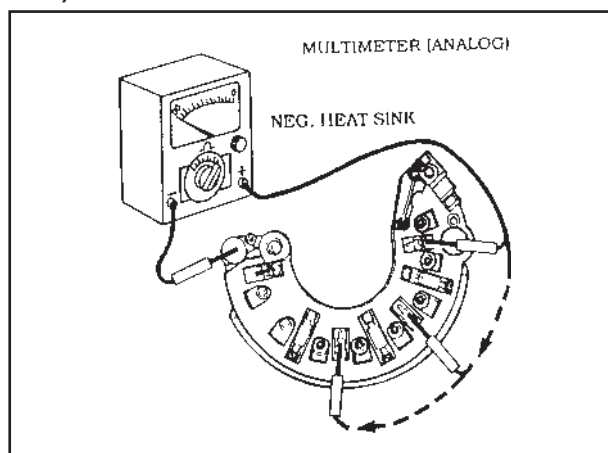
Connect. Use multimeter with two probes. Connect the positive probe of the multimeter to positive heat sink and negative probe to phase connecting points on the rectifier. It should not indicate continuity. If it indicates replace the rectifier assembly.

#### Testing positive heat sink diodes (Continuity check)



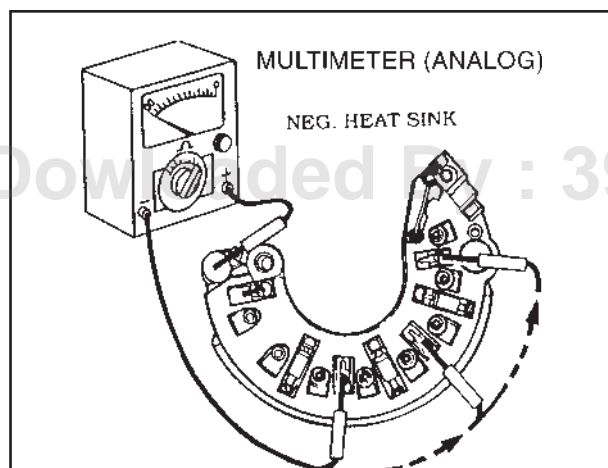
Connect as shown in Fig. Use multimeter with two probes positive probe to phase connector points and negative probe to positive heat sink of the rectifier assemblies. Diodes should indicate continuity. If there is no continuity it indicates open circuit. Replace the rectifier assembly.

### Testing of negative heat sink diodes (Short circuit check)



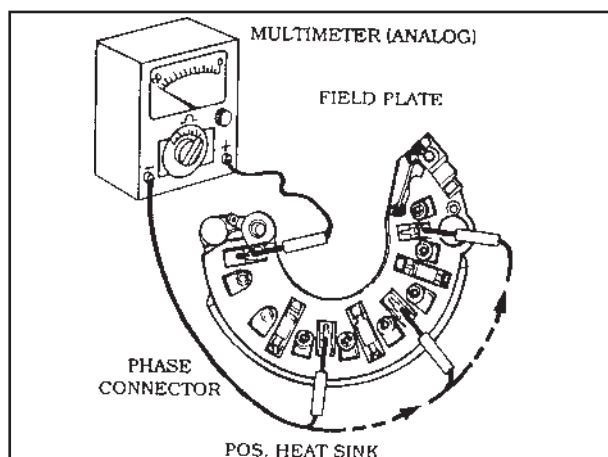
Connect as shown in Fig. Use the multimeter with two probes. Connect the positive probe of multimeter to phase connecting points and negative probe to rectifier body. Diodes should not indicate continuity. If it indicates replace the rectifier assembly.

### Testing of negative heat sink diodes (Continuity check):



Connect as shown in Fig. Use a multimeter with two probes. Connect negative probe of multimeter to phase connecting points and positive probe to rectifier body. Now all diodes should indicate continuity. If not, it indicates open circuit. Replace rectifier assembly.

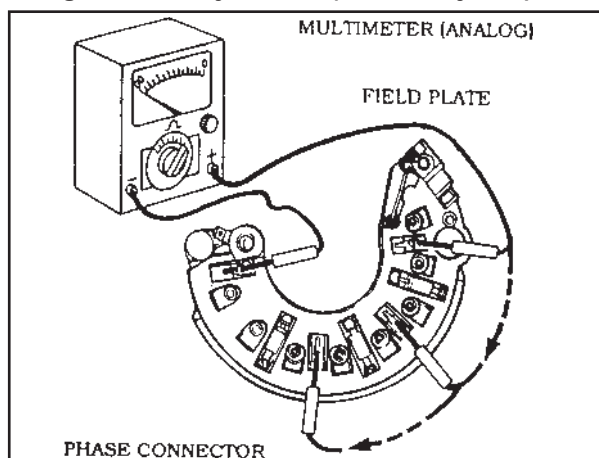
### Testing of auxiliary diodes (Short circuit test):



Connect as shown in Fig. Use a multimeter with two probes. Connect the positive probe of the multimeter to the

field plate, and negative probe to the phase connection on the rectifier. Diodes should not indicate continuity. If any diode indicates continuity replace the rectifier assembly.

### Testing of Auxiliary diodes (Continuity test):



Connect as shown in Fig. Use a multimeter with two probes. Connect the negative probe of the multimeter with the field plate and the positive probe to the phase connecting leads. It should indicate continuity. If not, replace the rectifier assembly.

### Reassembly

It is a reverse order of dismantling procedure. Note the following precautions.

\*Use only 40 - 60 grade solder for soldering.

\*Use 50 watts soldering iron.

\*Ensure tightening torques to the specified values given in the chart.

### Tightening Torque Chart:

Shaft Nut (M16)  $70 \pm 5$  Nm

Fixing Bolts (M5) 5.0 - 5.7 Nm

+ Ve Output

Terminal Nut (M6) 3.9 - 5.1 Nm

- Ve & Fuse Link

Terminal Nuts (M5) 2.0 - 2.9 Nm

Cover Moulding

Fixing Screw (M5) 2.5 - 3.0 Nm



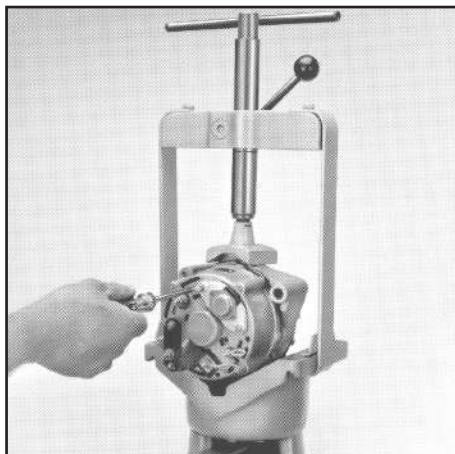
## TROUBLE SHOOTING - ALTERNATOR

**BEFORE STARTING ENSURE THE BATTERY CONDITION**

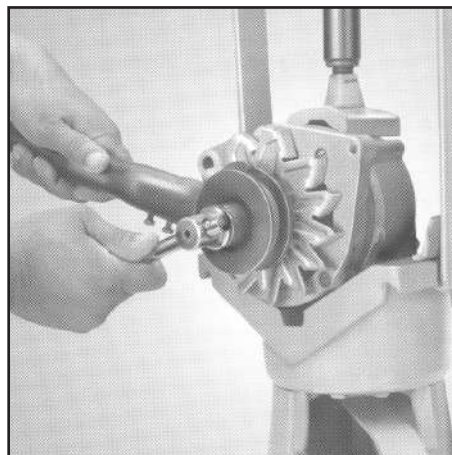
Defect	Cause	Remedy
1. Warning light does not light when Ignition switch is on.	(a) If the bulb does not glow, ground WL terminal of the alternator. (b) If the bulb now glows the causes are:- (ii) Jammed brushes or brush lead adrift. (iii) Dirty slip ring. (iv) Rotor open circuit. (v) Yellow lead connecting rectifier to regulator open. (c) If the bulb does not glow even after grounding WL terminal, the causes are:- (ii) Fused warning lamp bulb. (iii) Short circuited warning lamp holder. (d) If still WL does not glow when ignition switch is on, the cause is faulty regulator.	Free brushes. Replace, if necessary. Clean the slip ring. Check that the ends of the rotor winding are soldered properly to slip ring terminals. Resolder the windings. If open, or replace the rotor. Check for short circuit, if any, in the wiring harness. Then replace bulb. Replace Holder. Replace regulator.
2. Warning lamp glows dim.	(i) High resistance in warning lamp. (ii) Regulator defective. (iii) Rotor defective.	Check and correct. Replace regulator. Replace rotor.
3. Warning lamp 'on'. Ammeter shows no charge while engine is running.	(i) Loose belt. (ii) Aux. diode lead 'A' open. (iii) Shorted rotor (iv) Stator open / shorted	Check automatic belt tensioner as indicated in routine maintenance. Check diode connection and trace short. Rectify, if possible or replace rectifier assembly. Replace rotor. Replace stator assembly.
4. Warning lamp 'on' or dim but ammeter shows charge (low output)	(i) Faulty bridge	Replace defective heat sink assembly.
5. Warning lamp goes off. Ammeter shows low output.	(i) Faulty rectifier bridge (ii) Stator winding short.	Replace defective heat sink assy. Rectify or replace stator assy.
6. Warning lamp (Ammeter) flickers considerably.	(i) High resistance in the negative line. (ii) Slip ring dirty.	Check connections ensure use of recommended wire. Clean the slip ring and recheck.
7. Overcharging (battery gases)	(i) Faulty regulator. (ii) Rotor shorted to earth on negative side.	Replace regulator. Rectify or replace rotor assembly.

**60.4 K1 ALTERNATOR (MICO)****Repair Instructions****Dismantling**

- Clamp the alternator on swivelling vice 03-KDAW 9999.
- Remove the voltage regulator (17) by unscrewing screws (24).



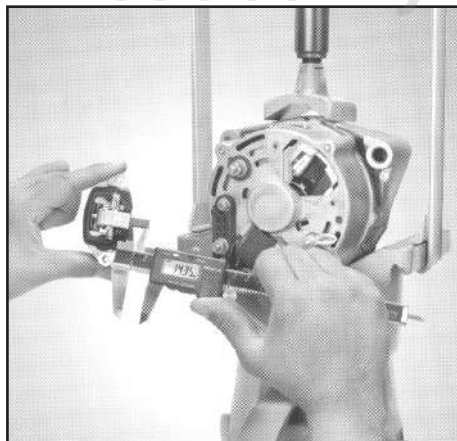
- Loosen the nuts holding the negative protection fuse, connecting lead and suppression capacitor and take them out.
- Hold the pulley with a pulley holding tool, or by holding the alternator shaft with an Allen Key, loosen and remove hexagonal nut (52). Remove spring washer (51), pulley with plate (54) and fan (53).



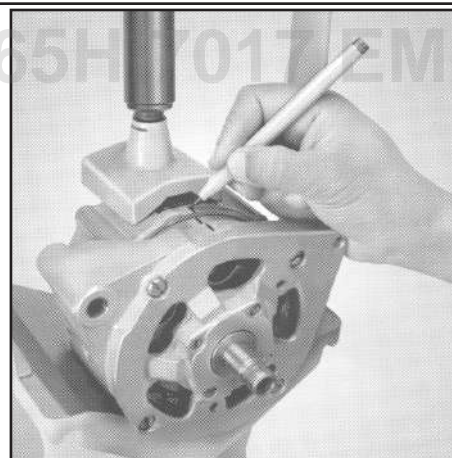
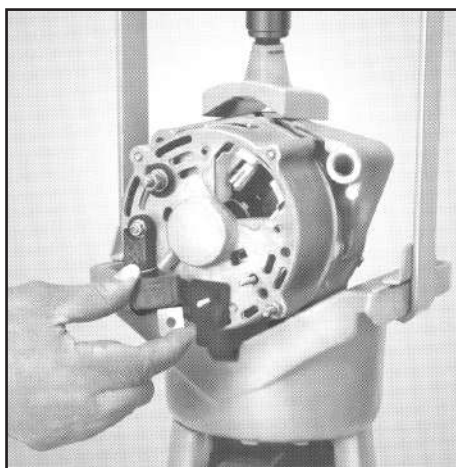
**Do not proceed with further dismantling of the alternator without removing the voltage regulator as it may lead to breakage of carbon brushes.**



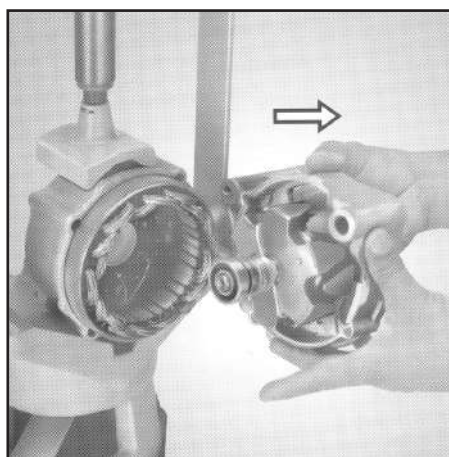
**Never hold the fan blades for loosening or tightening the hexagonal nut.**



- Check for free movement of carbon brushes and if the brushes are worn out, replace the brushes (min. projecting length = 5 mm).

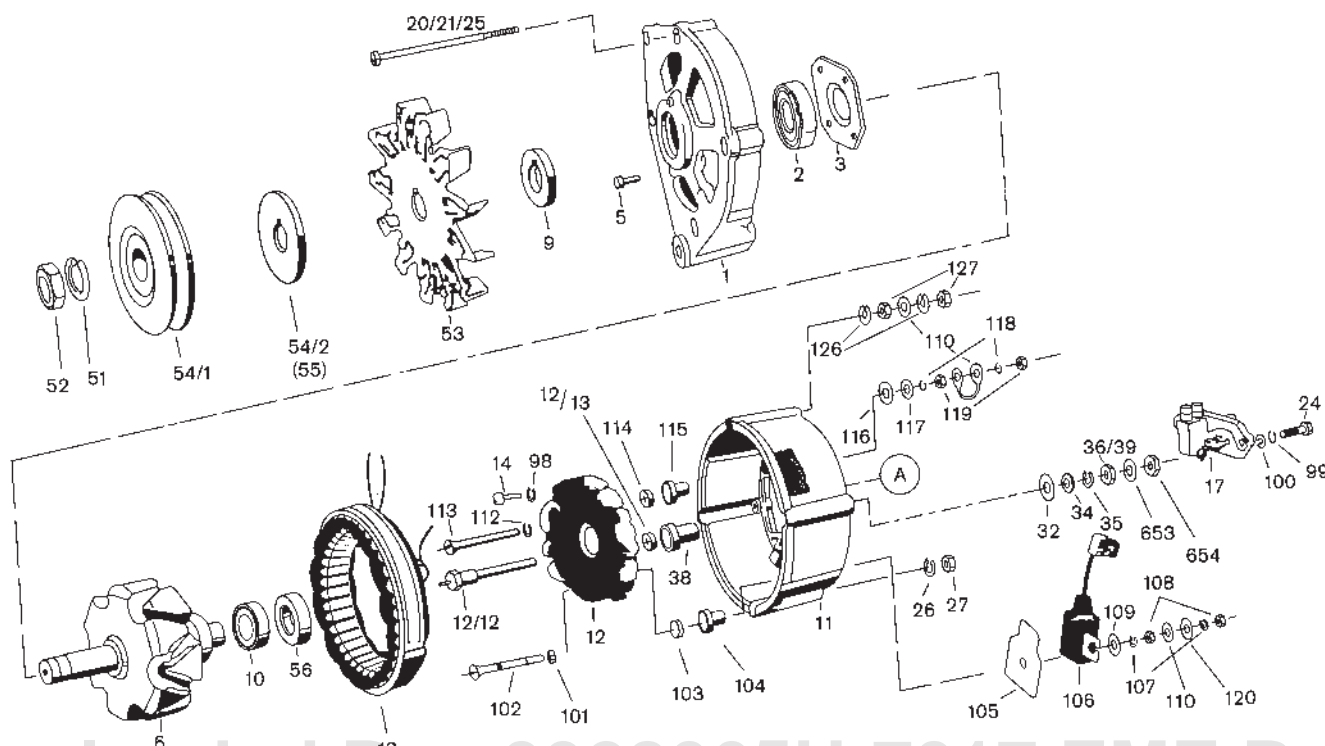


**Before the alternator is further dismantled, mark the drive end shield (1), slip ring end shield (11) and stator (18) so that these parts come to the same position during re-assembly.**





**EXPLODED VIEW OF K1 ALTERNATOR**



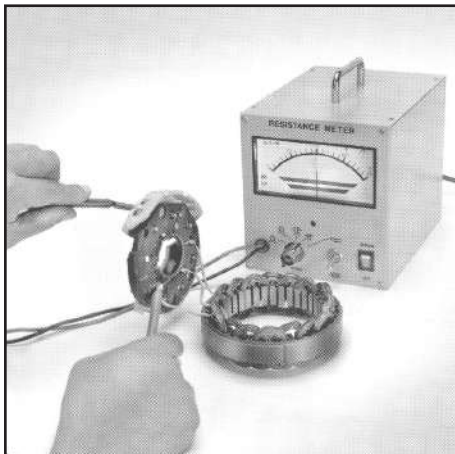
ILL. No.	Description	Qty.	ILL. No.	Description	Qty.
1	DRIVE END SHIELD	1	45	SPRING WASHER	3
2	DEEP-GROOVE BALL BEARING	1	51	SPRING WASHER	1
3	COVER PLATE	1	52	HEXAGON NUT	1
5	FLAT-HEAD SCREW	4	53	FAN	1
6	ROTOR	1	54/1	PULLEY	1
9	SPACER RING	1	63	INSULATING WASHER	1
10	DEEP-GROOVE BALL BEARING	1	64	WASHER	1
11	COLLECTOR-RING END	1	65	SPRING WASHER	2
12	RECTIFIER	1	66	HEXAGON NUT	1
13	SPLASH GUARD	1	75	LUCAR TERMINAL	1
17	TRANSISTOR REGULATOR	1	99	SPRING WASHER	2
18	STATOR	1	100	WASHER	2
19	O-RING	1	106	SUPPRESSION CAPACITOR	1
20	CHEESE HEAD SCREW	2	112	SPRING WASHER	1
21	CHEESE HEAD SCREW	1	113	CHEESE HEAD SCREW	1
22	CHEESE HEAD SCREW	1	114	HEXAGON NUT	1
24	CHEESE HEAD SCREW	2	117	WASHER	1
32	INSULATING WASHER	1	118	SPRING WASHER	1
32	INSULATING WASHER	1	119	HEXAGON NUT	1
34	WASHER	1	128	CONNECTOR	1
34	WASHER	1	129	SPRING WASHER	1
35	SPRING WASHER	1	130	HEXAGON NUT	1
38	INSULATING PART	1	131	SPRING WASHER	1
39	HEXAGON NUT	1	132	LEAD	1
43	HEXAGON NUT	2	136	HEXAGON NUT	2

- 1.6 Loosen the four cheese head screws (20/21/25) and withdraw the drive end shield (1) with the rotor (6) from the slip ring end shield. Note the position of the longer and shorter screws.

Withdraw the stator winding (18) along with the rectifier plate (12) from the slip ring end shield (11)

### Testing

#### Testing the Rectifier Plate



With test equipment 03-WPG 012.00

('On' and 'group diode' switch pressed and rotary knob in group diode position).

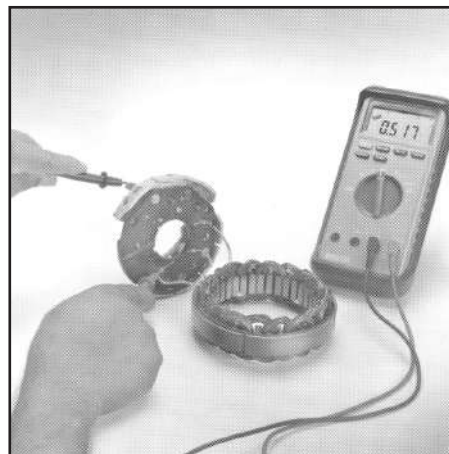
1. Check negative power diodes with prods between negative protection fuse terminal and winding ends.
2. Check positive power diodes with prods between B+ terminal and winding ends.
3. Check excitation diodes with prods between D+ terminal and winding ends.

Rectifier plate is OK if the pointer of the equipment remains in the green area in all the above cases. If not OK, replace the rectifier plate.

With digital multimeter Bosch model MMD 302 (0 684 500 301) or equivalent 3½ digit digital multimeter.

Keep selector switch on

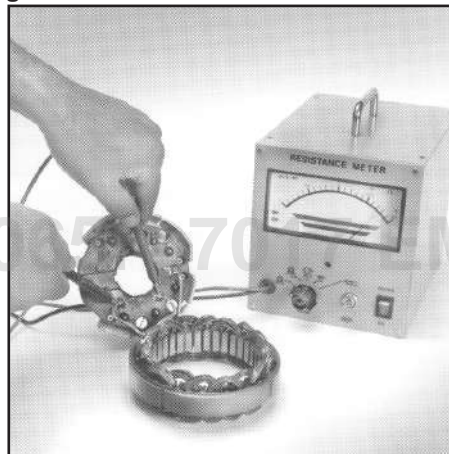
1. Check negative power diodes. Red prod on negative protection fuse terminal and black on winding ends. Reading should lie between 0.49 - 0.9 V. Reverse the polarity of the prods. There should be no change in reading (2.98 - 3.00 V).
2. Check positive power diodes. Black prod on B+ terminal and red prod on winding ends. Reading should lie between 0.49 - 0.9 V. Reverse the polarity of the prods. There should be no change in reading (2.98 - 3.00 V).
3. Check excitation diodes. Black prod on terminal D+ and red prod on winding ends. Reading should lie between 0.49 - 0.9 V. Reverse the



polarity of the prods. There should be no change in reading (2.98 - 3.00 V).

Replace the rectifier plate if the reading in any of the above tests is not within specified range.

#### Testing of Stator Resistance

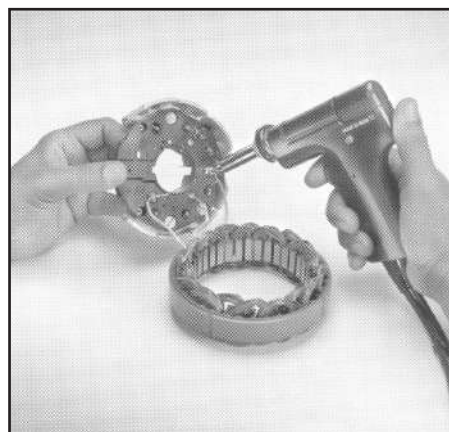


Using the equipment 03-WPG 012.00 (with knob turned to stator position).

Using the above equipment, measure the resistance between the phases of the stator winding.

Using digital multimeter.

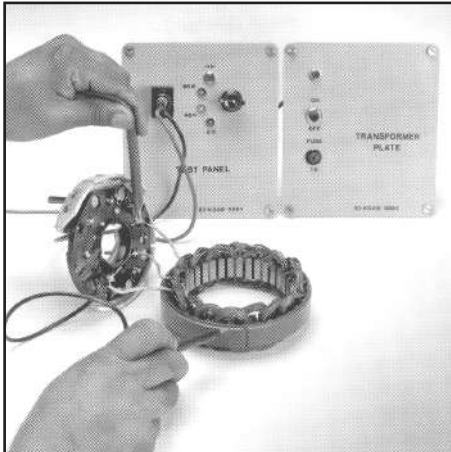
With selector knob on W between phases of the stator winding.



- If the rectifier plate or the stator is to be replaced, de-solder the phase connections from the rectifier plate, straighten the leads and remove rectifier plate from the stator.



### Testing short circuit to ground



Using the equipment 03-KDAW 9984 and 9985, test the stator for short circuit to ground. Light should not glow. Test voltage: 80V AC.

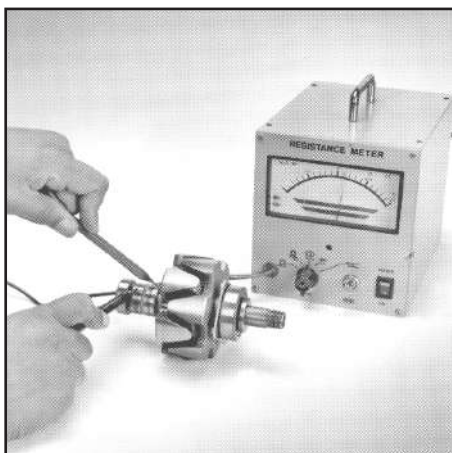
### Removing the Claw Pole Rotor

The claw pole rotor (6) needs to be removed from the drive end shield only if slip rings, rotor winding, deep groove ball bearing or drive end shield are defective.



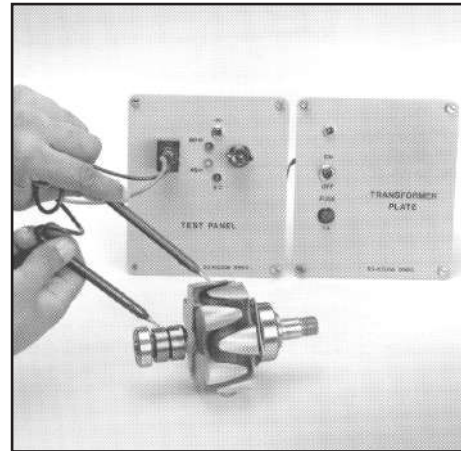
- Loosen the four countersunk screws (5) holding the cover plate to drive end shield and press out claw pole rotor with the bearing from the drive end shield. Remove the bearing using commercially available puller.

### Testing resistance of the Rotor Winding



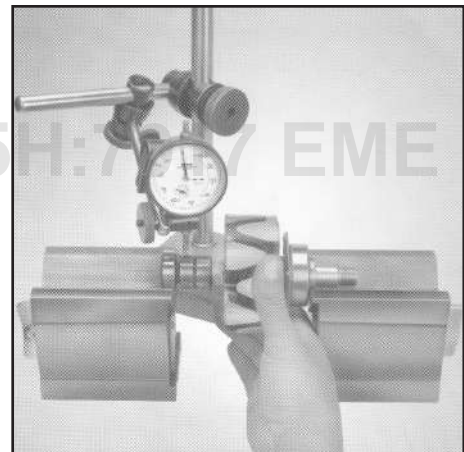
Measure the resistance of the rotor winding (between the two slip rings) using equipment 03 WPG 012.00 (knob in rotor position) or with a digital multimeter.

### Testing Rotor short circuit to ground



Test rotor short circuit to ground (between slip rings and claw poles or rotor shaft) using test equipment 03-KDAW 9984 and 9985. Test voltage: 80 V AC. Light should not glow.

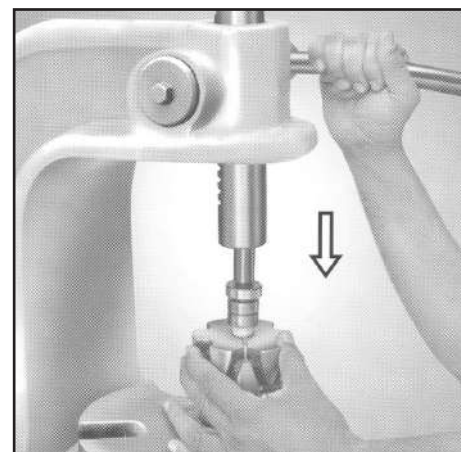
### True Running Test



Mount the rotor on suitable V blocks and align horizontally. Using a magnetic stand and dial indicator, check the true running on rotor and slip rings.

Max. runout on rotor: 0.05 mm  
Max. runout on slip ring: 0.03 mm  
Min. dia. of slip ring: 26.8 mm

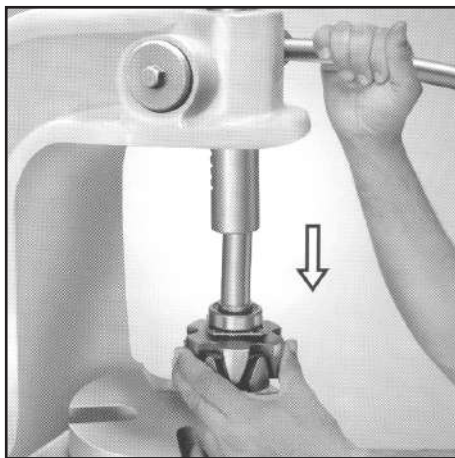
### Assembly



- Pressing the Deep Groove Ball Bearing on the Slip Ring End

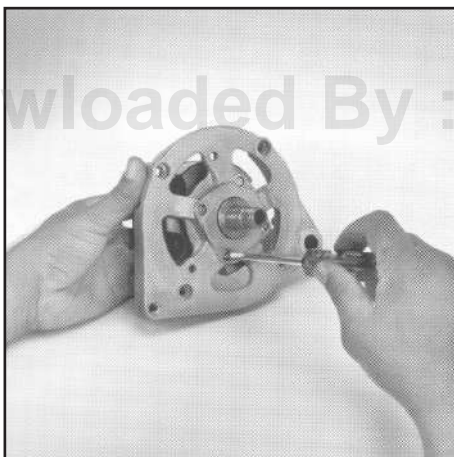
Place a new deep groove ball bearing (10) on the rotor shaft and press as far as it will go under and Arbor Press using a suitable mandrel.

#### **Assembling the Drive End Bearing**



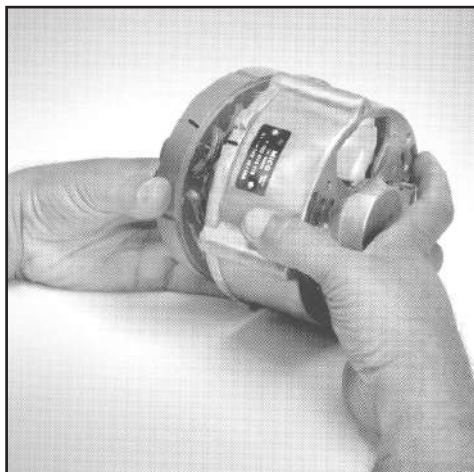
Assemble the bearing holding plate (3) onto the rotor such that projecting side is towards the rotor. Assemble the bearing (2) and the plate (9) such that the stepped portion is towards the rotor and press under an Arbor Press as far as it will go.

#### **Assembling Rotor into Drive End Shield**



Assemble the rotor assembly into the drive end shield and tighten the cover plate to the shield by the four countersunk screws (5).

- Replace the protective sleeve (13) in the slip ring end shield, if required. While assembling, ensure that the projection on the sleeve engages with the groove on the slip ring end shield.



- Solder the connecting wires of the starter to the rectifier plate. While doing this, ensure that the connecting wires will not touch the rotor later. Place the stator in the slip ring end shield and align the markings (made before dismantling).

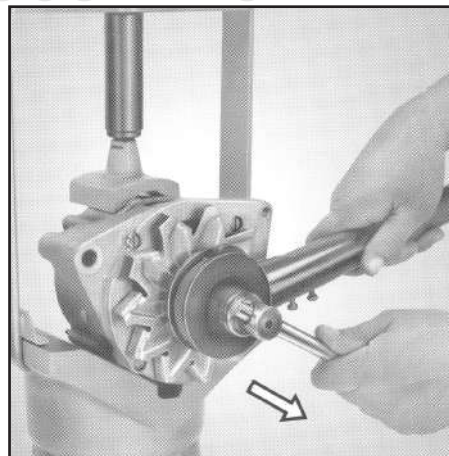
#### **Fitting the Stator and Rotor**



Carefully introduce rotor with drive end shield into the slip ring end shield and align the markings.

Introduce the 4 cheese heads screws 20/21/ 25 through the drive end shield and tighten.

#### **Mounting the Fan and Pulley**



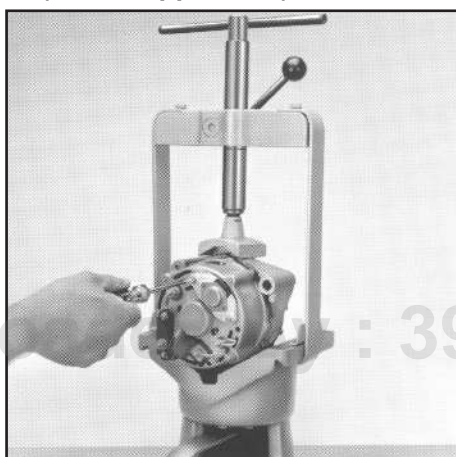
Assemble the fan (53), the pulley with plate (54) (projecting side of plate facing the fan), the spring washer (51) onto the rotor shaft. Assemble the hexagonal nut (52) and tighten to torque by holding the rotor shaft with Allen Key or holding the pulley with a pulley holder as shown in figure.



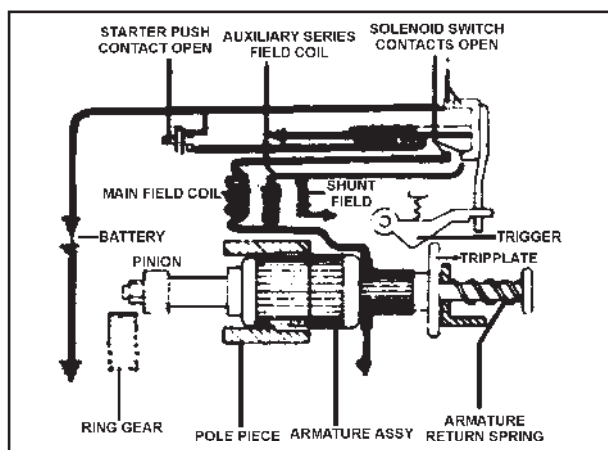


## SERVICE TOOLS AND EQUIPMENT. K1 ALTERNATOR

Sl. No.	Description	Alpha No./ Part No.	Application
1	Swivelling vice	03-KDAW 9999 9 689 033 060	For mounting the alternator for dismantling/assembly.
2	Resistance measuring meter	03-WPG 012 00	For measuring the resistance of the stator, rotor and checking rectifier plate.
3	Test panel	03-KDAW 9984	For checking shorting/open circuit of stator/armature. Used in conjunction with 03-KDAW 9985.
4	Transformer panel	03-KDAW 9985	For supplying power to test panel 03-KDAW 9984.
5	Digital multimeter or 3½ digit Digital multimeter	MMD 302 0 684 500 301 Commercially available	For measuring the resistance of the stator, rotor and checking rectifier plate.

**Installing the Regulator and Suppression Capacitor (where applicable)**

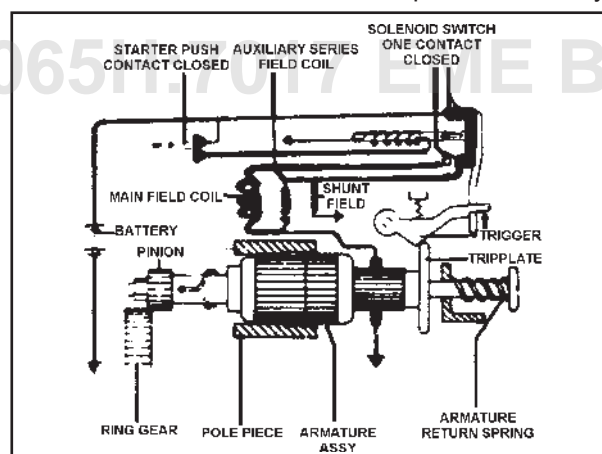
Assemble the voltage regulator on the slip ring end shield after carefully placing the spring loaded carbon brushes on the slip rings. Connect reverse polarity fuse, lead wire in position and fasten the nuts/screws. Assemble the suppression capacitor on the end shield and insert the plug end to the pin.

**60.5 BS5 AXIAL STARTER MOTOR (LUCAS TVS)****Description**

Axial starters are designed for use on the larger types of engine where because of the high inertia of flywheel and crankshaft, it is necessary for the starter pinion to engage with the engine flywheel before the starter develops full torque, thus avoiding

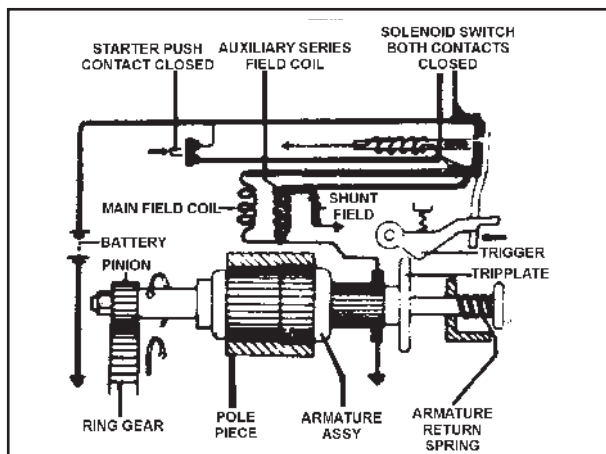
heavy engagement shock and excessive wear on the gear teeth. Engagement between starter and engine is armature assembly and its from this movement that the term 'Axial' starter is derived.

The field windings of the machine consists of a main series winding, an auxiliary series winding and a shunt winding. A solenoid operated two stage switch forms an integral part of the starter only a small switch to handle the solenoid current is required externally.



When the start switch is operated, the first stage contacts on the solenoid switch close and a small current passes through the auxiliary field windings, causing the armature to rotate slowly. Simultaneously the complete armature assembly is drawn towards the driving end of the machine and the pinion is brought into mesh with the engine flywheel gear. As the armature nears the end of its axial travel, a tripping disc operates the trigger on the solenoid switch, causing the second stage contacts to close and complete the circuit through the main series winding. The starter then exerts its full torque on the engine. When the starter button is released, the armature is returned to its disengaged position by the coiled spring on the armature plunger.

The auxiliary windings are arranged so as to hold the pinion in mesh until the starter push button is released; this reduces the number of engagements used to start



heavy engines as the pinion will remain in mesh despite irregular engine firing.

The starter is fitted with an overload clutch interposed in the drive between armature and pinion. The clutch has a slipping torque of about thrice the lock torque of the starter but below the shearing strength of the pinion teeth and is thus an effective safeguard against the teeth of the pinion being sheared due to the excessive load.

Where required oil sealing precautions are taken comprising an oil seal in the driving end shield and a rubber sealing ring inside the pinion.

#### Using the Starter

The following points should be rigidly observed when starting the engine:

Make sure that all engine controls are correctly adjusted.

Press the starter button firmly and release it immediately after the engine fires.

If the engine does not fire at once, allow it to come to rest before pressing the starter button again.

Do not run the battery down by keeping the starter button pressed when the engine refuses to start. Ascertain the cause of failure to start.

With some engines it is often helpful to depress the clutch when starting from cold.

ON no account should the starter be operated when the engine is running, otherwise serious damage would occur both to starter and to flywheel teeth.

#### Maintenance

Examine the starter to ensure that the mounting bolts are securely fastened and all electrical connections are clean and tight. The cable should be examined for fractures particularly at the point where the cables enter the terminal lugs. The cable insulations must be free from signs of shafting and deterioration due to oil, etc. Cable sizes/length generally recommended are as follows:

#### Length\*Size

Upto 5.5 metres 61/.044" (Single cable)

5.5 metres and 61/.044" (Double cable)

above

\*Refers to length of cable from battery to starter and return to battery.

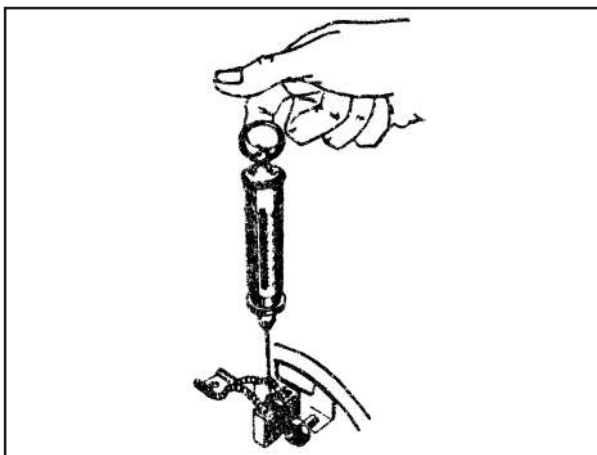
The total resistance between battery and starter should not exceed.

.0017 ohms for 24V system.

#### Brush Gear

Check that the brush leads are clear of any obstruction likely to impede movement and see that the brushes are free in their holders by first lifting brush spring and gently pulling on the brush leads. If a brush is inclined to 'stick', clean the inside of the brush holder with a clean cloth moistened in petrol. Be sure to replace the brush in its original position so that the curvature of its contact surface conforms accurately with commutator periphery.

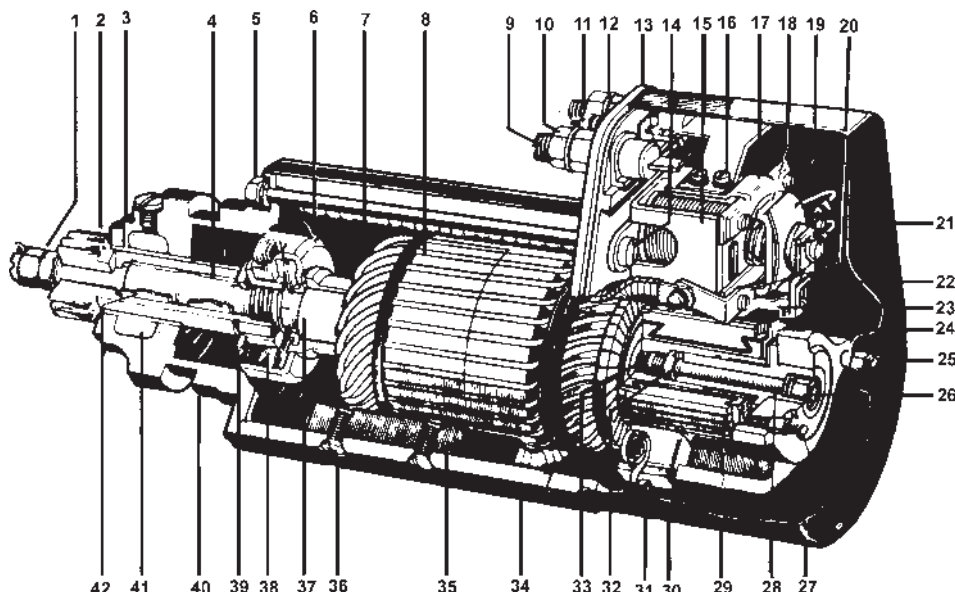
The brushes should be well bedded i.e., worn to the commutator periphery over atleast 80 per cent of their contact area. If not, lift each brush from commutator and wedge in position with spring. Wrap a strip of very fine emery paper or carborundum paper around the commutator with abrasive side outwards. Lower the brush (or brushes) in one brush gear arm on to the emery paper and bed to correct shape commutator. Raise the finished brushes and repeat the bedding procedure for the brushes on the other brush gear in turn. After bearing, each brush must be remove from its holder and all traces of dust and abrasive cleared away, preferably using compressed air or some form of hand bellows. Examine the brushes to ensure that no particles of abrasive are embedded in their contact surfaces.



Check pressure of brush springs using a spring balance hooked under or in the eye of the spring.

The brush spring pressure for starter motor is 950 - 1220 gm.

As a measure of preventive maintenance, the starter is to be removed from the engine, at least once a year, to check the following.

**Dismantling****Brushes**

The brushes must be renewed if they are worn to approximately 13 mm which is half of the original length or to a point where springs no longer provide effective pressure. It is essential that brushes are fitted in complete sets and under no circumstances should brushes of different grade be used together. Replacement brushes must be always bedded before use as described earlier.

**Commutator**

The commutator surface should be clean and entirely free from oil, any trace of which should be removed by pressing a dry clean fluffless cloth against the commutator while the armature is hand rotated.

If the commutator is dirty or badly discoloured, lift the brushes and wedge in position with their springs. Wrap a strip of very fine emery paper around the commutator with the abrasive side inwards and draw the emery paper backwards and forwards over the commutator whilst slowly rotating the armature until surface is clean. Remove all traces of dust and abrasive using compressed air or hand bellows.

Finally, lower the brushes on to the commutator and carefully replace the commutator end cover.

**Servicing****Dismantling**

Before overhauling the starter which is done during engine overhaul, it is advisable to obtain the special tools listed below. The tools will reduce the time spent in overhauling.

Plunger nut spanner.

Plunger nut (inner) spanner.

Extractor for, clutch outer torque.

Socket for checking clutch torque.

Face plate for rebushing drive end shield.

Dolly for pressing clutch housing.

Unscrew nuts (25) and take off commutator cover (21).  
Unscrew brush lead screws, lift brush springs (31) and remove brushes (30) from their holders. It will be seen that removal of brush lead screw also frees the auxiliary field connections to the brush gear.



**At this stage, the leads to the brush gear and solenoid switch (15) should be marked so that they can easily be identified when the starter is reassembled.**

Remove nut (26) in the commutator end shield (13) from the armature plunger (28) using a box spanner.

Remove main fixing bolts (5) tap driving end shield (40) gently away from yoke (34) with a hide or wooden mallet, and withdraw end shield complete with armature (8).

Hold the armature clamping device or in a vice fitted with soft metal or wood jaw clamps.

Remove lubricating plug.

Remove split pin and nuts (1) and washer from front end of pinion and slide pinion (2) and drive end shield (40) off the armature shaft.

Remove pinion spring (37).

Collect clutch inner race (39) clutch plates (38) shim washers, back ring and pressure plates from clutch assy.



**The clutch plates (38) should be tied together in the order of removal so that they can be replaced in their original positions in the clutch when the starter is reassembled.**

Withdraw shims and rubber sealing ring from bore of pinion.

Undo armature plunger retaining nut (32) by means of tubular spanner.

Withdraw armature plunger from bore of armature.

Remove the screws (16) securing positive terminal connector, main field coils ends and auxiliary field connections to solenoid switch.

Separate carefully the commutator end shield from the yoke by tapping with hide or wooden mallet.

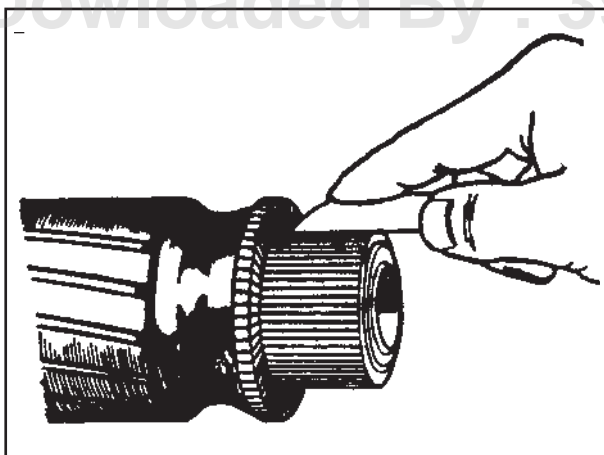
Disconnect the solenoid coil leads.

Unscrew solenoid fixing screw (14) and remove solenoid switch (15).

### Inspection and Repair

#### Commutator

The surface of the commutator should be clean and free from grooves, pits or uneven discolouration. For moderate surface cleaning, a very fine grade of emery paper (not emery cloth) or carborundum paper may be used. If the surface condition is severe, however, the component should be set up on lathe and the commutator skimmed.

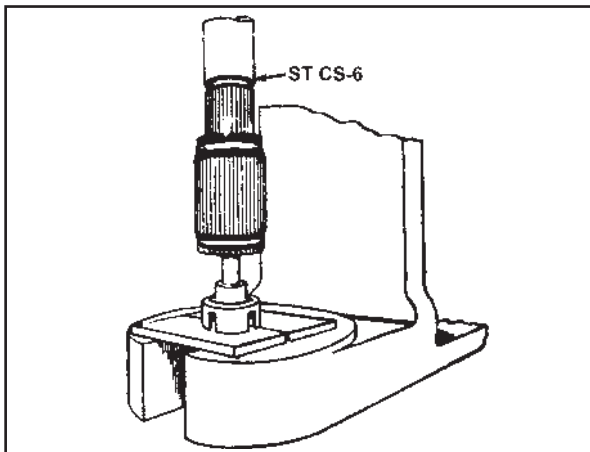


A coarse cut should first be made to remove sufficient copper to clear traces of pitting or distortion. The commutator should be under cut, that is, the insulation, should be removed to a depth not exceeding the width of the insulation. Certain proprietary tools are available for this purpose, but an old hacksaw blade, ground to the width in case of emergency. Finally, the component should again be set up on the lathe and a fine finishing cut taken using a diamond or tighten carbide tipped tool to obtain the desired quality of finish. After machining the commutator armature must be cleaned thoroughly preferably by means of compressed air, or by the use of hand bellows.

The minimum dia to which the commutator can be skimmed and still remain serviceable is 45.6 mm (original dia.  $48 \pm 0.15$ ).

#### Armature Winding

This can be tested for continuity and short circuits by means of a 'growler' tester. To test the insulation use a 110 V AC main and a 110V, 15w bulb with two probes one of which is applied to the armature core and the other to all the segments of the commutator in turn. In the event of the armature being found to be faulty, it must be replaced.



When the clutch outer race is pressed on to the shaft to the new or replacement armature, a suitable tool should be inserted into the armature core, so that the press bears upon the tool and not upon the end of the commutator. If this is not done the force exerted by the press may distort the commutator segments.

#### Field Windings

Field windings can be tested for short circuits to the yoke and poles by means of probes connected to a supply main not exceeding 110 volt and in series with a 15 watt lamp of suitable voltage positioned on the live side of the system. One probe should be applied to the yoke and the other applied to the ends of each of the winding in turn. If the lamp does not light then the insulation is intact.

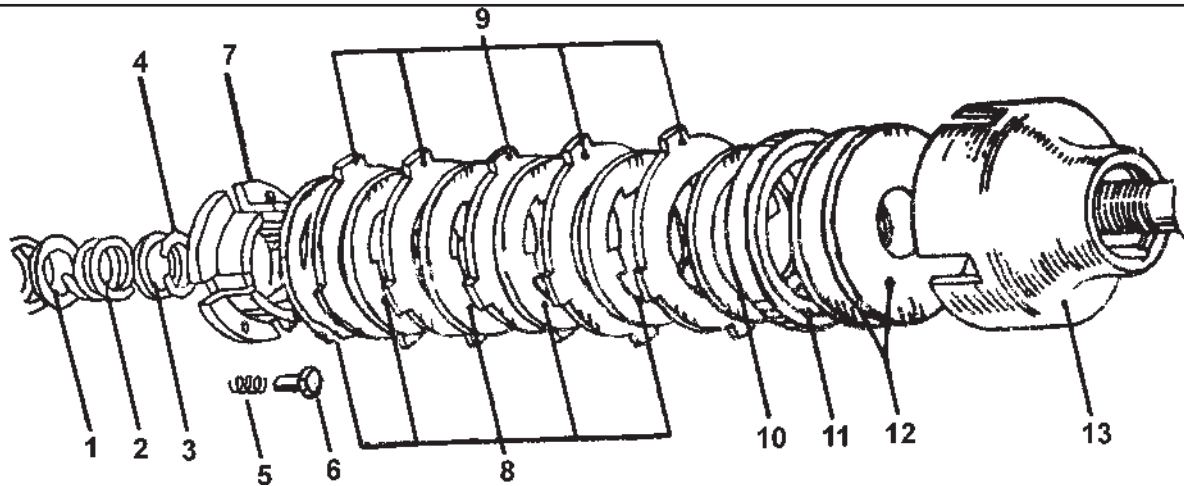
Open circuits can be detected easily by means of a Ohm Meter. The instrument should be connected across each of the winding in turn and if infinity or maximum ohms is obtained, then an open circuit is indicated in the winding being tested.

Internal short in the auxiliary coils can be best detected by means of a low rating ohm meter. Where no such instrument is available and if the existing windings are suspect, they should be checked by substitution.

Unserviceable coils should be replaced as follows:

Unscrew pole screws and withdraw poles and windings, noting the position of the winding in order to facilitate reassembly. It will be seen that the pole piece is stamped No.1 and the corresponding No.1 is on the yoke. Pole pieces are numbered 1 to 4 and fitted clockwise looking from the commutator end. When replacing the poles care must be taken that the side of the pole pieces with lesser thickness are





towards the commutator end of the yoke, and the number correspond.

Fit the new windings to the pole pieces as dismantled, so that they bed down as far as possible on pole shoe wings.

Assemble poles and winding into yoke and insert pole screws.

Tighten the screws using a commercial pole screw - driver. Care must be taken that the screws are tightened down firmly so that no gap is left between the mating surfaces of the poles and yoke.



**The windings will bend down more easily if the yoke, windings and poles are heated gently in an oven before the pole fixing screws are tightened.**

### Bearings

Insert the pinion into its bearing in the drive end shield and slide the commutator end of the armature into the bearing in the end shield. Then check both bearings for excessive side - play.

If the bearing pin is worn, we recommend replacing the complete commutator end shield assembly as the end shield spigot is machined concentric with bearing pin after the pin has been assembled. Check for wear in the armature CE brush.

The driving end bearing may be removed from its end shield and renewed provided facilities exist for accurate machining.

If the bearing is to be renewed, the following procedure should be adopted :

Push the lubricating wick well away from the bore so that it does not get trapped during the pressing operations.

Press the old bearing out of the end shield.

Press in the new bearing from the inside of the end shield using a split dolly to prevent the lubricating wick from being trapped between the end of the bearing and the edge of the oil reservoir.

Set up the end shield in a lathe in such a manner that when watching of the bearing bore is complete the bore is perfectly concentric with the end shield spigot where it registers with the yoke. This can best be done by means of a faceplate.

Turn the bearing bore to 35.050 - 35.095 mm dia and ensure that the surface finish is of the highest quality.

Turn both ends of the bearing to be in flush with the faces of the casting.

When fitting a new or used pinion, the clearance between the pinion and bearing should be 0.05 to 0.10 mm.

### Brush Gear

Check the brush gear insulation, using a 110 V supply mains, test probes and lamp as described in section headed Field Windings between positive and negative brush holder, positive brush holder and frame and negative brush holder and frame (for insulated versions).

During any of this checks if the lamp lights the insulation is faulty.

### Clutch

The starter is provided with a multiple disc clutch (**Fig - 6**) for transmitting torque from armature shaft to pinion apart from performing two important specific function such as :

- It acts as a free wheel and protects the armature from danger of running at excessively high speeds.
- Protects pinion and armature shaft against overload.

The outer race (13) which is a housing for the whole clutch is keyed on to the armature shaft. The inner race (7) which has a three start thread, mates with pinion and is capable of axial movement. The inner and outer plates (8,9) are arranged alternatively in a stack. The outer plates have

outward projections which engage into slots cut in the outer race while the inner grooves machined in the inner race. The back ring (11) is positioned in between the plate stack and the pressure plates (12). As a specific minimum pressure between the discs is an indispensable condition for effective functioning of clutch, initial pressure springs (5) mounted over guide-pins (6) are provided in the cover of the inner race and exert pressure on the first disc (steel).

When the starter is energised the armature rotates and moves forward axially. Any attempt to stop or load the pinion will result in the inner race moving inwards due to screw-push action of the thread thus increasing the pressure between the plates. The plates bear on the back ring which ultimately rests on pressure plates. The pressure plates being supported around their centre by ribs in the outer race and also pressed on the periphery by the backing ring bend backwards and act like diaphragm springs. The rise in the axial pressure between the plates directly increases the torque that can be transmitted through the plates. The process continues until the friction between the plates become strong to transmit the starting torque required at the time, the course of drive being armature shaft-outer race-outer plates-inner race-pinion.

In the event of starter being over run by the engine the pinion will be forced to run with the engine while the armature due to its inertia will try remain stationary. This will cause the inner race to move outwards with no increase in the initial axial pressure between the plates. The inner plates will rotate along with the inner race loosely over the outer plates and the clutch will slip thus safeguarding the armature from being run at high speeds.

Overloading is caused when the pinion engages into a back rocking engine or when back fire results. The starter will get locked and the rate of application of load on drive parts will be very high. In such an event the clutch would slip at a preset torque and mechanically disconnect the pinion and armature. As the transmittable torque depends on axial pressure between the plates which in turn depends on the torque transmitted by the virtue of push screw action, this limit is achieved when the inner race (which moves towards comm. end on load) pushes the pressure plates and relieves the backing ring leading to the clutch slip. The value of the axial pressure (which determines the slipping torque) at which this happens can be adjusted by adding or deleting the steel shims (10) between the last outer plate and backing ring.

The pinion will have a certain axial float to ensure that it is not bound to the armature by the shaft nut and a helical spring (2) mounted on armature shaft behind pinion acts as a resilient intermediate member without exerting any pressure on the clutch plates.

If clutch plates are badly worn or discoloured they must be renewed. Individual new parts should not be put in unless facilities exist for testing the slipping torque. Where no such facilities exist and parts of the clutch need renewing a complete new assembly should be fitted. Method of adjusting the slipping torque is given under assembly.

### Pinion

In the pinion teeth are badly worn or damaged the pinion should be changed. See that the new pinion has the same number of teeth and is made of the same material as the old component.

### Oil seal

On those starters fitted with oil seals, the rubber sealing ring inside the pinion and the oil seal in the drive end shield should be discarded each time the starter is dismantled and new ones fitted. The sealing ring inside the pinion must be fitted with a shim on either side. The new oil seal must be fitted with its plain end towards the driving end shield and should be seated into its recess with a good sealing compound.

### Assembly and Adjustment

Hold the armature (8) in armature clamping device, or in a vice fitted with soft metal or wood jaw clamps.

Liberal smear the spring and thrust washer on armature plunger (28) with grease. Insert the plunger into the bore of the armature and tighten plunger retaining nut (32) using the appropriate tool.

Insert pressure plates, back ring and shim washers into clutch outer race (6).

Lightly smear initially by pressure springs with grease and place them in their holes in clutch inner race, over the guide pins. Each spring should be inserted with its largest diameter first.

Lightly grease clutch plates (38) and place them on the splines of the clutch inner race, taking care to fit them alternatively bronze and steel. Fit steel plate first so that it takes the pressure of the clutch springs.

Assemble clutch inner race together with clutch plates and springs in the clutch outer race.

Grease pinion spring (37) and slide it on the armature shaft.

Grease bore of pinion (2) and insert rubber sealing ring and shims.

Insert pinion into driving end shield (40) in order not to damage the felt lubricating pads, the pinion should be twisted in the direction of the spiral of the pinion thread whilst the lubricating pad is lifted by one flinger from inside the casting. Also a suitable shroud should be used along with the pinion so as not to damage the oil seal.



**Before fitting a new shield, ensure to remove the protective paper pad which is put there to prevent ingress of foreign material when the DE shield assembly is stored for service sales.**



Slide pinion and driving end shield on the armature shaft. Push the pinion forward and rotate it until its thread engages in the internal thread in the clutch inner race. Hold it in this position and replace shim, washer and nut. Make sure that the shim locates over the shoulder of the shaft and tighten the nut securely. After the nut has been tightened the pinion must be capable of a small endways movement on the armature shaft.

### Clutch Setting Procedure

- Both inner and outer plates must be smeared with Veedol Artworth heavy grease prior to assembly.
- Clamp the armature to the bench using a clamp bracket and fit the torque wrench to the pinion using a special socket. The torque meter should be fitted so that torque is applied in the opposite direction to the normal starter rotation.
- Adjust the clutch to slip at 150 - 180 lb. ft. This should be done by removing or adding shims between the clutch plates and the back ring. The shims are made to thicknesses 0.1 (0.004"). Adding shims will increase the slipping torque and vice versa.
- Slip the clutch about 10 times, and then adjust the clutch to slip at between 120 - 150 lb.ft. If slipping torque is above 150 lb. ft. remove one 0.004" shim and recheck. If slipping torque is below 120 lb. ft. add one 0.004" shim and recheck.

Replace castellated nut (1), tighten securely and then insert split pin.

Pour approximately 8 cc of oil into the oil filler hole in the drive end shield. Allow sufficient time for the lubricating pad to absorb the oil then replace the lubricating plug. Wipe off any surplus oil which may have run into the inside of the driving end shield.

Fit solenoid switch (15) to commutator end shield and secure in position with fixing screws (14).

Reconnect the solenoid winding leads to their respective terminals.

Fit commutator end shield to yoke, ensuring that the dowel in the yoke is correctly located.

Replace screws (16) securing the main field coil ends, positive terminal connector and auxiliary field connections to the solenoid switch.

Assemble armature and driving end shield to yoke.

Replace fixing bolts (5) and tighten.

Spin the armature to see it is not binding and is free to rotate.

Fit washers and nut (26) to armature plunger and tighten.

Replace brushes (30) taking care that each brush is replaced in its original position. If new brushes are

to be fitted, they must be bedded to the commutator.

Connect brush leads and auxiliary field leads to the brush gear.

Check that the relationship between trigger and tripping disc is correct by pulling the armature forwards until the trigger is raised to its highest extent by the tripping disc. When the trigger is raised there should be an ample gap between the shoulder on the trigger and the bottom of the slot in the catch plate.

### Testing

#### Engagement Mechanism

Connect the starter to a battery.

Insert a strip of insulating material between the moving contact and the second stage contact of solenoid switch to prevent the second stage contacts closing.

Operate the starter push switch. The first stage contacts of the solenoid switch should close and the pinion should revolve in its normal direction of rotation. At the same time the pinion should move forward for a distance of approximately one inch (25.4mm).



**Do not keep the starter button depressed longer than is necessary to check that the starter is functioning satisfactorily, otherwise windings may be damaged by overheating.**

Remove insulating strip from the second stage contact.

### Test Data

Lock Torque	Torque	4.6 kgm (33 lb. ft.)
	Current	780 Amps max.
	Voltage	9.0 volts
Running Torque	Torque	2.1 kgm (152 lb-ft)
	Current	400 Amps max.
	Voltage	16.0 volts
Light Running	Speed	1450 - 1650 rpm
	Current	70 Amps max.
	Voltage	24 volts
	Speed	3800 - 4200 rpm

The above values correspond to a temperature of 20°C. Battery used should be associated vehicle battery and should be fully charged.

### Performance Tests

For the purpose of these tests, the brushes must be bedded over atleast 80 percent of their contact area.

Fit the starter to a starter test rig and connect the power supply. The out of mesh clearance between the starter pinion and test rig flywheel must be set at 3.4 mm.

Check the lock torque, the running torque, the light running current and RPM at specified voltage. Refer Test Data for values.

### Insulation Test

Using test probes connected to a 110 volts (maximum) supply mains and in series with a 15 watt lamp of suitable voltage, check the insulation of the machine between

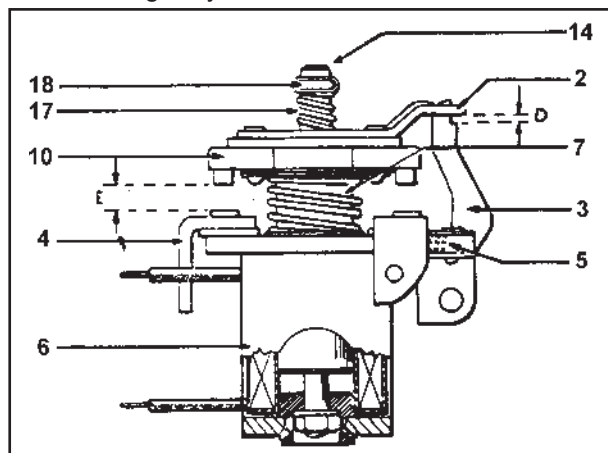
- (i) Positive terminal and frame.
- (ii) Negative terminal and frame (for insulated versions only).

If the lamp lights during any of these tests, the insulation is faulty. Alternatively a 100 volts mega ohm meter can be used and the necessary recommended value is 1 mega ohm.

### Solenoid Switch

#### Description

These are two stage solenoid switches, each switch consists of a solenoid operating coil assembly (6) on the top of which are mounted two fixed contacts (4). The solenoid plunger is inserted through the centre of the operating coil and carries moving contact (10) which is held in the 'off' position by the coil spring (7). Catch plate (2) is also attached to the top of the plunger and prevents the plunger from travelling fully home.



When the solenoid operating coil is energised, the magnetic field set up in the winding, draws in the solenoid plunger until the first stage contacts are closed, and the catch plate rests on the step in the trigger. This position is held until the trigger is raised by the tripping disc on the starter armature, allowing the plunger to travel fully home and close the second stage contacts. Both contacts will remain closed until the operating coil is de-energised, when the moving contact will return to its normally open position under the influence of the coiled spring.

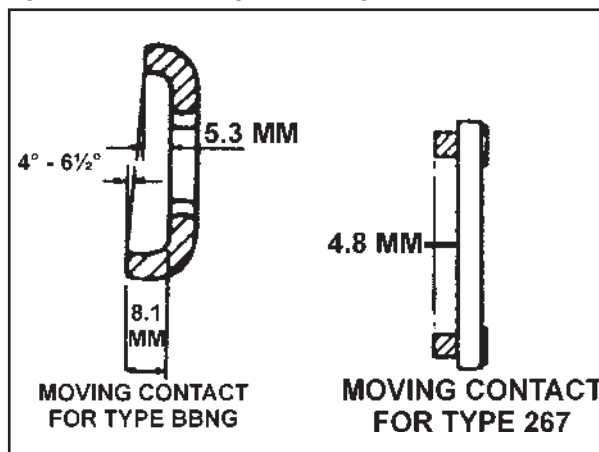
### Dismantling

Remove twicklip (18) with No. 4 twicklip pilers.

Withdraw contact spring (17) and moving contact assembly (10).

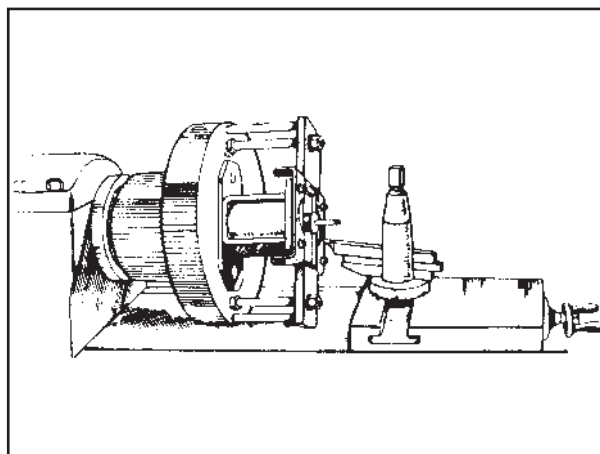
Remove trigger spring (5).

### Inspection and Repair Components



If moving contact (10) is dirty it can be cleaned with spirit of very fine carborundum paper unless it is very badly burnt or pitted when it should be set up in a lathe and refaced. After machining, the contact surface must be smooth, flat and on the same plane. This is most important as if the surfaces are uneven, poor contact will result and the whole operation will have to be repeated after a short time. Not more than 0.5 mm may be removed from the contact faces and in the unlikely event of this not being enough, a new moving contact should be fitted.

### Fixed Contacts:



Fixed contacts (4) can be cleaned with spirit or very fine carborundum paper, unless they are in a badly burnt pitted condition when they should be refaced on a lathe while still in position on the switch. Not more than 0.5 mm should be removed from the contact faces. If this is not sufficient to remove all trace of burning and pitting the contacts should be renewed. As new contacts are supplied in an unmachined state,





they must be assembled to the switch and faced on a lathe before being placed in service using a fixed contact machining fixture. If no machining facilities are available a new switch should be fitted. However, everytime the fixed contacts (4) or moving contact (10) is replaced, it is essential that leaf spring (11) is also replaced.

### Assembly

Lightly smear plunger (14) with petroleum jelly.

Replace trigger spring (5).

Slide moving contact assembly (10) and contact spring (17) on the plunger.

Locate the end of the trigger in the slot in the catch plate and replace twicklip (18).

Check that contact gap 'E' (Fig. 10 is  $3.79 \pm 0.33$  mm) if not, the gap should be adjusted by adding or removing packing pieces beneath the fixed contacts.

Check the gap 'D' is  $2.06 \pm 0.61$  mm.

### Simple Service Setting

After the mechanical settings have been carried out the following check may be made. Push the plunger forward until the first contacts just touch, the gap between the trigger and catch plate should then be approximately 1 mm before the catch plate hits the trigger.

Trip the trigger and push plunger so that the second contacts just touch. From this point tell the plunger completes its travel, the distance should be approximately 1 mm.

### Electrical Tests

Check that both contacts close when 15.00 Volts (max.) is applied to the solenoid winding.

Subject the switch to a test of a few seconds duration at twice the normal voltage to ensure that the trigger operation is satisfactory. Any faulty assembly or 'rounding off' of the trigger or catch plate will cause the catch to trip.

When these tests have been successfully completed, the commutator end cover should be carefully fitted and the machine subjected to insulation test.

### Solenoid Winding

In the event of the winding becoming broken or damaged the complete switch should be replaced.

### Catch plate and trigger

Inspect the catch plate and trigger for wear. If the shoulder on the trigger and the bottom of the slot in the catch plate show sign of "rounding off" the two components must be renewed.

### Insulation Test

Using the prods connected to a 110V (max.) supply and in series with a 15 watt lamp of suitable voltage, check the insulation of the machine by touching prods on terminal B and frame. If the lamp lights the insulation is faulty.

### Lubrication

The drive end bearing is lubricated by oil (Servo System 150) from a large reservoir contained in the drive end shield. Lubrication of starter components which can be done at overhaul periods is as follows.

Location	Lubricant	Instruction
DE Bearing	Servo System 150 before assembly.	Saturate wick and felt pad Top up with 8 ccs. oil. Frequency - once a month.
Pinion Sleeve & Helix	Veedol Atworth grease	Lightly oil.
Mating inner race	Veedol Atworth grease	Lightly oil.
Felt seat in trip plate	Veedol Artworth or any Heavy grease	Grease both sides of plates before assy.
Return spring on armature assembly		Strongly grease the spring and smear the plunger shaft.
Inner race fibre thrust washer		Smear with grease.
DE shaft and Pinion bore	Shell Retinax or Shell Alvania 3 grease	Lightly grease the surface.
CE bearing bush, pin and thrust washer	Molybdenum, sulphide grease	Smear with grease. Frequently - Once in 3 months.

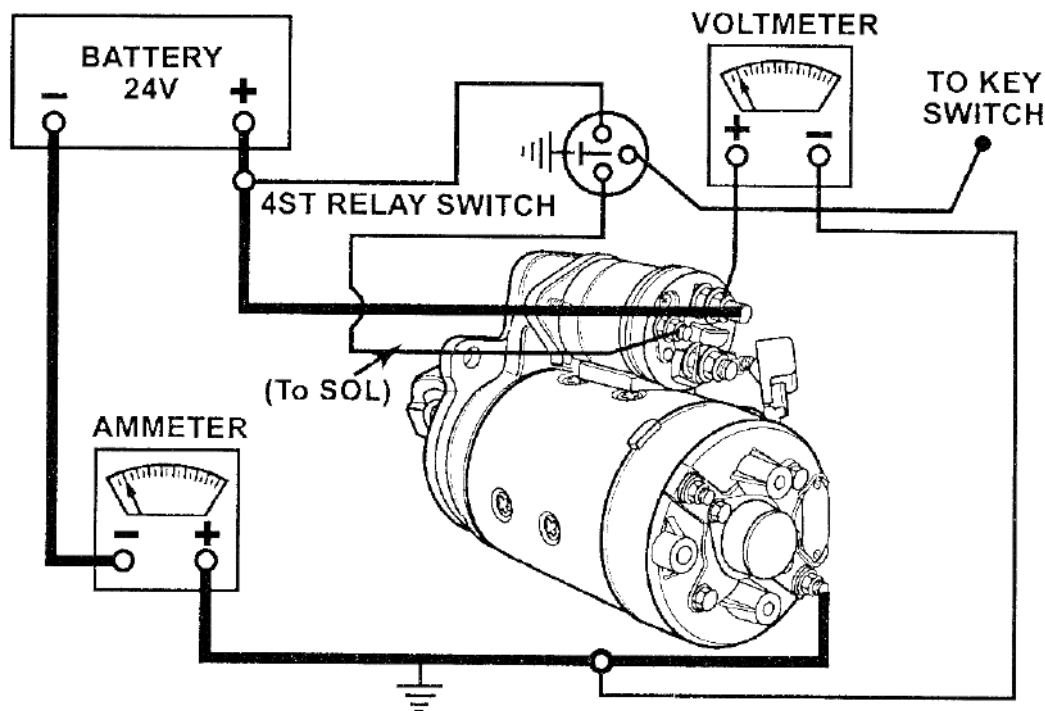
**Trouble Shooting - BS5 Starter Motor**

Difficulty in obtaining a smooth engagement between pinion and flywheel may be due to incorrect flywheel-to-pinion clearance. This clearance should be  $0.125" \pm 0.031"$  ( $3.18 \pm 0.79$  mm) between the face of the flywheel and the engaging face of the pinion when the pinion is at rest.

In case of trouble it should be remembered that it may be traced not only to the starter proper of the battery, switches, wiring, connections, but also to the ignition systems or fuel supply. The following are hints for dealing with trouble limited to starting such as:

Defect	Cause	Remedy
I. When starter is operated its shaft fails to rotate or rotates slowly.	<ol style="list-style-type: none"> <li>1. Discharged / Defective battery</li> <li>2. Loose or oxidised battery terminals / corroded or loose connectors / defective earth connectors.</li> <li>3. Starter terminals or carbon brushes earth/short circuited.</li> <li>4. Brushes worn-out and do not have proper contact with commutator. Dirty or oily or badly burnt commutator due to sticky brushes.</li> <li>5. Solenoid switch defective or points badly pitted.</li> <li>6. Armature / Field coil defective.</li> <li>7. Excessive voltage drop</li> </ol>	<p>Recharge battery / have it checked at a competent garage.</p> <p>Clean the terminals. Tighten all connections and smear petroleum jelly.</p> <p>Spot faulty earthing and rectify it.</p> <p>Renew brushes/clean commutator. If commutator is badly burnt due to sticky brushes skim/replace complete armature.</p> <p>Replace switch / clean the contacts.</p> <p>Replace armature or field coil as the case may be.</p> <p>Check and rectify circuit of starter.</p>
II. Pinion fails to engage though armature rotates.	<ol style="list-style-type: none"> <li>1. Pinion fouled</li> <li>2. Burr formation on pinion or ring gear.</li> <li>3. Defective Aux. Coil</li> <li>4. Mounting loose</li> <li>5. Worn CE / DE bush</li> <li>6. CE bearing pin loose</li> </ol>	<p>Clean it</p> <p>Deburr it by filing.</p> <p>Change Aux. Coil</p> <p>Tighten mounting.</p> <p>Change CE / DE bush</p> <p>Check the tightness of bearing pin fixing screws and caulk if necessary.</p>
III. Starter continues running after release of starting switch	<ol style="list-style-type: none"> <li>1. Sticky starting switch</li> <li>2. Short in wiring Harness</li> <li>3. Dry - DE bush</li> <li>4. Pinion flywheel gear fouled or damaged.</li> </ol>	<p>Repair / Replace switch.</p> <p>Repair fault in wiring.</p> <p>Trace cause and lubricate.</p> <p>Clean thoroughly / deburr gear and pinion by filing (push the vehicle to and fro with gear engaged).</p>
IV. Pinion engages but starter does not crank the engine	<ol style="list-style-type: none"> <li>1. Insufficiently charged battery / corroded terminals.</li> <li>2. Insufficient pressure on carbon brushes or worn-out brushes.</li> <li>3. Shorted / Earthing armature</li> <li>4. Slipping Clutch assembly</li> <li>5. Partially earthing field coil</li> <li>6. Solenoid 2nd contact not making</li> </ol>	<p>Change the battery or clean terminals.</p> <p>Change brush springs / brushes.</p> <p>Change armature.</p> <p>Change clutch assembly.</p> <p>Change field coil.</p> <p>Reset solenoid and replace spring.</p>





## 60.6 STARTER MOTOR

### 60.6.0 7M14 Starter Motor

The 7M 14 Starter Motor is a pre-engaged Starter Motor, of four pole, four Brush construction with earth return system. This Starter Motor is of 114 mm dia frame size and suitable for diesel engines of upto 7.0 litres capacity.

On closing the Starter Key switch on the panel board, the solenoid mounted on the Starter Motor gets energized thereby pulling the plunger towards its core. An actuating lever supported on a pivot pin has one of its ends linked with the plunger and its other end with the Drive assembly.

The pinion is thus thrown forward into mesh with the flywheel ring gear. When the solenoid plunger moves in, the plunger at the end of its travel closes a pair of contacts which connects the Starter Motor directly to the battery. This enables the startup enabling it to develop full power. As soon as the engine fires, the Starter switch is released, the solenoid is de-energised, and the plunger is brought back to its original position by the plunger return spring. This also disengages the Drive assembly from the ring gear.

## PRECAUTIONS

The following points to be adhered to while starting the Starter Motor.

- Ensure that all electrical connections to the Starter Motor are in firm condition.
- Press the Starter switch on the panel board firmly and release it as soon as the engine fires.
- If the engine does not fire at once, allow it to rest, before operating the Starter switch again.
- If the engine does not start, ascertain the cause and do not run down the battery by keeping the Starter switch continuously on.
- Do not operate the Starter while the engine is running. Otherwise serious damage could occur both to the Starter Motor and to the ring gear teeth.
- Do not operate the Starter Motor for, more than 30 seconds continuously at any time.
- Ensure that a 4ST Relay switch incorporated in the starter circuit and mounted on to the chasis.

## Routine Maintenance

- Ensure that the Starter Motor mounting bolts to the engine are securely fastened.
- Check all electrical connections are clean and tight.
- Cables should be examined for fractures particularly where the strands enter the terminal plugs.
- Check carbon brushes every 20,000 kms run.

**STARTER FEATURES****Armature assembly**

- |  |  |
|--|--|
| 1. Resistance brazed joints                | - Improved Stamina   |
| 2. Class 'F' Varnish for impregnation      | - Better insulation at high temperature.                         |
| 3. Resi glass tape banding for end baskets | - To provide mechanical rigidity better protection against fling |

**Field coil assembly**

- |  |   |
|--|---|
| 1. Lap welded joints for inter coil connection | - Better reliability                                |
| 2. Class 'F' Varnish for impregnation          | - Toguard against carbon dust and hence better life |
| 3. All main field coils                        | - Improved electrical performance                   |

**Carbon brushes**

- |                                    |                         |
|------------------------------------|-------------------------|
| 1. Special metal impregnated grade | - For long service life |
|------------------------------------|-------------------------|

**D.E bracket**

- |                                    |                              |
|------------------------------------|------------------------------|
| 1. Special metal impregnated grade | - For better impact strength |
|------------------------------------|------------------------------|

**Engagement**

- |   |
|---|
| - Pre - Engaged positive engagement of pinion, even at high temp.( 80°C ) |
|---|

**Brush carrier assembly**

- |                   |   |
|-------------------|---|
| 1. Solid riveting | - To improve strength of brush boxes & to prevent earthing failures |
|-------------------|---|

**Sealing**

- |                                  |  |
|----------------------------------|--|
| 1. Radial Sealing ('O' Rings)    | - For better protection against water and dust ingress |
| 2. Oil seal in the inter bracket | - To guard against oil ingress through clutch housing. |
| 3. Shroud in the solenoid switch | - To prevent water & dust ingress.                     |

**Drive assembly**

- |  |  |
|--|--|
| 1. New Heavy duty roller clutch            | - Over run protection. No servicing required. No clutch setting required |
| 2. Case hardened & double chamfered pinion | - Smooth and ease engagement. Longer life.                               |

**Solenoid switch**

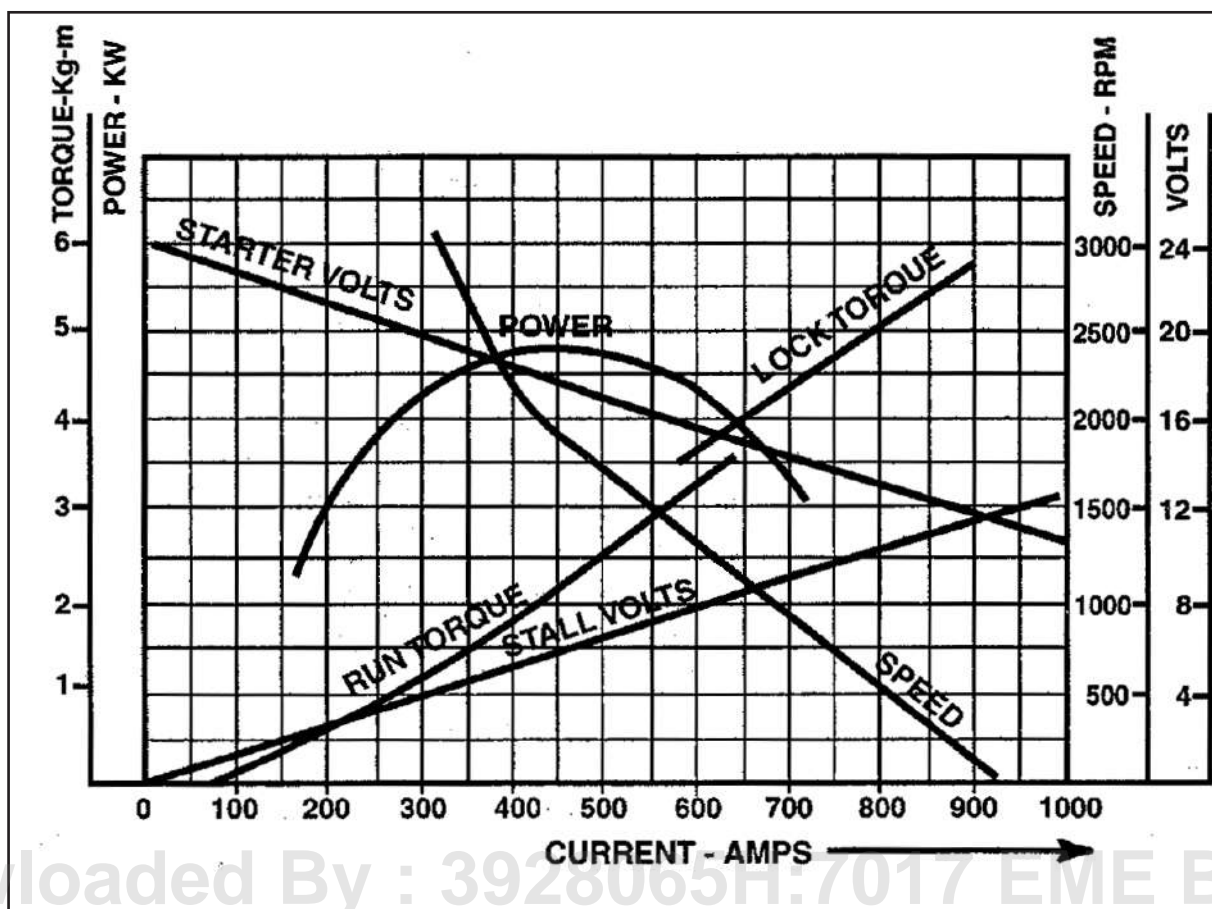
- |                        |  |
|------------------------|--|
| 1. Dual winding design | - To withstand a high circuit resistance. Positive engagement even at low voltage. |
| 2. Steel terminal      | - For better service life  |

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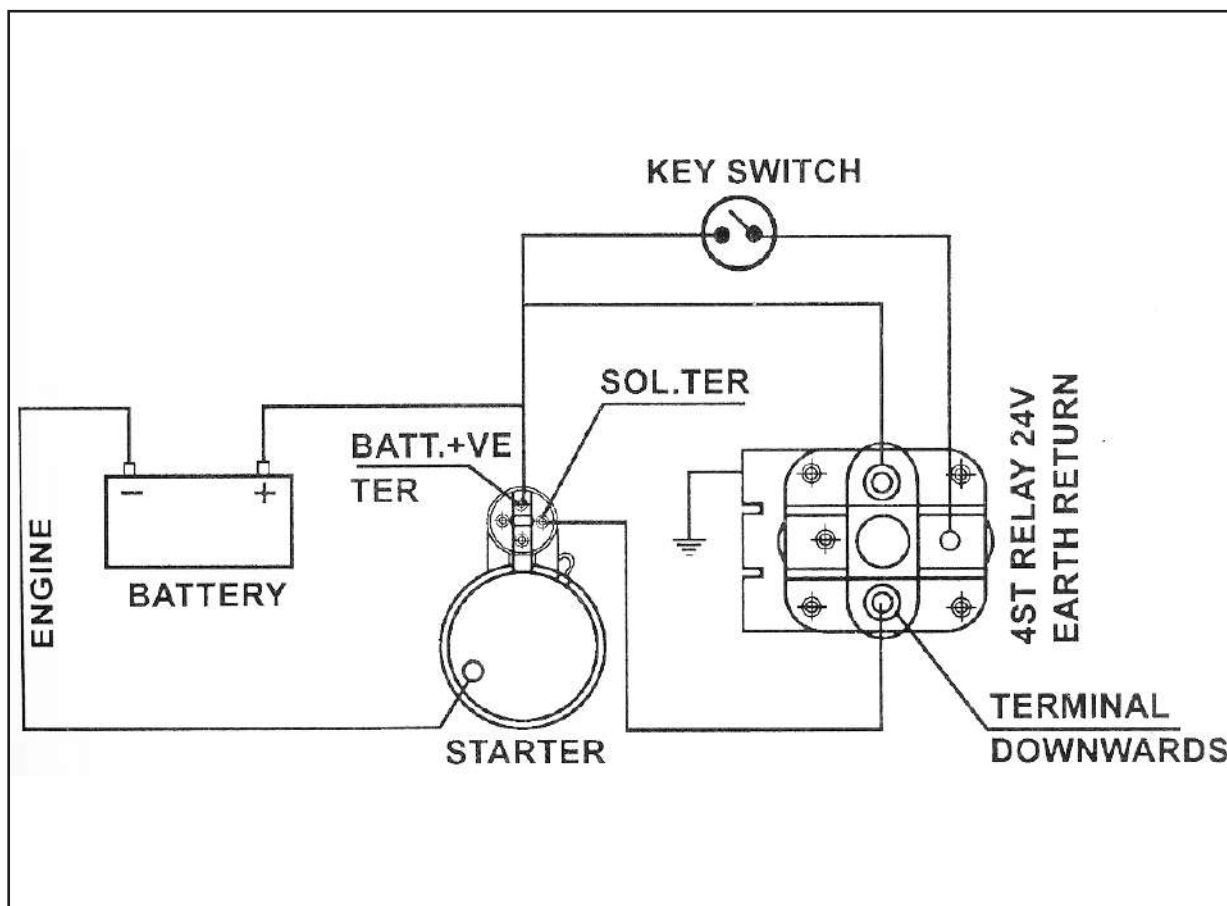




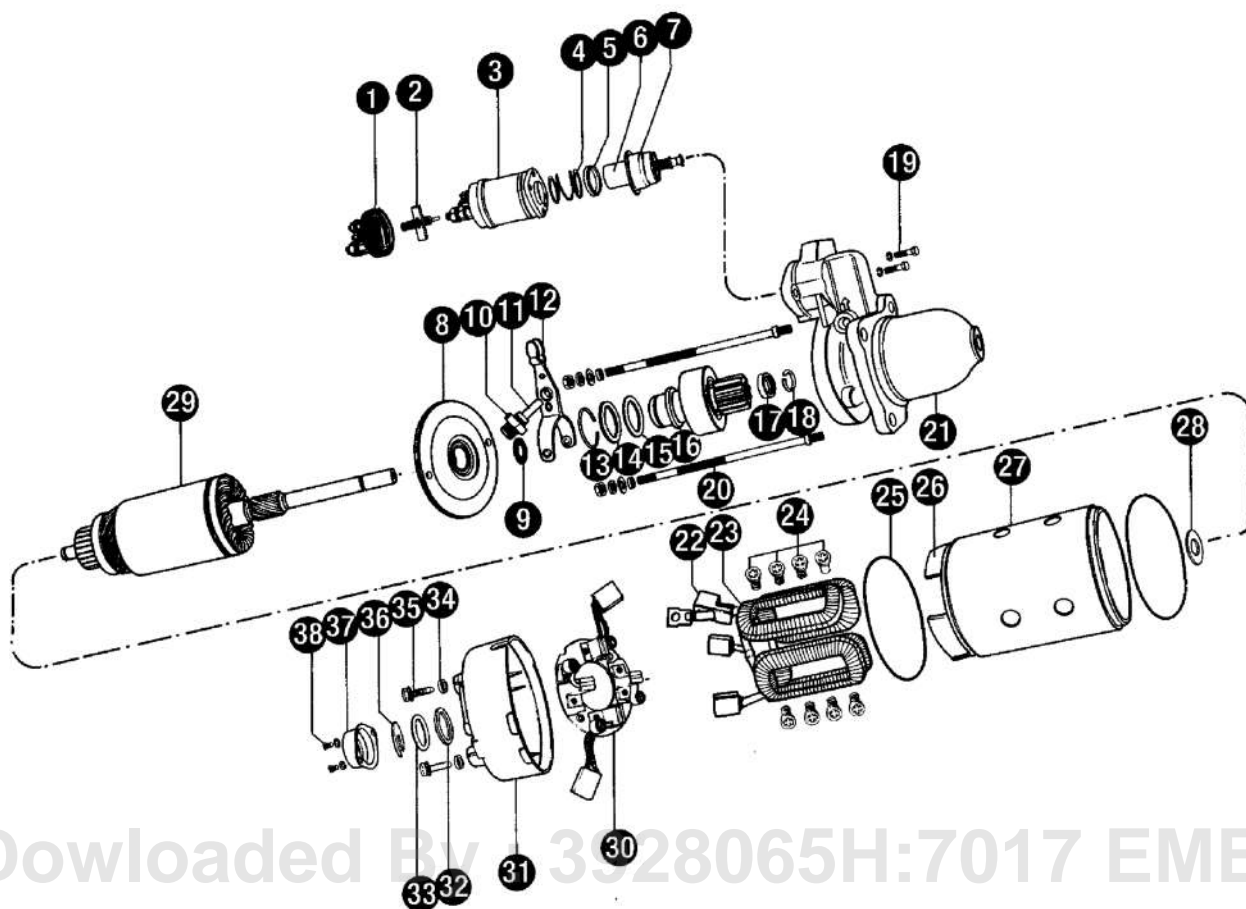
## TYPICAL PERFORMANCE CURVE (PROVISIONAL)



## WIRING DIAGRAM FOR USING 4ST RELAY IN SOLENOID



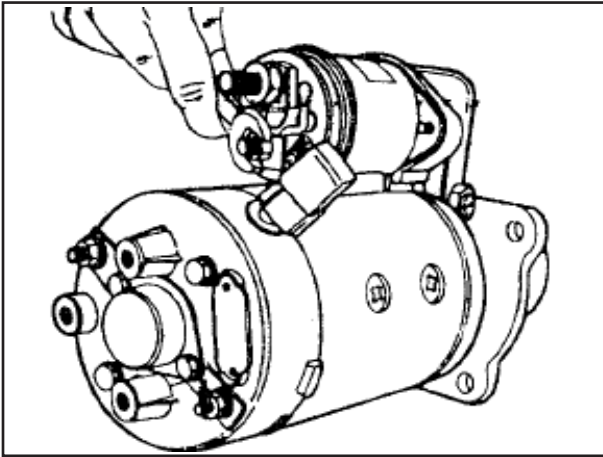
## STARTER MOTOR - EXPLODED VIEW



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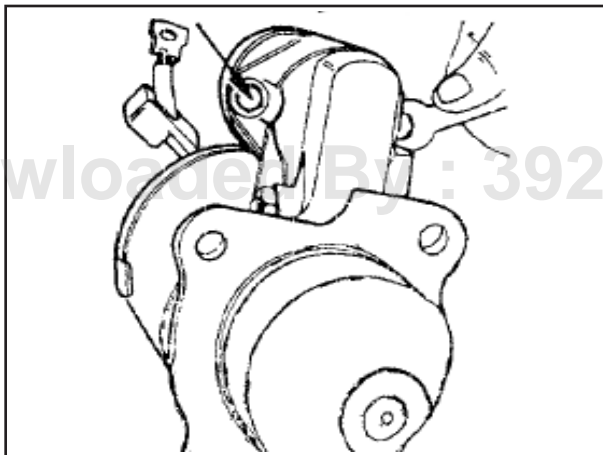
ILL NO.	DESCRIPTION	QTY	ILL NO.	DESCRIPTION	QTY
1	TERMINAL BASE ASSEMBLY	1	21A	BEARING BUSH	1
2	SPINDLE ASSEMBLY	1	22	TERMINAL COVER (FIELD COIL)	1
3	SOLENOID SWITCH	1	23	FIELD COIL ASSMEBLY	1
4	PLUNGER RETURN SPRING	1	23A	INSUL BRUSH - LONG	1
5	CUP WASHER	1	23B	INSUL BRUSH - SHORT	1
6	PLUNGER ASSEMBLY	1	24	POLE SCREW	4
7	SHROUD	1	25	'O' RING	2
8	INTER BRACKET ASSEMBLY	1	26	INLATOR YOKE	1
8A	BEARING BUSH	1	27	YOKE ASSEMBLY	1
9	OIL SEAL	1	28	STOP WASHER	1
10	NUT - PIVOT	1	29	ARMATURE ASSEMBLY	1
11	PIVOT PIN	1	30	BRUSH GEAR ASSEMBLY	1
12	ENGAGING LEVER ASSY	1	30A	EARTH BRUSH	2
13	JUMP RING - DRIVE	1	31	C.E.BRACKET ASSEMBLY	1
14	THRUST WASHER -HYLAM	1	31A	BEARING BUSH	1
15	THRUST WASHER	1	32	THRUST PAD	1
16	DRIVE ASSEMBLY	1	33	SHIM	1
17	THRUST COLLAR	1	34	SEAL -B.G.FIXING	2
18	JUMP RING (ARMATURE)	1	35	B.G.FIXING SCREW	2
19	SOL. FIXING SCREW	2	36	'C' WASHER	1
20	THROUGH STUD KIT	1	37	END COVER	1
21	FIXING BRACKET ASSEMBLY	1	38	SCREW (COVER FIXING)	2

## DISMANTLING

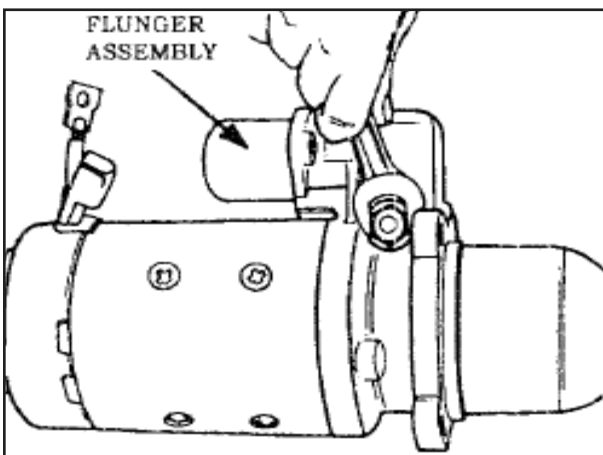


When dismantling the starter, carefully note down the positions of various parts are fitted, In order to ensure their correct replacement on re-assembly.

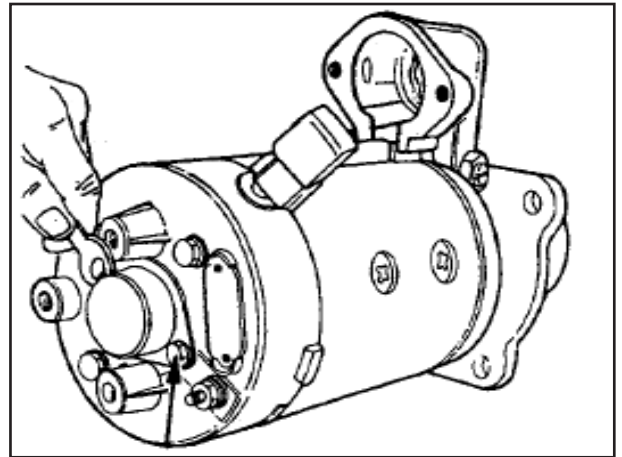
- Remove the lead assembly connecting the solenoid terminal and the field terminal on the yoke assembly.



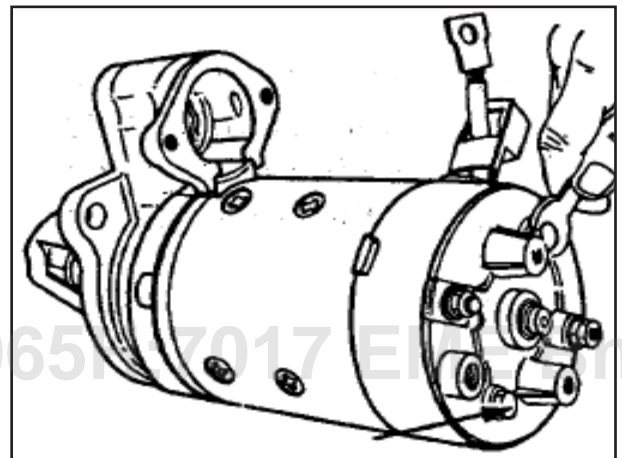
- Unscrew the solenoid screws from the fixing bracket and withdraw the solenoid.



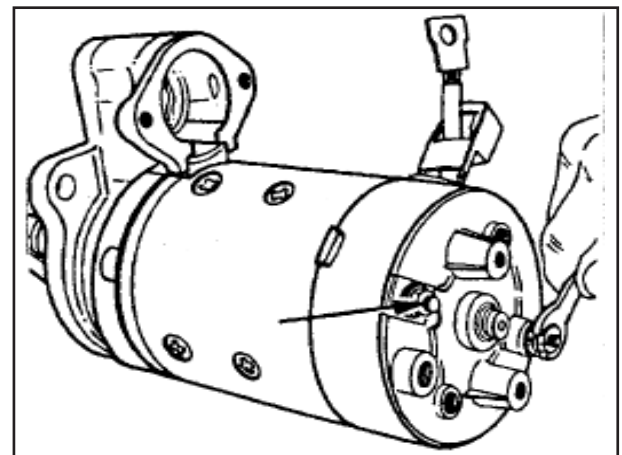
- Slacken the nut from securing the pivot pin and unscrew the pivot pin from the fixing bracket and remove the plunger from the assy.



- Remove the dust cap screw from the fixing bracket then remove the 'C' washer and shim holding the shaft.

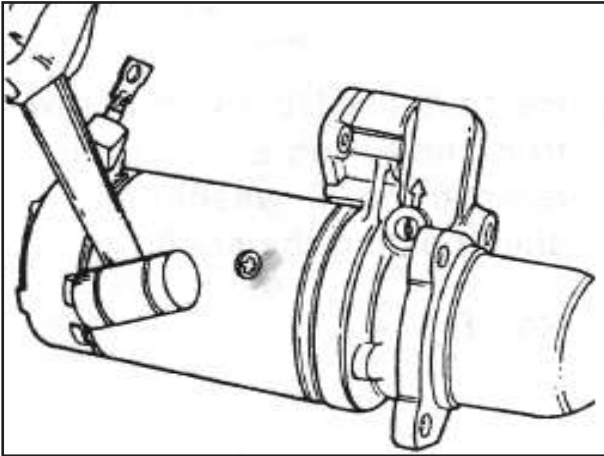


- Unscrew the brush carrier assemble screws from the C.E bracket assembly.

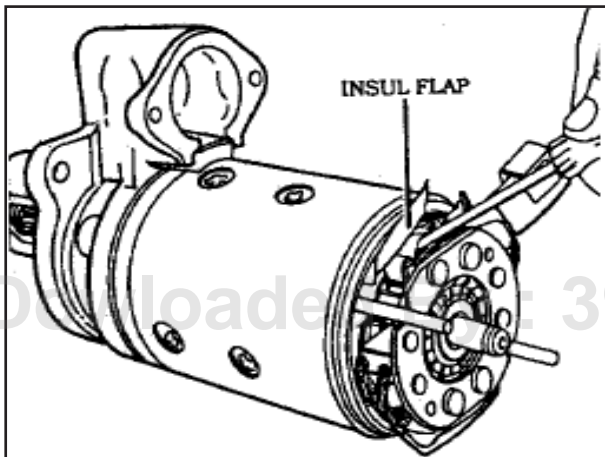


- Unscrew the through stud nuts from the C.E bracket.

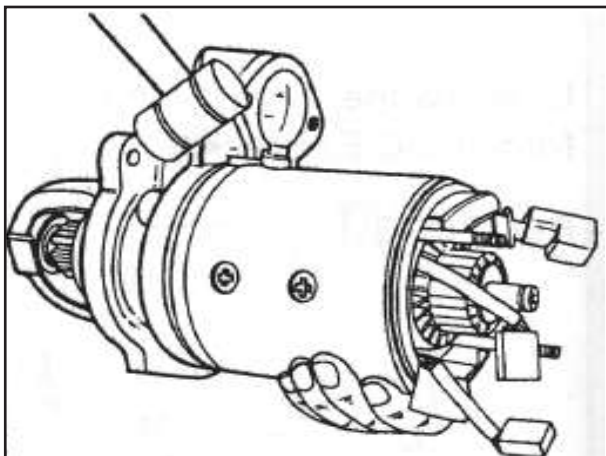




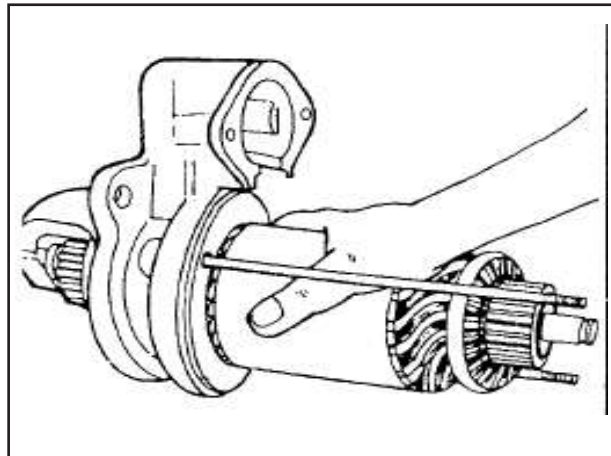
- Gently tap away the C.E bracket with a wooden mallet from the yoke assembly.



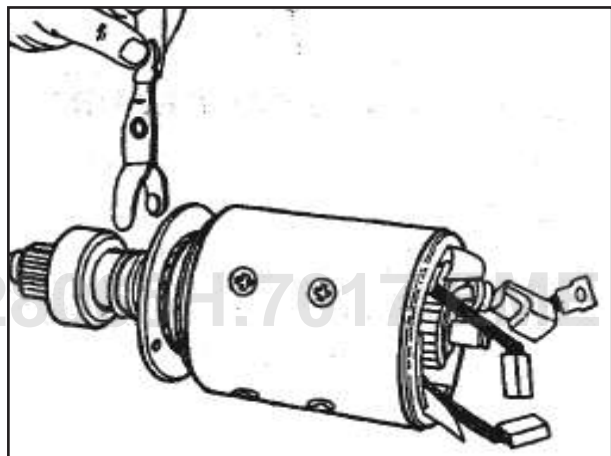
- Fold out the insul flaps over the brush carrier assembly and remove the brushes by pulling out the brush spring.



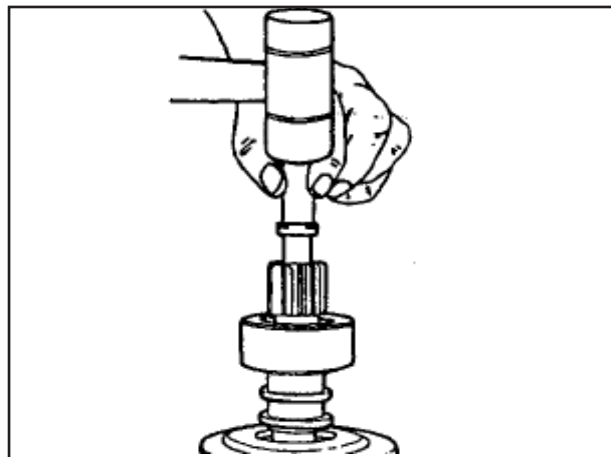
- Remove the yoke assembly from the fixing bracket.



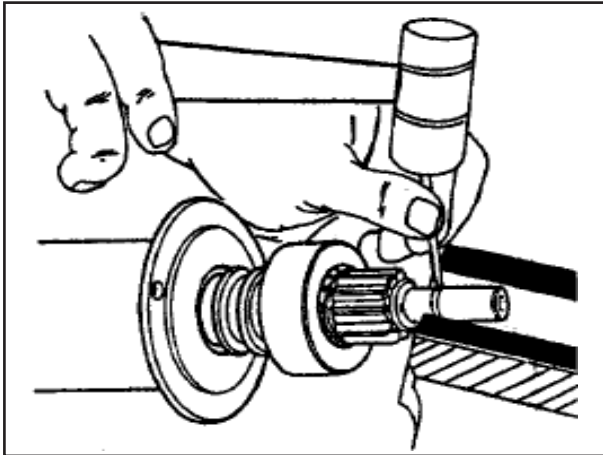
- Remove the armature assembly from the fixing bracket.



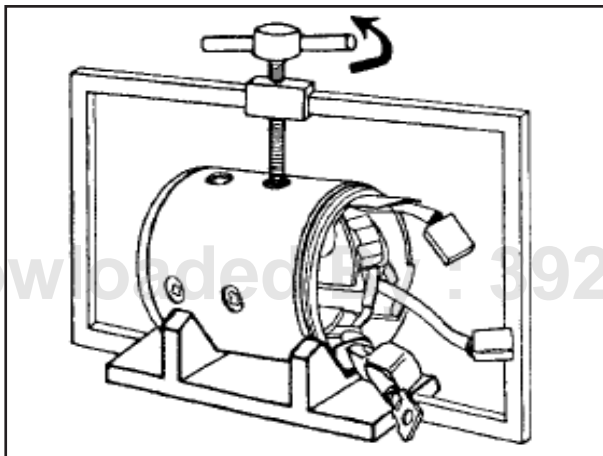
- Remove the engaging lever assembly from the drive assembly.



- Displace the thrust collar from the jump ring using a mild steel tube of suitable bore.



- Hold the armature assembly in soft vice and insert a steel sleeve to suit the shaft dia. and hammer it. After removing the thrust collar extract the jump ring with a screw driver.

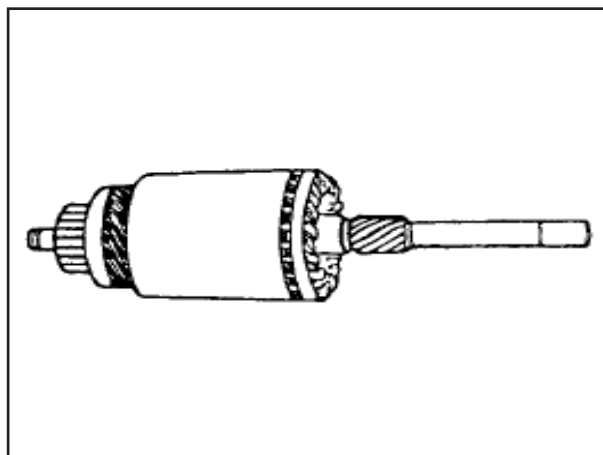


- Removal of pole screw: Hold the yoke assembly in rig as shown in the fig. and remove the pole screws.

#### MAINTENANCE PROCEDURE

- At the time of engine overhaul remove the starter from the engine and carry out the following checks to ensure proper functioning of the starter.

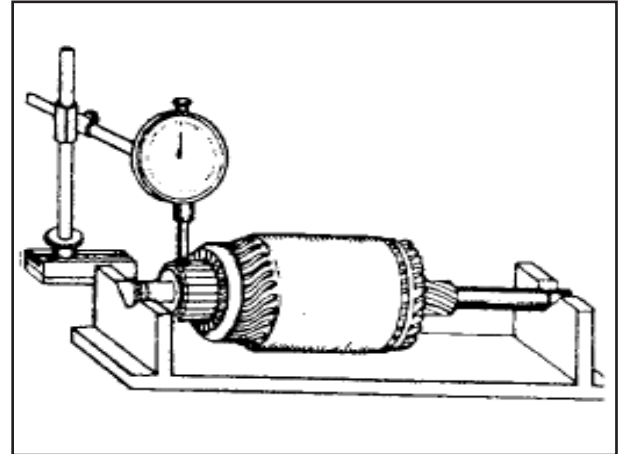
#### COMMUTATOR CHECK



- Commutator surface should be clean and free from oil, if not it should be cleaned by pressing a dry cloth. If the surface is dirty or dis - coloured clean

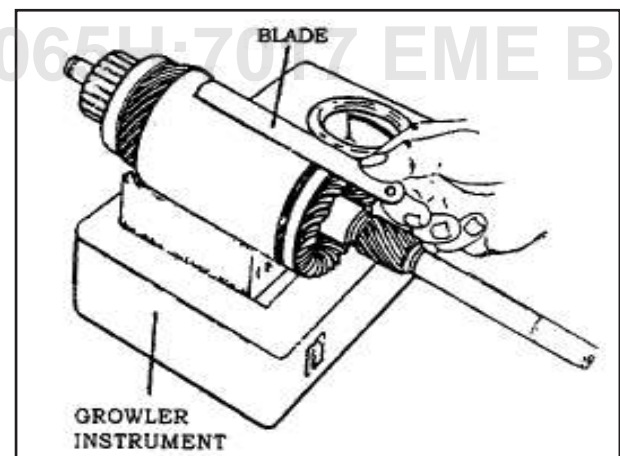
it with strip of fine emery sheet and remove mica burrs / carbon dust in the under cut portion of the commutator using a knife. All traces of dust and abrasives to be removed using compressed air.

#### COMMUTATOR RUN-OUT CHECK



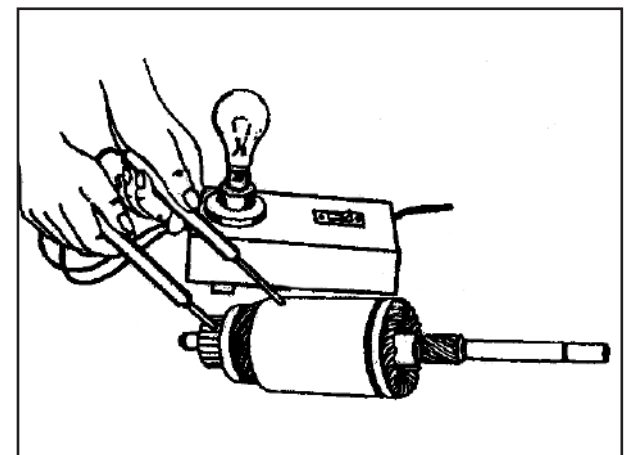
- Check the commutator run-out as shown in fig. If run out exceeds the limits, give a fine cut on the commutator on a lathe. If it is not possible replace the armature.

#### ARMATURE WINDING GROWLER TEST



- Check the Armature on a Growler tester for short circuit and continuity of winding as shown in fig.

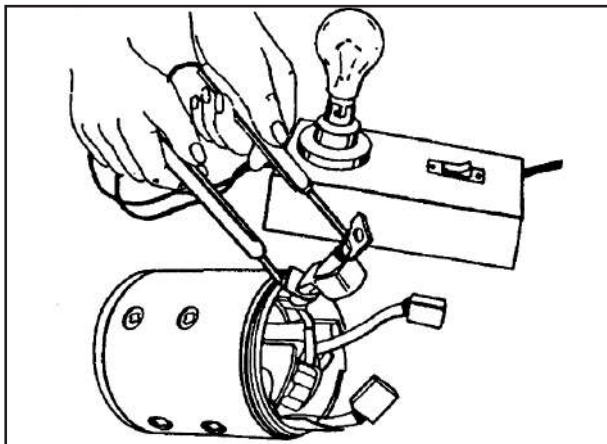
#### ARMATURE INSULATION TEST



- Use 110 Volts AC mains 15 W bulb with two probes, connect as shown. Bulb must not glow when the

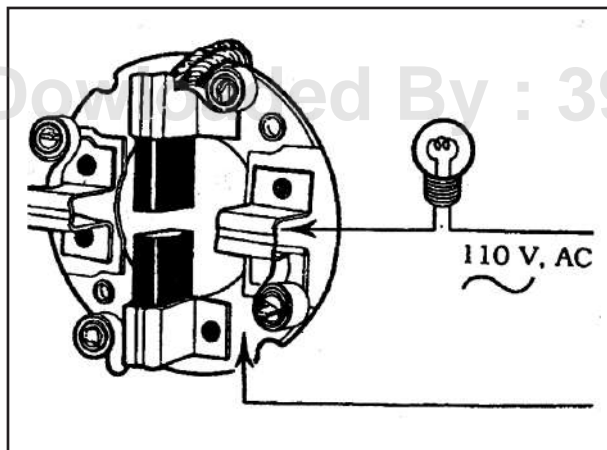
probes are connected between any one of the commutator segments and Armature core. If the bulb glows the fault is with the insulation. Replace the armature.

#### FIELD COIL CHECK



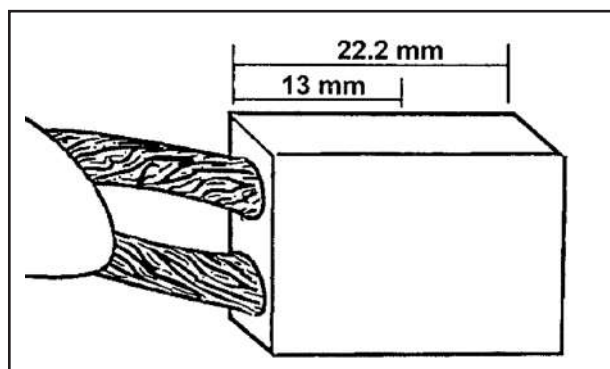
- Make sure that the insulation is proper. Use 100 Volts AC mains 15W bulb with two probes. Connect as shown in fig. Bulb should not glow; If it glows the field coil is earthing. Locate the fault and rectify by re-taping or replacing the field coil assembly.

#### BRUSH CARRIER ASSEMBLY CHECK



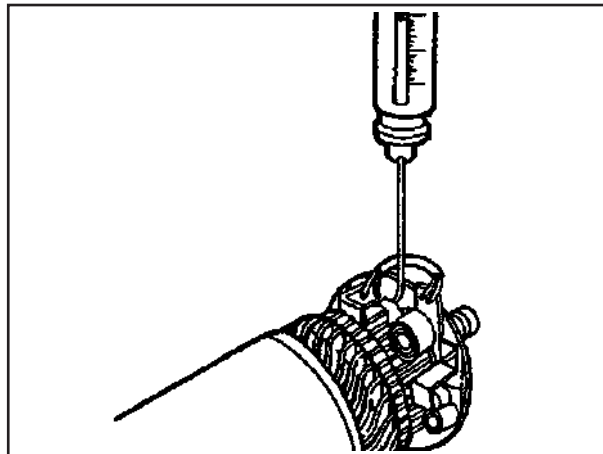
- Use 110 Volts AC mains 15 W bulb with two probes. When the probes are connected to the insul brush box and to the earth brush box the bulb should not glow. If the bulb glows it is improper insulation. Brush carrier assembly to be replaced.

#### BRUSH LENGTH CHECK



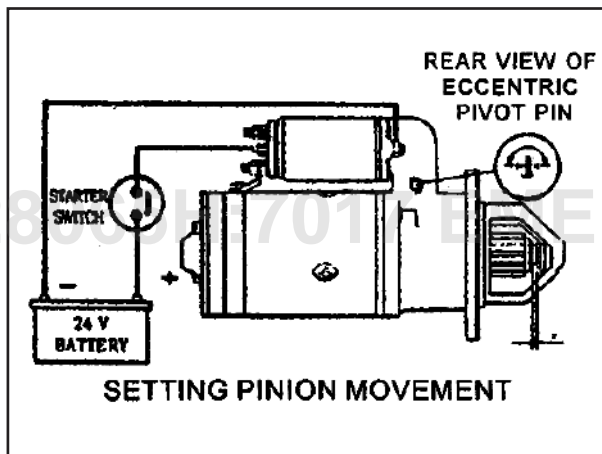
- Inspect the brushes length are of required.  
New brush length : 22.2 mm.  
Min. Required length : 13 mm.  
If not renew the brushes in sets and not individually.

#### BRUSH SPRING PRESSURE CHECK



- Check the brush spring pressure with a spring balance in conjunction with new brushes sitting on commutator as in working position. Spring pressure reading at the moment of lift should be to the recommended value. If not renew spring in sets and not individually.

#### SOLENOID CHECK

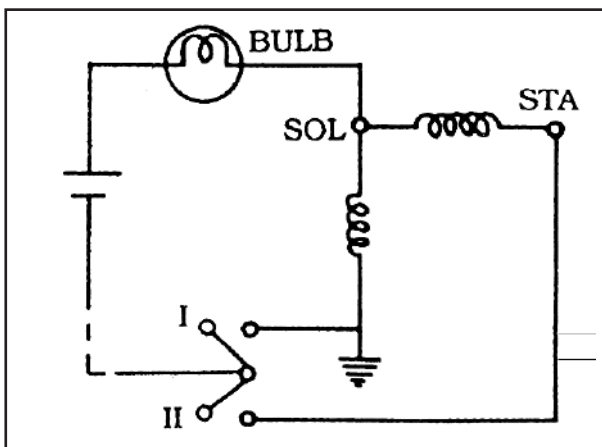


- To check the solenoid function connect 24 Volts supply across the solenoid terminal and body of the solenoid. Check for complete movement of the drive. If not, engaging lever or solenoid could be defective. Locate the faulty component and replace.



**Do not keep the switch continuously on for more the 5 seconds.**

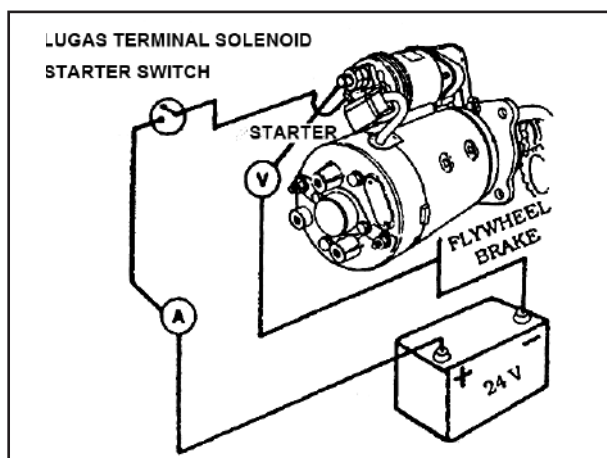
#### WINDING CONTINUITY CHECK



- Connect as shown in fig. Energize the solenoid and



switch on to position 1 and then to 11. The Bulb should glow in both case. If the bulb does not glow in any of this case, replace the switch.

**CONTACT CLOSURE CHECK:**

- Connect as shown in fig. Place the spacer in between the pinion and thrust collar face, so that the gap between pinion face and the spacer is 1.5 - 2 mm.
- Now energise the solenoid switch. The meter should indicate continuity. If not replace solenoid switch.

**DRIVE ASSEMBLY CHECK**

- Hold the drive assembly and inspect the pinion to ensure that it can be rotated in the direction of starter rotation and it should be locked while rotating in the opposite direction.
- Inspect the pinion teeth; if damaged replace the drive assembly with a new one.
- Inspect the condition of the rubber sealing parts of C.E. bracket, intermediate bracket and fixing bracket; if required replace with a new one.

**RE-ASSEMBLY PROCEDURE**

- Re-assembly should be done in the reversed order to that of dismantling.
- The following points to be adhered to, while re-assembly, smear shell retinax 'A' grease over the shaft splines.
- Smear grease shell retinax 'A' over the C.E. bracket end cover shaft.
- Replace all rubber sealing parts on every re-assembly
- Tighten all screws, and nuts to tightening torque values mentioned in the chart.

**TIGHTENING TORQUE**

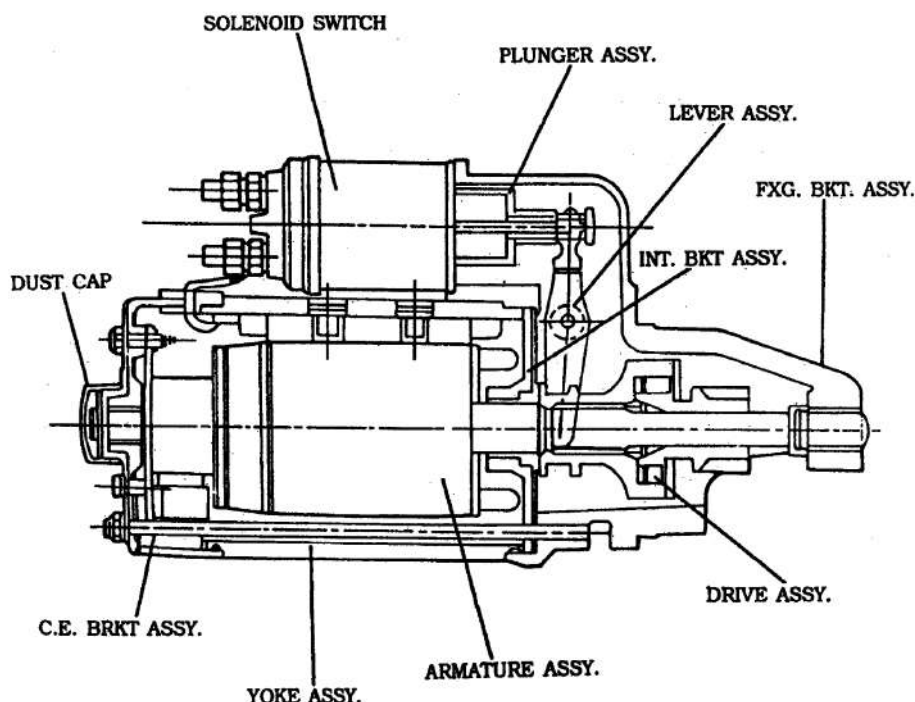
DESCRIPTION	VALUE
Fixing Stud / Nut	0.70 Kg.m
Main terminal	1.5 kg.m
Earth terminal	0.60 kg .m
Sol. Terminal	0.3 kg. m
Brush gear fixing screw	0.70 kg.m
Pole screw	3.0 kg.m

After every re-assembly check the starter motor as mentioned below.

**LIGHT RUN TEST**

Volts	:	24 Volts
Amps	:	100 Amps (Max.)
Speed	:	5500 RPM (Min.)

**LOCK TORQUE** test and **RUN TORQUE** test Values should be in line with the technical data details.

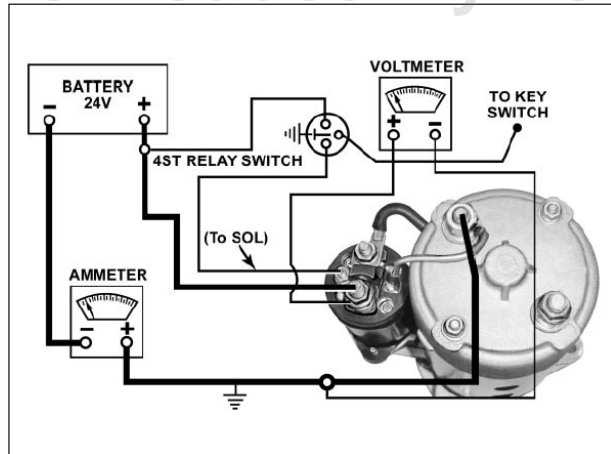
**ARRANGEMENT DRAWING**



**60.6.1 9M14 Starter Motor - Lucas TVS****General description**

The 9M14 Starter Motor is a pre-engaged Starter Motor, of four pole, four Brush construction with insul return system. This Starter Motor is of 114 mm dia frame size and suitable for diesel engines of upto 7.0 litres capacity.

On closing the Starter Key switch on the panel board, the solenoid mounted on the Starter Motor gets energised thereby pulling the plunger towards its core. An actuating lever supported on a pivot pin has one of its ends linked with the plunger and its other end with the Drive assembly. The pinion is thus thrown forward into mesh with the fly wheel ring gear. When the solenoid plunger moves in, the plunger at the end of its travel closes a pair of contacts which connects the Starter Motor directly to the battery. This enables the startup enabling it to develop full power. As soon as the engine fires, the Starter switch is released, the solenoid is de-energised, and the plunger is brought back to its original position by the plunger return spring. This also disengages the Drive assembly from the ring gear.

**Connecting Diagram****Precautions**

The following points to be adhered to while starting the Starting Motor.

- Ensure that all electrical connections to the Starter Motor are in firm condition.
- Press the Starter switch on the panel board firmly and release it as soon as the engine fires.
- If the engine does not fire at once, allow it to rest, before operating the Starter switch again.
- If the engine does not start, ascertain the cause

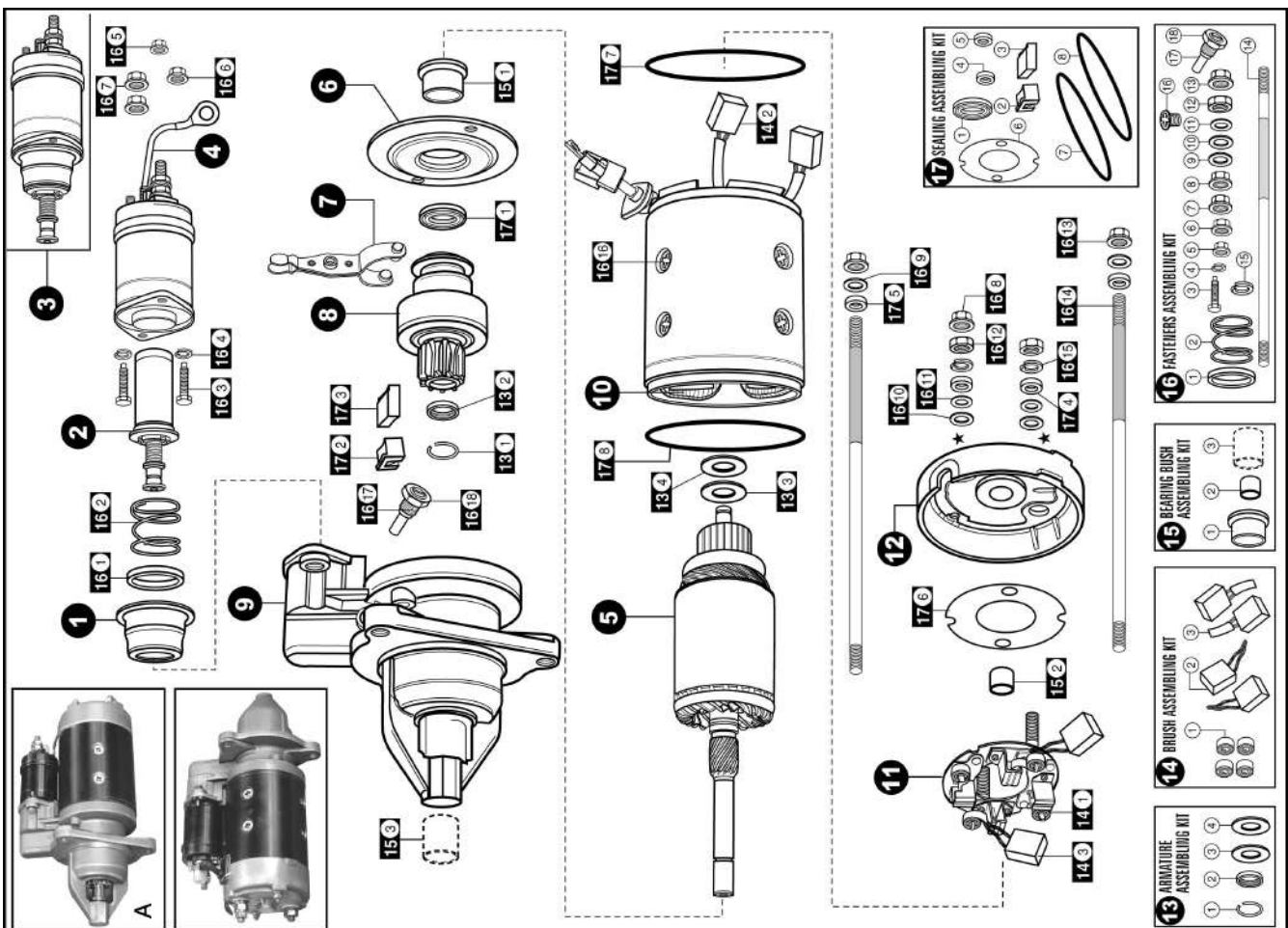
and do not run down the battery by keeping the Starter switch continuously on.

- Do not operate the Starter while the engine is running. Otherwise serious damage could occur both to the Starter Motor and to the ring gear teeth.
- Do not operate the Starter Motor for, more than 30 seconds continuously at any time.
- Ensure that a 4ST Relay switch incorporated in the starter circuit and mounted on to the chassis

**Routine maintenance**

- Ensure that the Starter Motor mounting bolts to the engine are securely fastened.
- Check all electrical connections are clean and tight.
- Cables should be examined for fractures particularly where the strands enter the terminal lugs.
- Check carbon brushes regularly.

LL NO. DESCRIPTION	QTY	LL NO. DESCRIPTION	QTY
A STARTER MOTOR WITH INTEGRATED RELAY - 24V (LTVS)	1	16 FASTENERS ASSY KIT CONSIST OF	1
1 SHROUD	1	1. CUP WASHER	1
2 PLUNGER ASSEMBLY	1	2. PLUNGER RETURN SPRING	1
3 SOLENOID SWITCH ASSEMBLY	1	3. SCREW (SOLENOID)	2
4 LEAD ASSEMBLY	1	4. SPRING WASHER	2
5 ARMATURE ASSEMBLY	1	5. M6 FLANGE NUT (SOL. TERMINAL)	1
6 INTERMEDIA BRACKET	1	6. M8 FLANGE NUT (STA)	2
7 ENGAGING LEVER ASSEMBLY	1	7. M10 FLANGE NUT (BAT)	2
8 DRIVE ASSEMBLY	1	8. M10 FLANGE NUT (EARTH)	1
9 FIXING BRACKET ASSEMBLY	1	9. M10 PLAIN WASHER	2
10 FIELD COIL ASSEMBLY	1	10. M10 INSUL WASHER	2
11 BRUSH GEAR ASSEMBLY	1	11. M6 PLAIN WASHER	2
12 CE BRACKET ASSEMBLY	1	12. NUT	2
13 ARMATURE ASSY KIT CONSIST OF	1	13. M6 FLANGE NUT (FIX. STUD)	2
14 BRUSH ASSY KIT CONSIST OF	1	14. THRO STUD	2
1. BRUSH SPRING	4	15. SPRING WASHER	2
2. INSUL BRUSH	2	16. POLE SCREW	8
3. EARTH BRUSH	1	17. PIVOT PIN	1
15 BEARING BUSH ASSY KIT CONSIST OF	1	18. NUT (PIVOT PIN)	1
1. BEARING BUSH (INTER. BRKT) 1		17 SEALING ASSY KIT CONSIST OF	1
2. BEARING BUSH (CE BRKT)	1	1. OIL SEAL	1
3. BUSH (FIX. BRKT)	1	2. GROMMET (SOLENOID)	1
		3. GROMMET (FIX. BRKT)	1
		4. INSUL BUSH (BG STUD)	2
		5. SEAL (THRO STUD)	2
		6. INSUL PLATE	1
		7. 'O' RING (YOKE)	1
		8. 'O' RING (INTER BRACKET)	1





**Starter features****Armature assembly**

1. Resistance brazed joints	Improved Stamina
2. Class 'F' Varnish for impregnation	Better insulation at high temperature.
3. Resistance glass tape banding for end baskets	To provide mechanical rigidity Better protection against fling

**Field coil assembly**

1. Lap welded joints for inter coil connection	Better reliability
2. Class 'F' Varnish for impregnation	To guard against carbon dust and hence better life
3. All main field coils	Improved electrical performance

**Carbon brushes**

1. Special metal impregnated grade	For long service life
------------------------------------	-----------------------

**Fixing bracket**

1. Special metal impregnated grade	For Better impact strength
------------------------------------	----------------------------

**Engagement**

Pre-Engaged positive engagement of pinion, even at high temp. (80°C)

**Brush carrier assembly**

1. Solid riveting	To improve strength of brush boxes & to prevent earthing failures
-------------------	---

**Sealing**

1. Fall Sealing ('O' Rings)	For better protection against water and dust ingress
2. Oil seal in the inter bracket	To guard against oil ingress through clutch housing
3. Shroud in the sol. Switch	To prevent water & dust ingress

**Drive assembly**

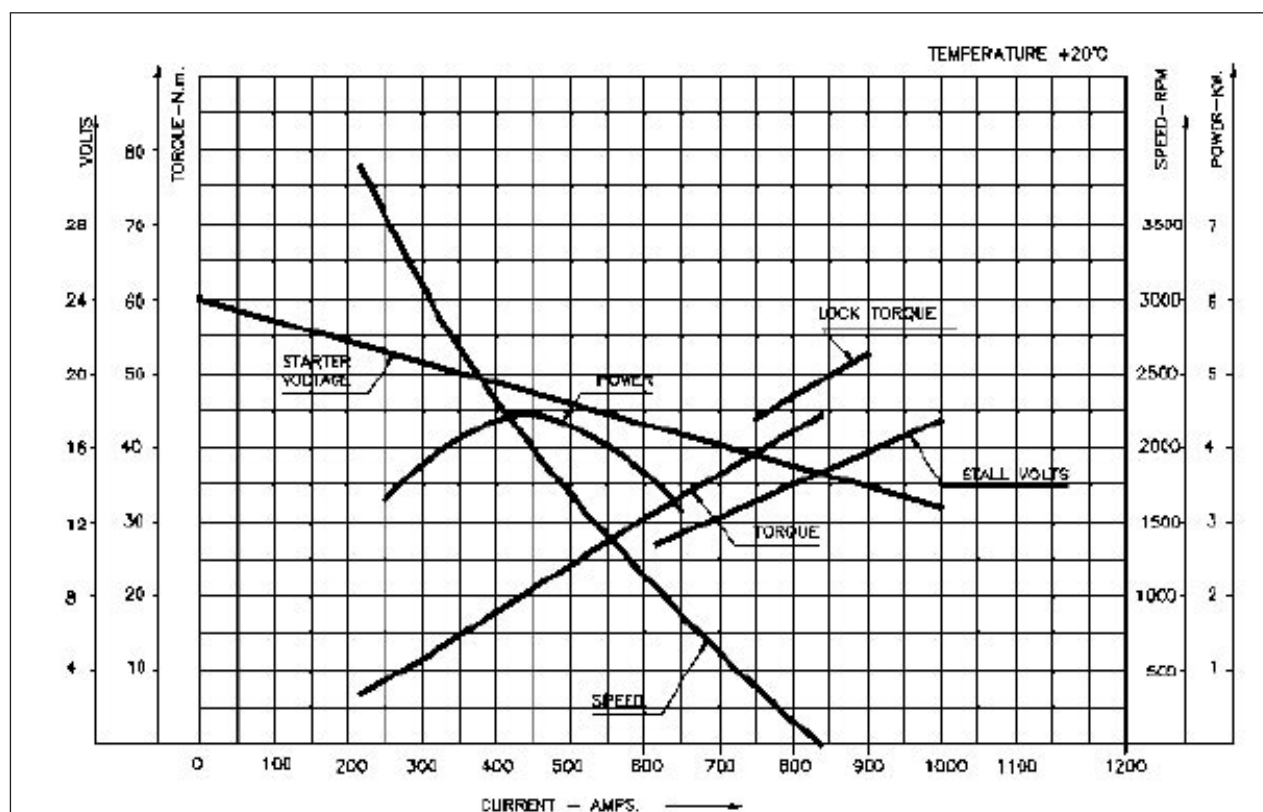
1. New Heavy duty roller clutch	Over run protection no servicing required no clutch setting is required
2. Case hardened & double chamfered pinion	Smooth and ease. Engagement longer life

**Solenoid switch assembly**

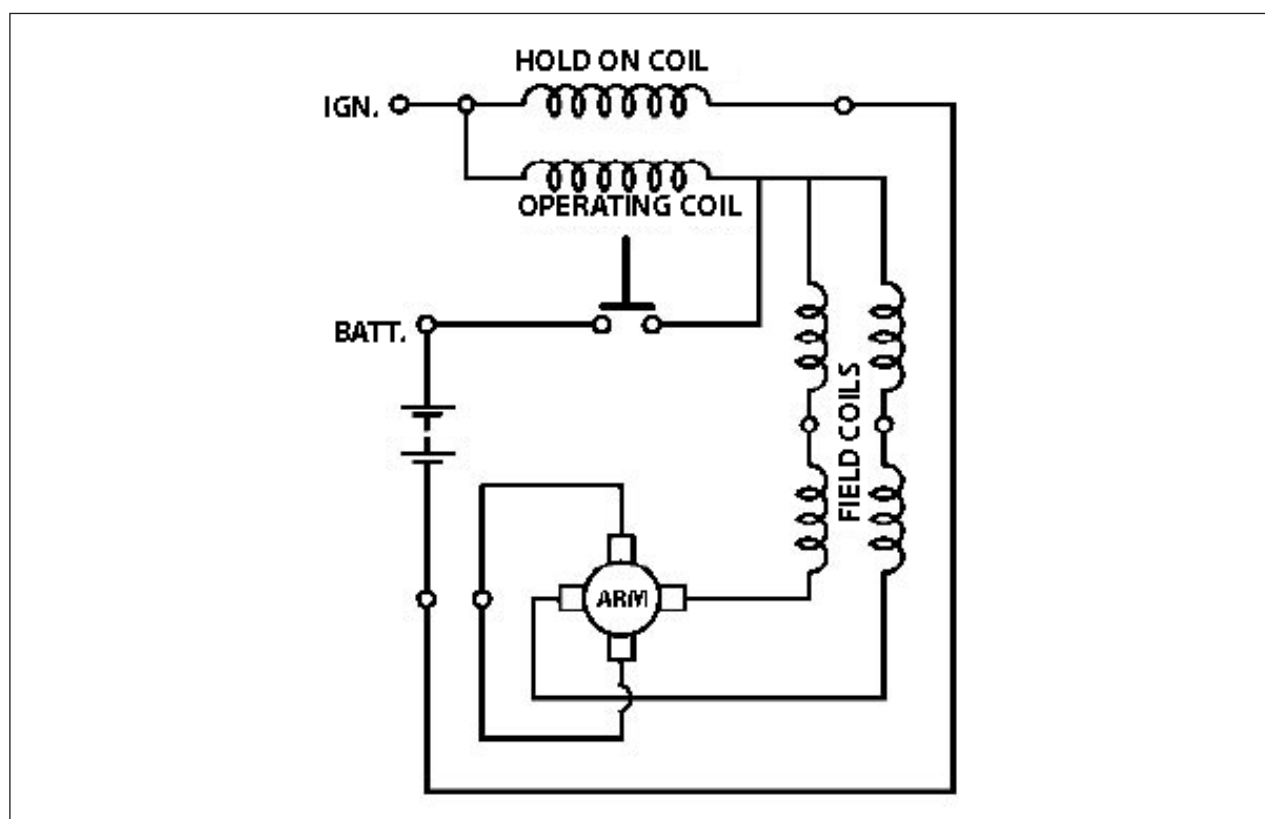
1. Dual winding design	To withstand a high circuit resistance. Positive engagement even at low voltage
2. Copper terminal	For better service life



## Typical Performance Curve

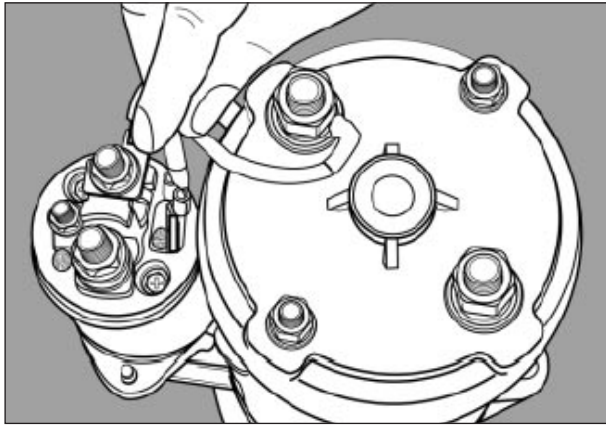


## Wiring Diagram

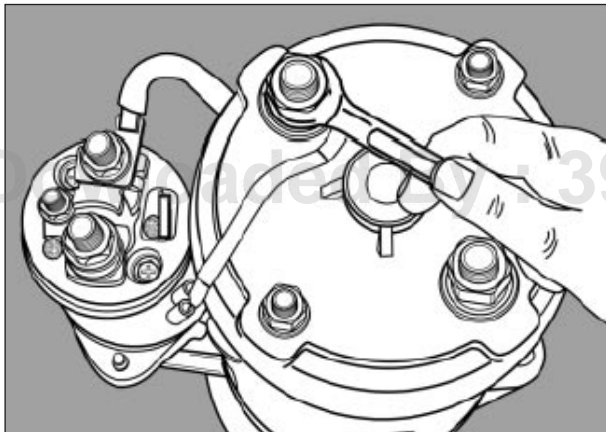


**Dismantling**

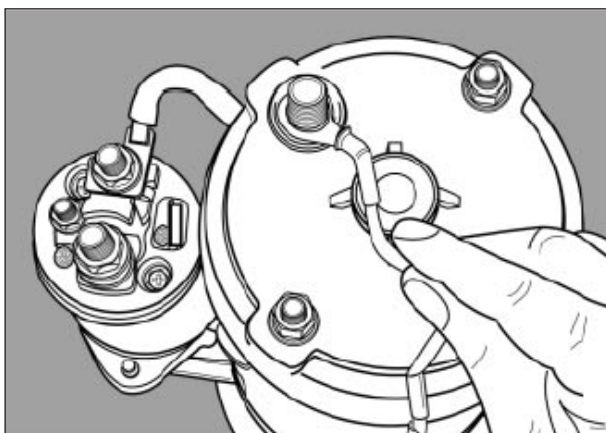
When dismantling the starter, carefully note down the positions of various parts fitted, in order to ensure their correct replacement on Re-assembly.



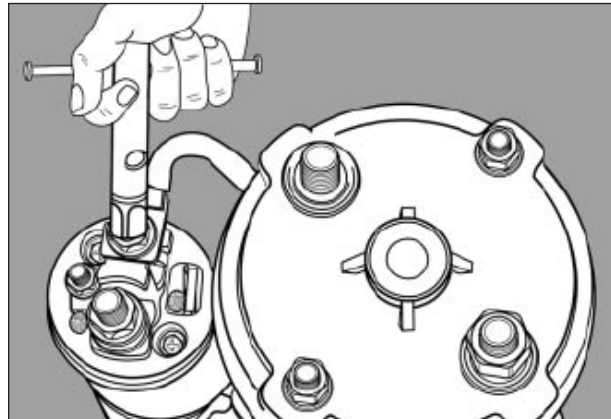
- Remove the Lead assembly connecting the Solenoid Terminal and the field terminal on the solenoid assembly



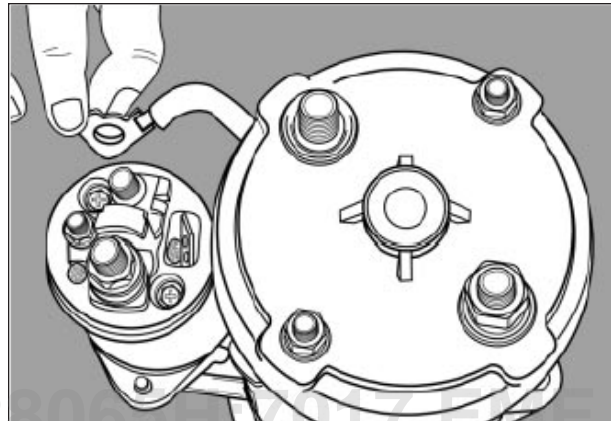
- Unscrew the nut from CE Bracket assembly which secure lead assembly connecting the Solenoid Terminal and the field terminal.



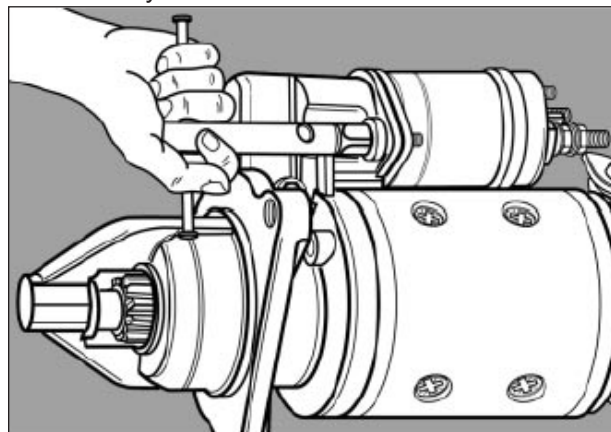
- Remove and separate the lead assembly.



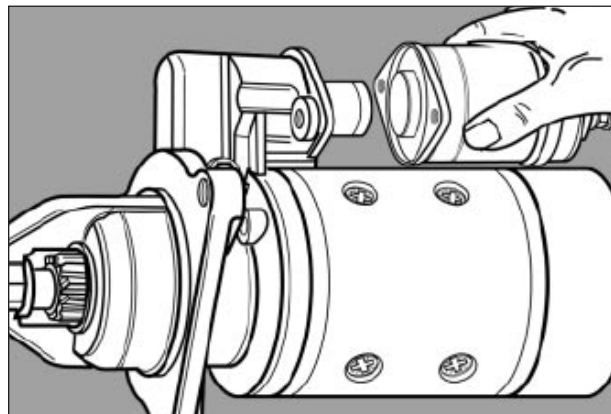
- Unscrew the Field Coil lead assembly fixing nut from solenoid assembly.



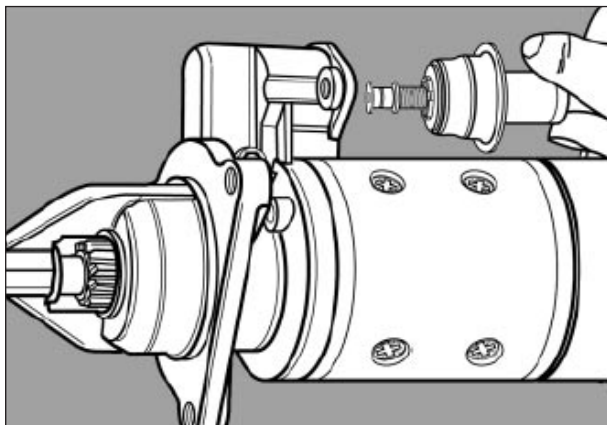
- Release the Field Coil lead assembly from solenoid assembly.



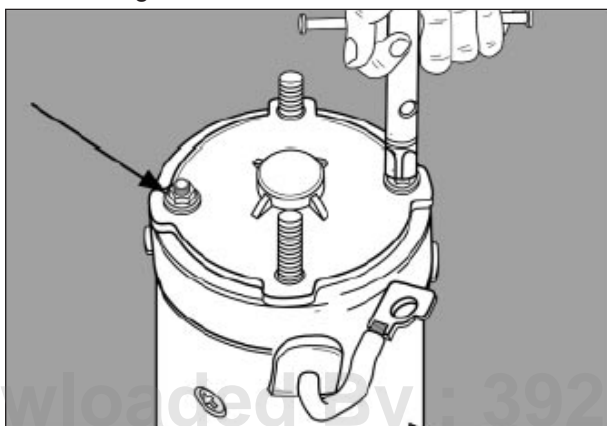
- Unscrew the solenoid fixing screws from the fixing bracket.



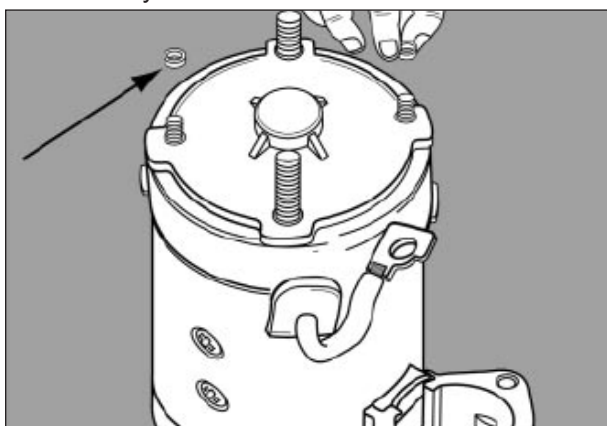
- Remove and separate the solenoid switch assembly from the fixing bracket.



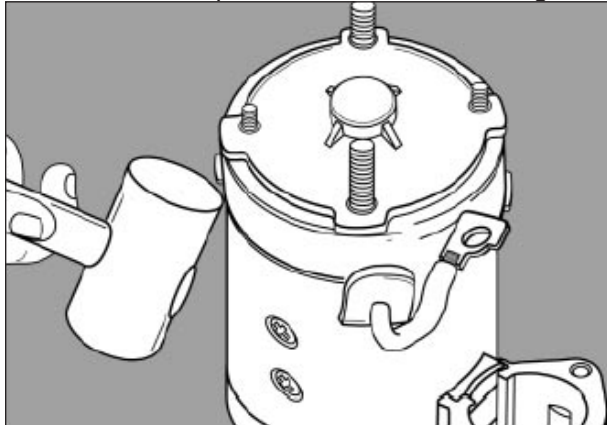
- Remove and separate the plunger assembly from the fixing bracket.



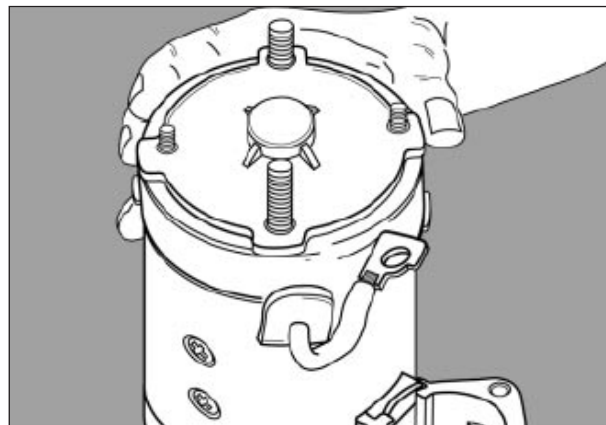
- Unscrew the through stud nuts from the CE bracket assembly.



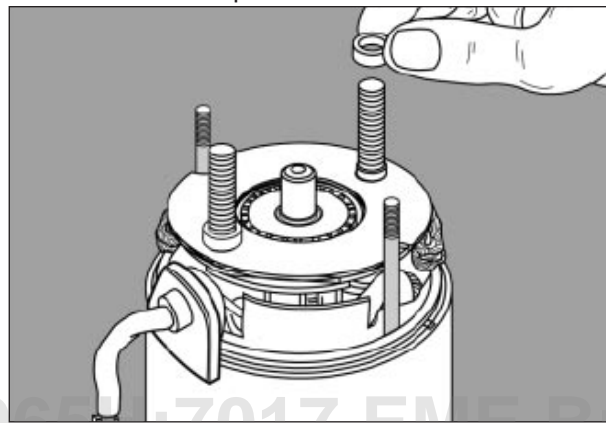
- Remove and separate the seal from the through stud.



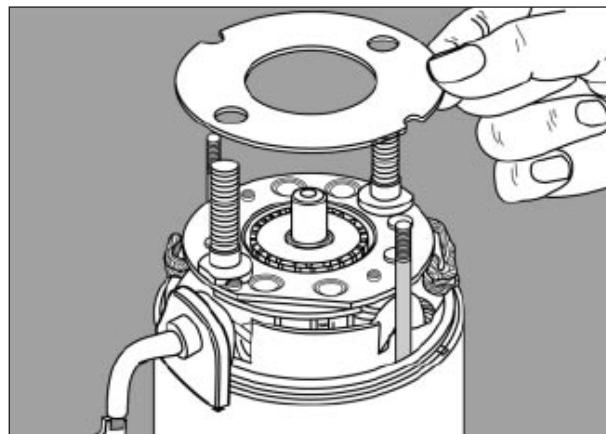
- Gently tap the CE bracket with wooden mallet.



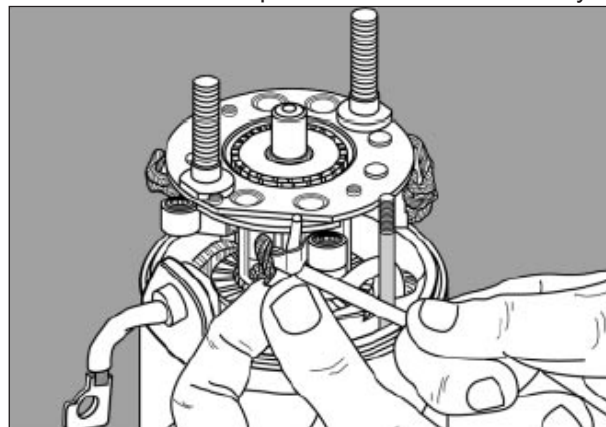
- Remove and separate the CE bracket



- Remove the insul bush from the BG stud.

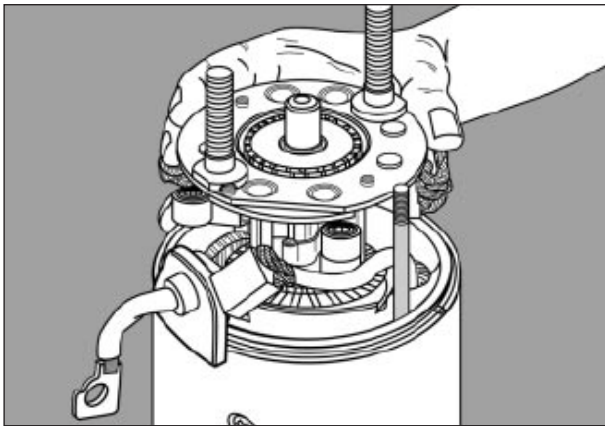


- Remove the insul plate from the BG assembly.

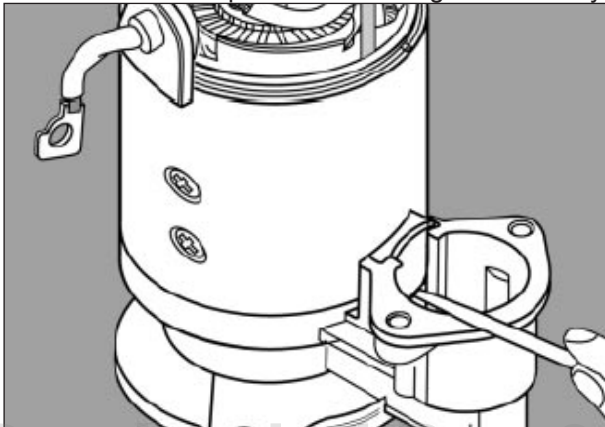


- Fold out the Insul flaps over the brush gear assembly and remove the brushes by pulling out the brush spring.

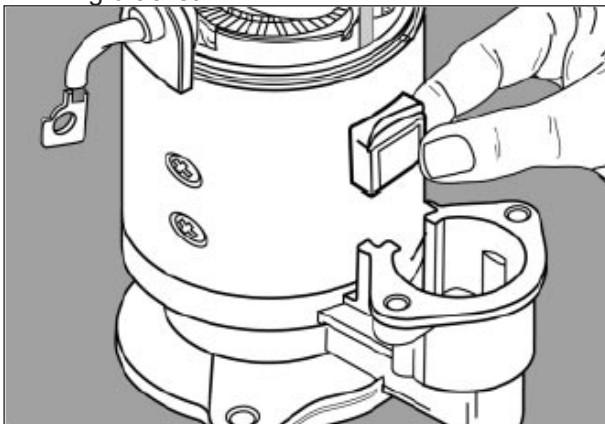




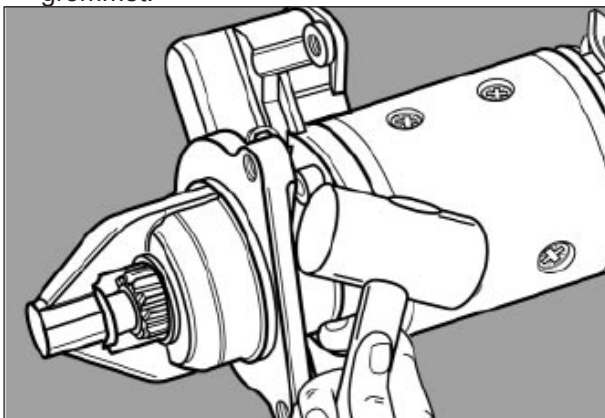
- Remove and separate the brush gear assembly.



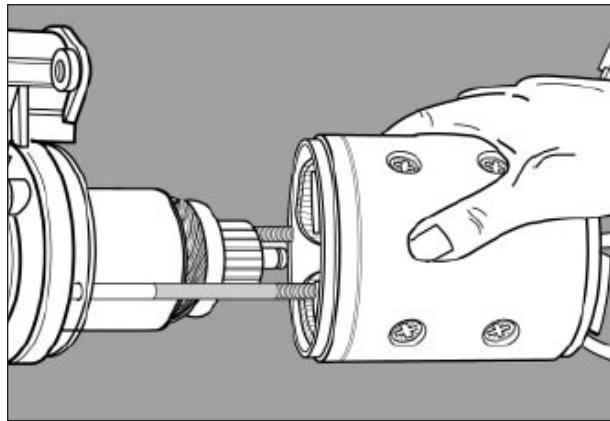
- Pull out the solenoid seating grommet from the fixing bracket.



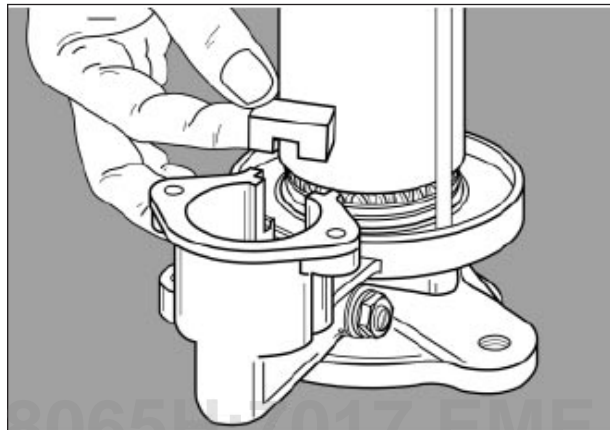
- Remove and separate the solenoid seating grommet.



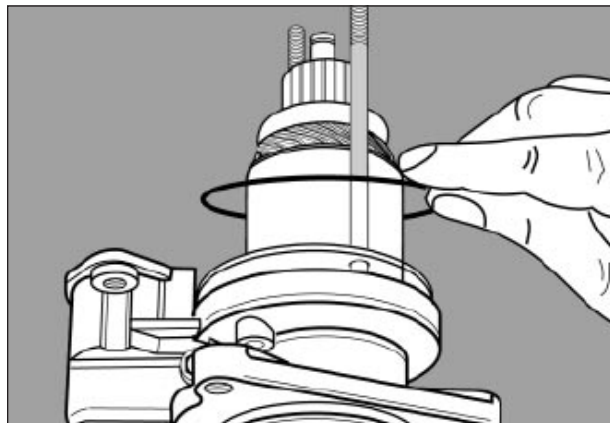
- Gently tap away the fixing bracket assy. with a wooden mallet from the yoke assembly-



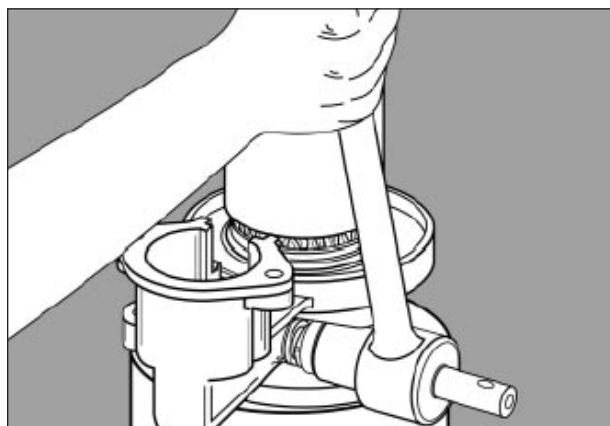
- Remove the yoke assembly from the fixing Bracket.



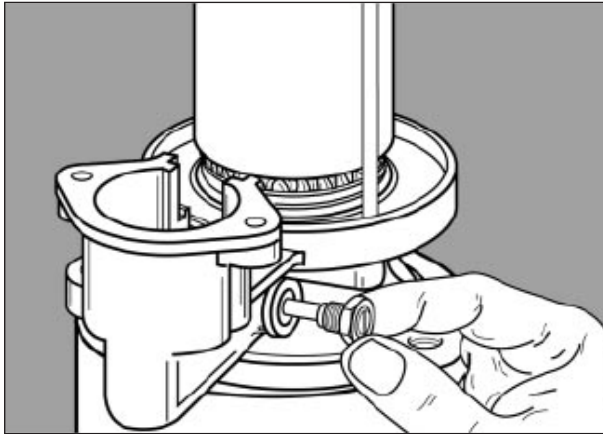
- Remove the grommet from the fixing Bracket.



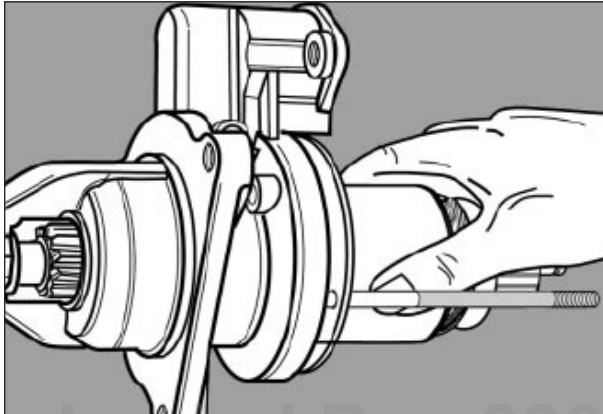
- Remove the 'O' ring from the inter bracket.



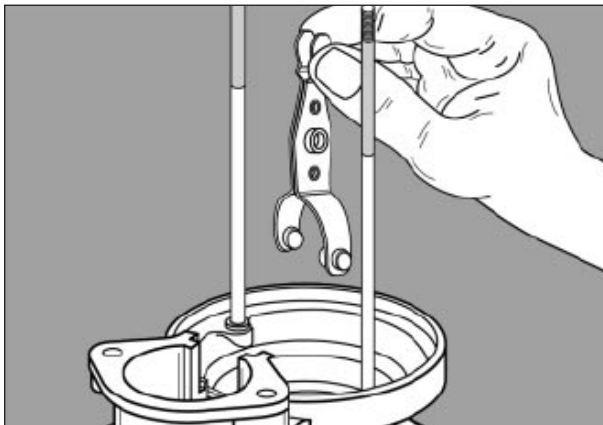
- Slacken and remove the nut with special tool from securing the pivot pin from the fixing bracket.



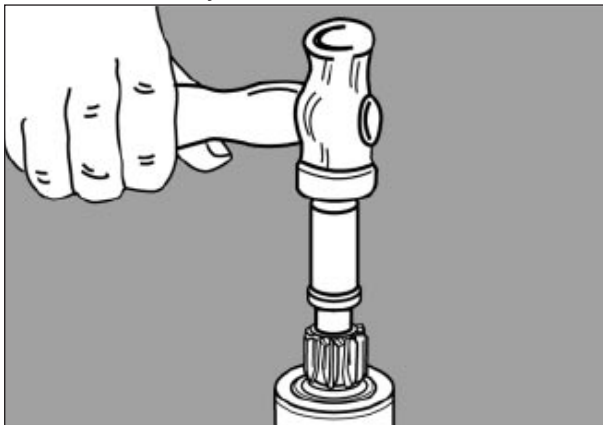
- Remove and separate the pivot pin & nut.



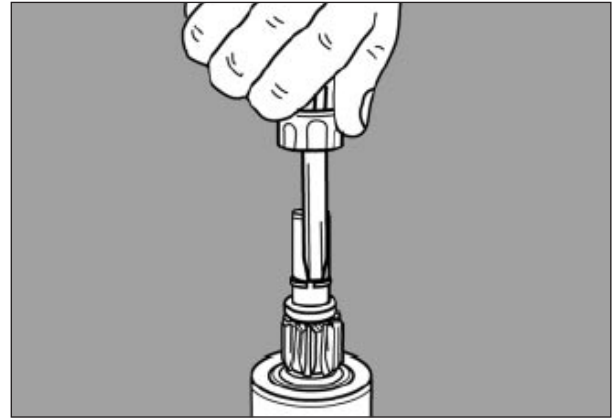
- Remove the armature assembly from the fixing bracket.



- Remove the engaging lever assembly from the drive assembly



- Displace the thrust collar from the jump ring using a mild steel tube of suitable bore.

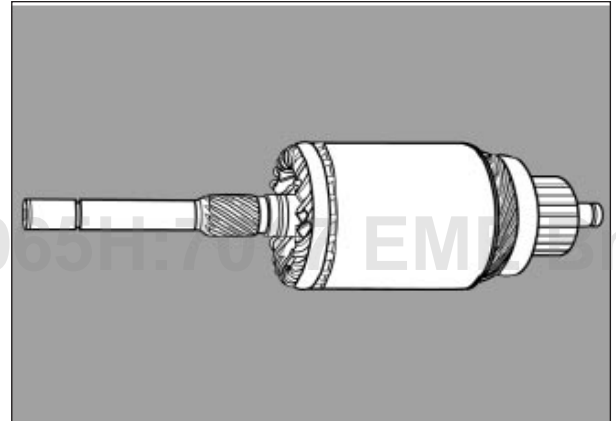


- Remove the thrust collar extract the jump ring with a screw driver.

#### **Maintenance procedure**

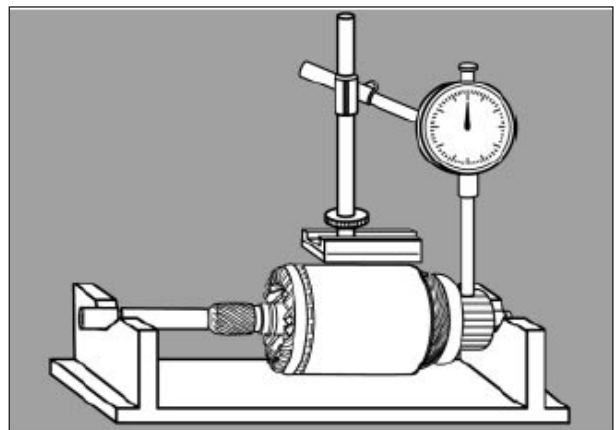
- At the time of engine overhaul remove the Starter from the engine and carry out the following checks to ensure proper functioning of the Starter.

#### **Commutator check**



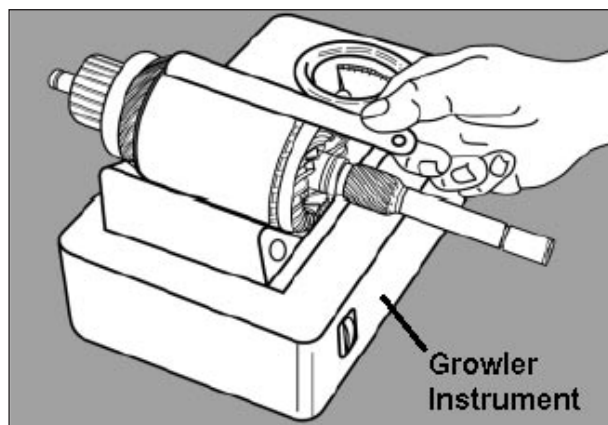
- Commutator surface should be clean and free from oil, if not it should be cleaned by pressing a dry cloth. If the surface is dirty or discoloured clean it with strip of fine emery sheet and remove Mica Burrs 1 carbon dust in the under cut portion of the commutator using a Knife. All traces of dust and abrasives to be removed using compressed air.

#### **Commutator run-out check**

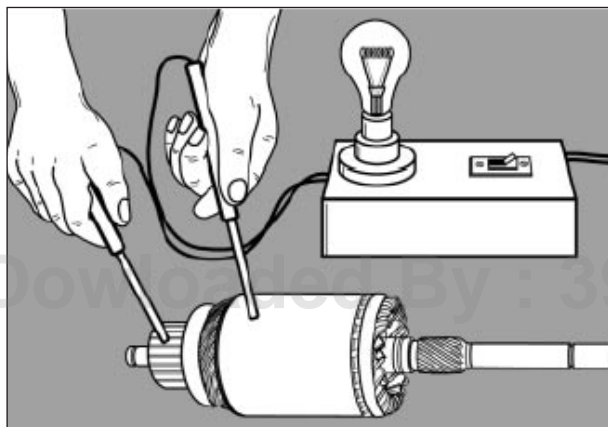


- Check the commutator run-out as shown in fig. If run out exceeds the limits, give a fine cut on the commutator on a lathe. If it is not possible replace the Armature.

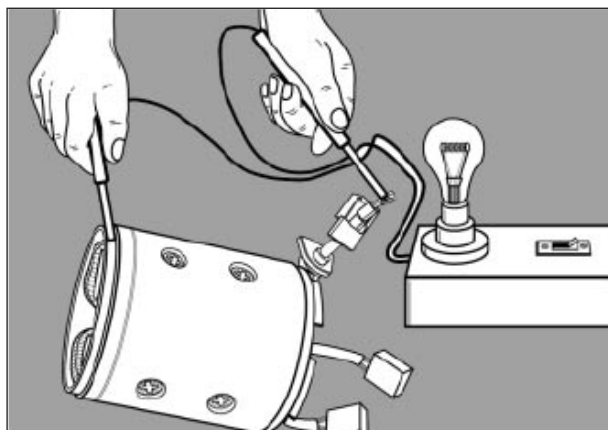


**Armature winding growler test**

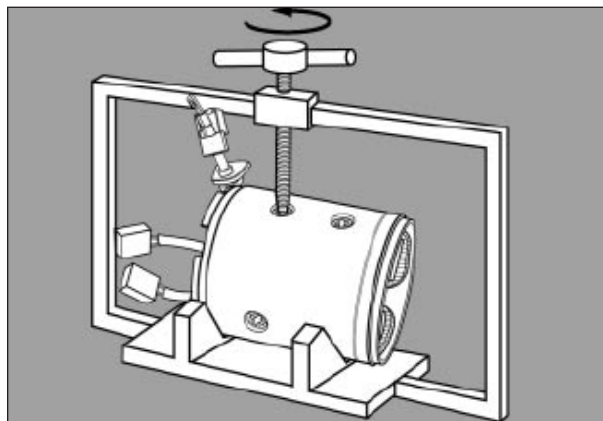
- Check the Armature on a Growler tester for short circuit and continuity of winding as shown - in

**Armature insulation test**

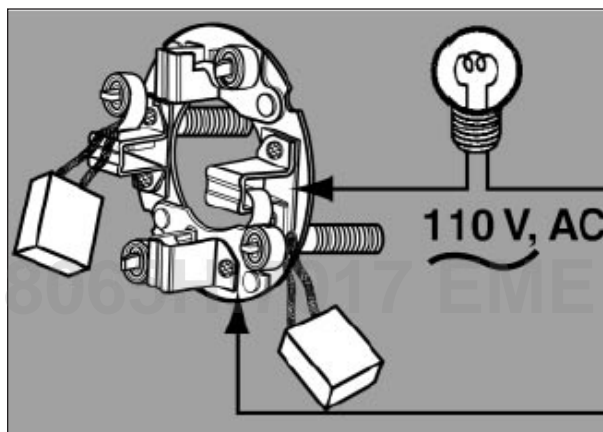
- Use 110 Volts AC mains 15W bulb with two probes, connect as shown in figure. Bulb must not glow when the probes are connected between any one of the commutator segments and Armature core. If the bulb glows the fault is with the insulation. Replace the Armature.

**Field coil check**

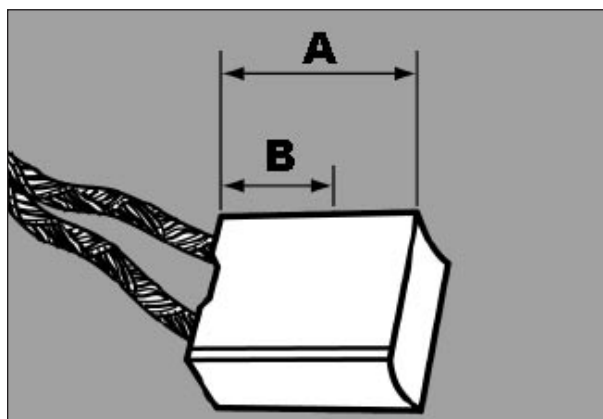
- Make sure the insulation is proper. Use 100 Volts AC mains 15W bulb with two probes. Connect as shown in figure. Bulb should not glow; if it glows the field coil is earthing. Locate the fault and rectify by re-taping or replacing the field coil assembly.



- Removal of Pole Screw : Hold the yoke assembly as shown in the fig. rig and remove the pole screws.

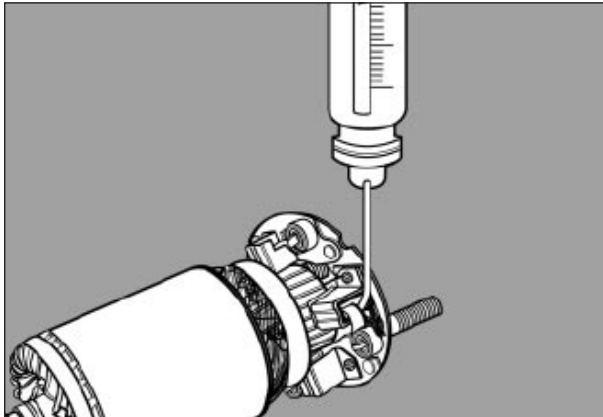
**Brush carrier assembly check**

- Use 110 Volts AC mains 15W bulb with two probes. When the probes are connected to the insul brush box and to the earth brush box the bulb should not glow. If the bulb glows it is improper insulation. brush carrier assembly to be replaced.

**Brush length check**

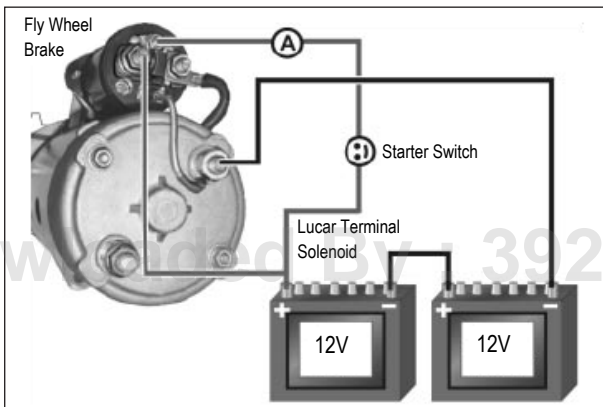
- Inspect the brushes length are of required.
- New brush length : 22.2 mm.
  - Min. Required length :13 mm. If not renew the brushes in SETS and not individually.

### Brush spring pressure check



- Check the Brush spring pressure with a spring balance in conjunction with new brushes sitting on commutator as in working position- Spring pressure reading at the moment of lift should be Kgs. If not renew spring in SETS and not individually.

### Solenoid check

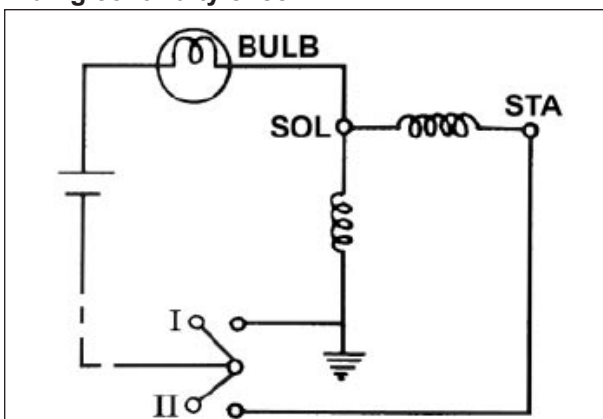


- To check the solenoid function connect 24 Volts supply across the solenoid terminal and body of the solenoid. Check for complete movement of the drive. If not, engaging lever or solenoid could be defective. Locate the faulty component and replace.



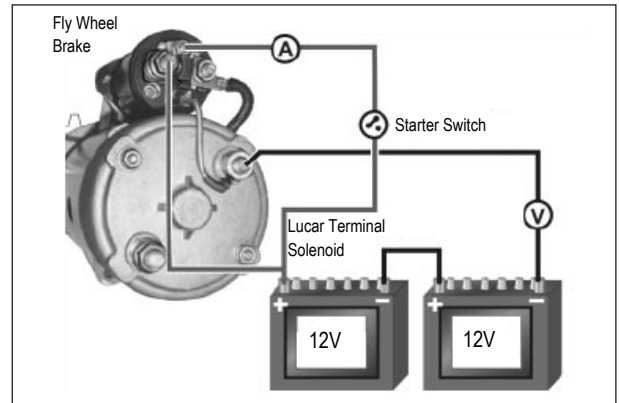
**Do not keep the switch continuously on for more the 5 seconds.**

### Winding continuity check



- Connect as shown in figure. Energize the solenoid and switch on to position I and then to H. The Bulb should glow in both case. If the bulb does not glow in any of their case, replace the switch

### Contact closure check:



- Connect as shown in figure place the spacer in between the pinion and thrust collar face, so that the gap between pinion face and the spacer is 2- mm.
- Now energise the solenoid switch. The meter should indicate continuity. If not replace solenoid switch

### Drive assembly check

- Hold the drive assy\_ and inspect the pinion to ensure that it can be rotated in the direction of Starter rotation and that it should be locked in the opposite direction rotation.
- Inspect the pinion teeth; if damaged replace the drive assy. with a new one.
- Inspect the condition of the rubber sealing parts of C\_E. Bracket Intermediate Bracket and Fixing Bracket ; if required replace with a new one.

### Re-assembly procedure

- Re-assembly should be done in the reversed order to that of dismantling.
- The following points to be adhered to, while reassembly. Smear sheel Retinax 'A' grease over the shaft splines.
- Smear grease Shell Retinax 'A' over the C.E. bracket end cover shaft.
- Replace all rubber sealing parts on every re-assembly
- Tighten all screws, and nuts to tightening torque values mentioned in the chart.
- Ensure that while re-assembly solenoid switch, plunger and the rubber shroud is fitted properly.
- Never use the brush springs remove from the burnt starter assembly.

### Light run test

Volts	: 23.5 Volts
Amps	: 80 Amps (Max.)
Speed	: 8500 rpm (Min.)

### Run test values

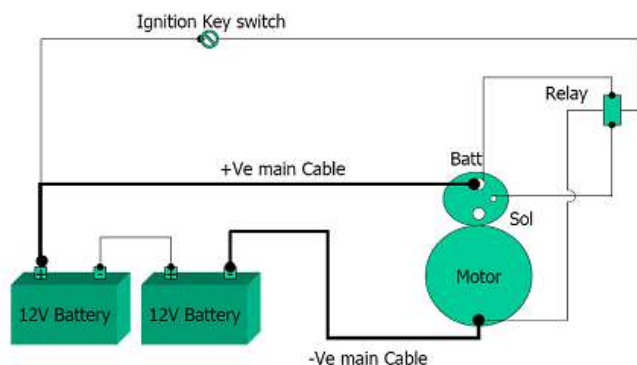
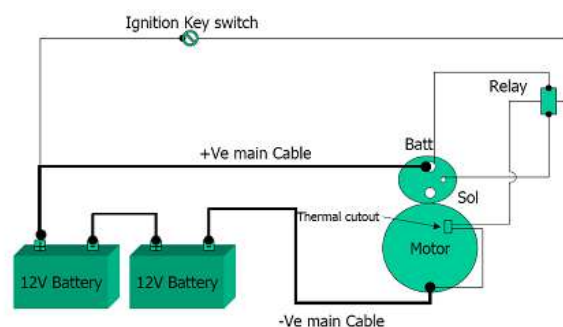
Volts	: 18.0 Volts
Amps	: 600 Amps (Max.)
Torque	: 24 Nm (Min.)
Speed	: 1200 rpm (Min.)

### Lock values

Volts	: 15.0 Volts
Amps	: 850 Amps (Max.)
Torque	: 48 Nm (Min.)

## Operation of Thermal cutout :

## Starter Motor Circuit with Integral Relay

Starter Motor Circuit with Integral Relay  
and Thermal cutout

Thermal cutout is a device added on to the current starter motor (internally) and will protect the starter motor when it overheats due to some reason.

The starter motor may overheat due to one or more of the following reasons -

- Continuous cranking,
- Inching the vehicle forward using starter motor,
- Discharged batteries,
- Defective ignition switch,
- Longer cranking due to use of increased battery cable lengths by body builders
- Centrifuging of starter motor electrically due to general short circuits & earthing in the starting system, Starter motor internal components failures etc.

**Principle :**

Thermal cutout consists of a bimetal snap-action element that opens or closes an electric circuit through switching its contact at a preset open and closing temperature.

**Identification :**

This bimetal element is inserted inside the starter motor casing and positioned close to the armature of the starter motor. The two thin wires connecting the element to the starter motor wiring are visible externally. A red sticker on the rear aluminium cover indicates that the starter motor is with thermal cutout feature.

**Working :**

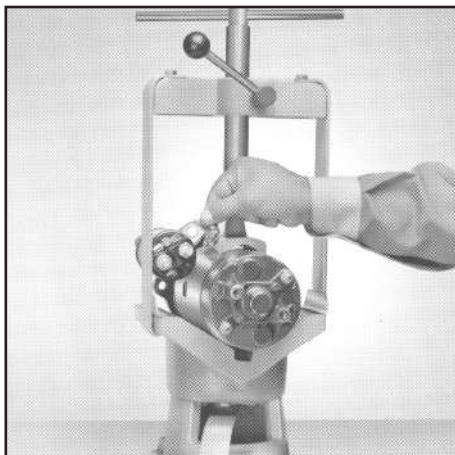
When temperature of starter increases, the thermal cutout contact opens and electrical supply to motor gets disconnected. The contact remains open for some time, till the motor cools down. After the starter motor cools down to the reset temperature, the contact closes automatically, completing the circuit once again. The starter motor is now ready for re-cranking.

The cooling down may take 2 – 3 minutes depending upon the severity of the overheating. Please note that during this period, any attempt by the driver to crank / start the engine will not have any effect.

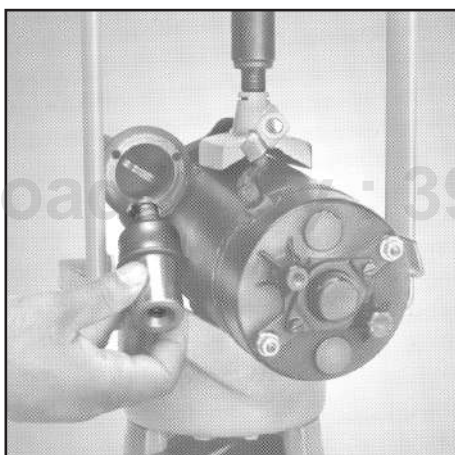


**60.7 IF STARTER****Dismantling**

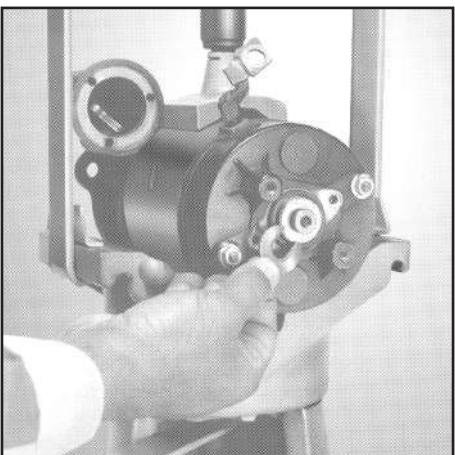
- Clamp the IF starter motor on universal swivelling vice 03-KDAW 9999.



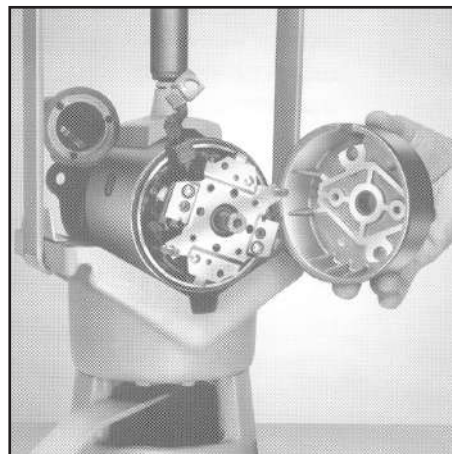
- 1.2 Loosen the hexagonal nut (40) and take out the washer (39) and the supply terminal from the solenoid (804).



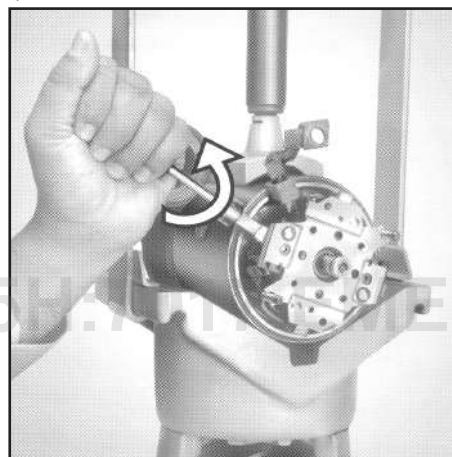
- Loosen the three counter sunk screws (17) and take out the solenoid housing. Disengage the solenoid armature from the fork lever by holding the pinion.
- Loosen the cheesehead screws (38) and take out the mounting flange (27), 'O' rings (67), cap (37) and the sealing ring (36).



- Press out locking washer (35) and take out play compensating washers (33, 34).



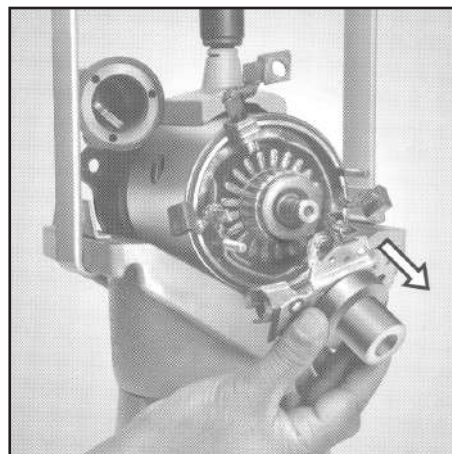
- 1.6 Loosen the hexagonal nut (32) on the commutator end shield and take out the washer (31), 'O' ring (18) and withdraw the end shield (30) from the commutator shaft.



- By holding the carbon brush spring with the help of tool 03-KDAL 5030, twist the tool, straighten the bent portion of the brush holding spring on the brushes which are connected to the excitation winding. Take out the springs (29) and pull out the carbon brushes from the brush holder.

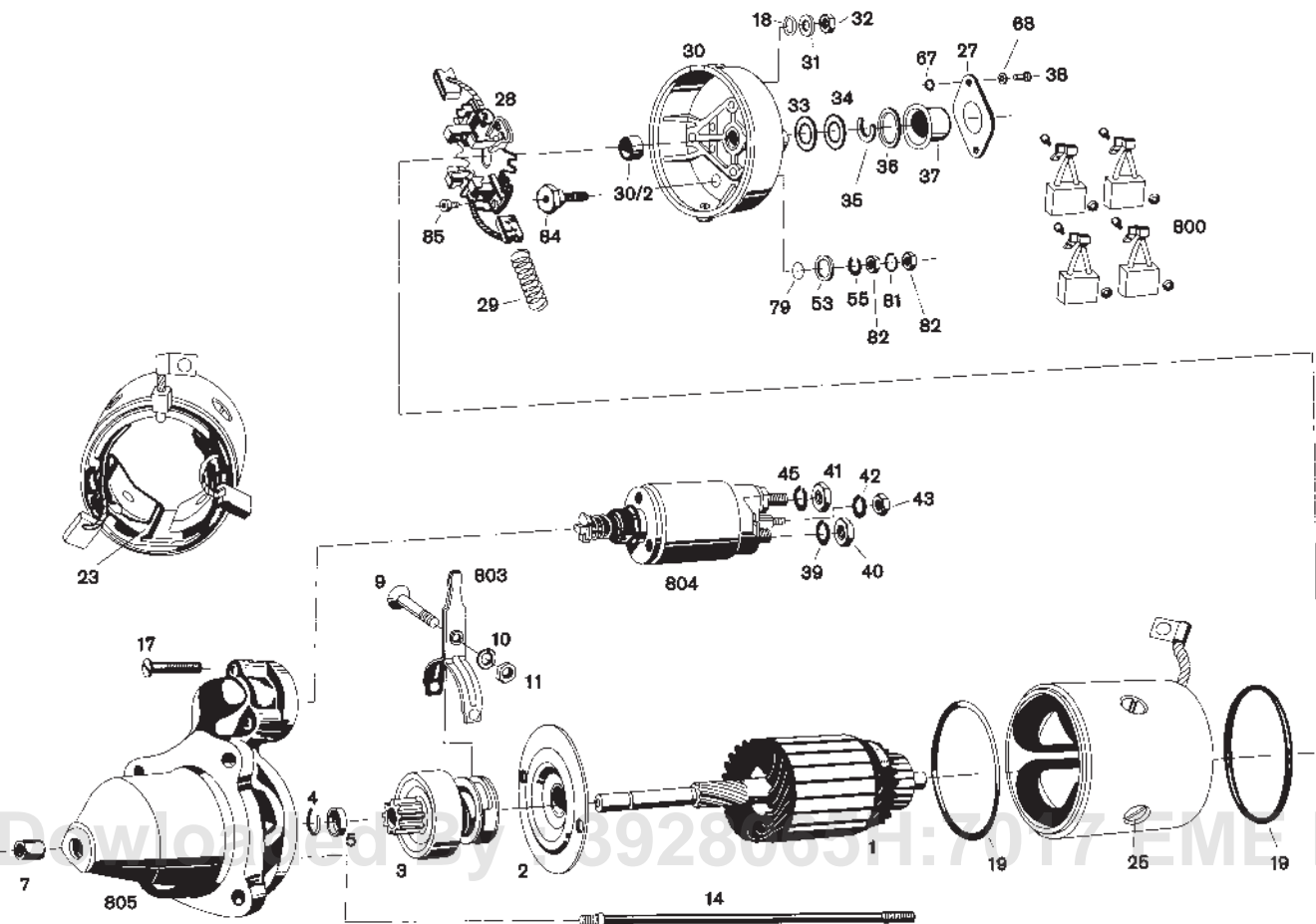


**Note orientation of tool during dis-assembly of spring as shown in figure.**



- By engaging the tool 03-KDAL 5035 in the four holes provided on the brush holder (28), withdraw the brush holder from the commutator.

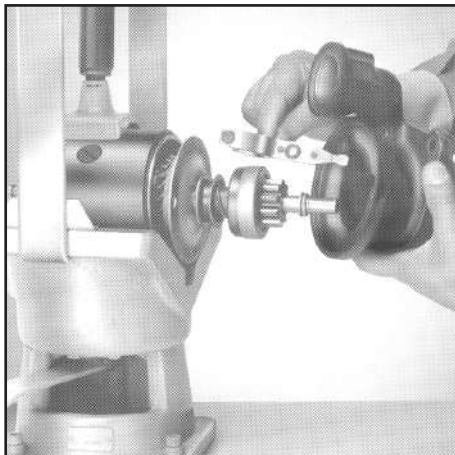
## EXPLODED VIEW OF IF STARTER



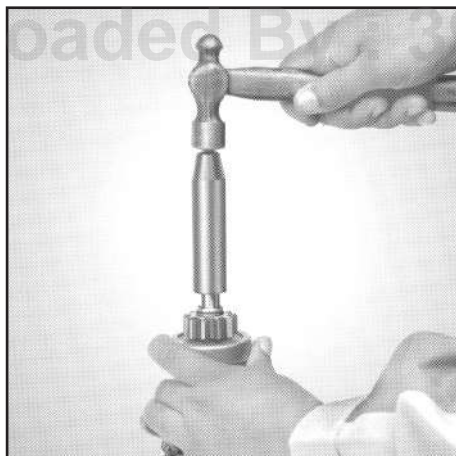
ILL. No.	Description	Qty.	ILL. No.	Description	Qty.
1	ARMATURE	1	32	HEXAGON NUT	3
2	INTERMEDIATE BEARING	1	34	SHIM	AR
3	OVERRUNNING-CLUTCH	1	34	SHIM	AR
4	RETAINER	1	34	SHIM	AR
5	STOP RING	1	34	SHIM	AR
7	SINTERED BUSH	1	34	SHIM	AR
9	COUNTERSUNK WOOD SCREW	1	35	LOCKING WASHER	1
10	WASHER	1	36	SEALING RING	1
11	HEXAGON NUT	1	37	CAP	1
14	THREADED PIN	2	38	HEXAGON SCREW	2
804	SOLENOID SWITCH	1	39	SPRING WASHER	2
17	COUNTERSUNK WOOD SCREW	3	40	HEXAGON NUT	2
18	O-RING	2	42	SPRING WASHER	1
19	O-RING	2	53	WASHER	1
23	EXCITATION WINDING	1	67	O-RING	2
27	MOUNTING FLANGE	1	68	FLAT SEAL RING	2
28	BRUSH HOLDER	1	79	GASKET	1
29	SPRING	4	800	CARBON-BRUSH SET	
30	COMMUTATOR END SHIELD	1	803	FORK LEVER	
30/2	SINTERED BUSH	1	805	DRIVE END SHIELD	1
31	WASHER	2			



- Loosen the fork lever fulcrum screw (9) and take out washer (10) and hexagonal nut (11). Loosen the threaded pin (14) from the drive end shield (805).
- Withdraw the drive end shield from the stator, disengage the fork lever from the overrunning clutch and take out the parts.
- Withdraw the armature from the stator.



- Check overrunning clutch for proper functioning by holding the body and turning the pinion. Pinion should rotate only in the direction of rotation of the starter motor.



- Overrunning clutch, intermediate bearing and armature are to be dismantled further only if any of these items are to be dismantled. Using tool 03-KDAL 5496, push back the stop ring (5) by slight hammering. Open the ends of the spring ring (4) with a nose plier and take out the spring ring, stop ring, overrunning clutch and intermediate bearing from the armature shaft.

### Cleaning of Parts

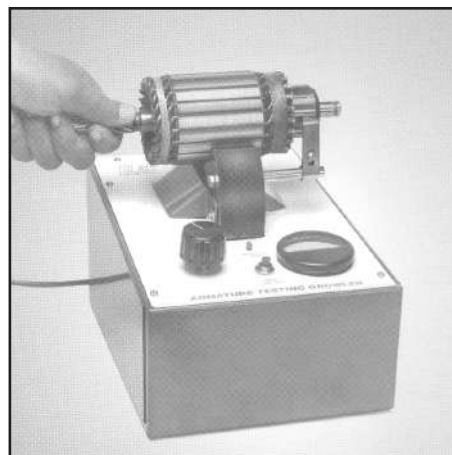
Armature, windings and overrunning clutch must be cleaned only with compressed air (max.4 bar) and a clean rag. Do not use liquid cleaning agent. Other parts such as screws, armature shaft can be washed with low inflammable commercially available liquid.



**Washed parts must be dried thoroughly, otherwise gases may form later leading to explosion.**

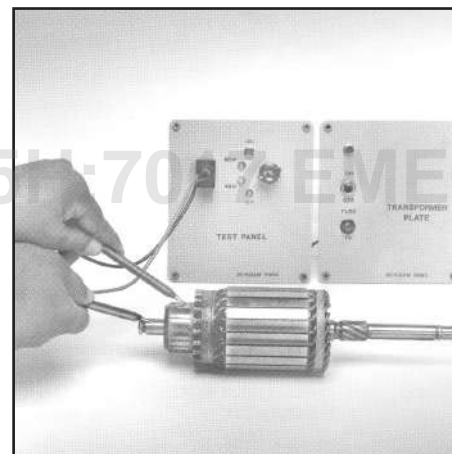
### Testing of Components

#### Testing of Armature



- Check the armature for 'winding short' using 'Growler Test'. Using an iron strip (eg. hacksaw blade). The strip will get stuck wherever armature is short circuited.

Replace the armature, if any windings are short circuited.

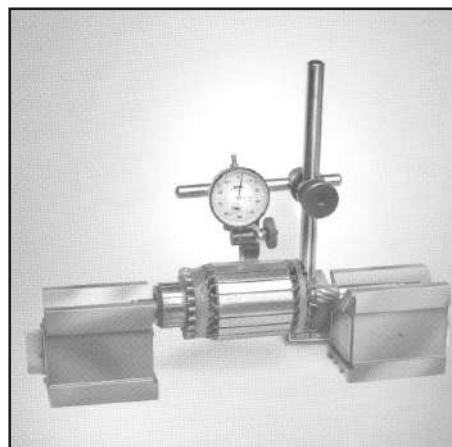


- Test for short circuit to ground using 03-KDAW 9984 and 03-KDAW 9985.

Test voltage: 40V AC for 12V starter. Test voltage: 80V AC for 24V starter.

With one probe on the armature shaft, run the other probe along the circumference of the commutator segments. The indicator lamp should not glow.

Replace the armature, if armature is short circuited to ground (shaft).





- Test the true running of the armature using a V-block, dial gauge stand and dial gauge.

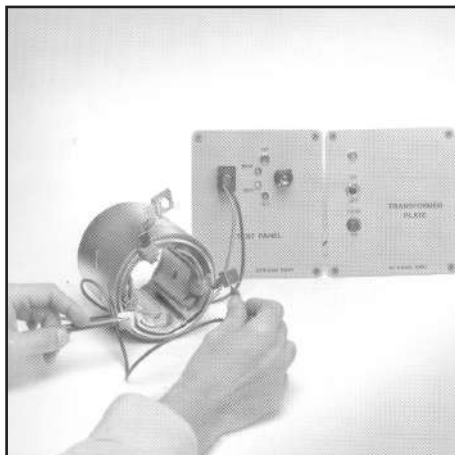
Max. run-out:

At commutator < 0.1 mm

At armature < 0.5 mm (at the centre of laminated cores)

Commutator min. dia. = 42.5 mm

#### Testing of Excitation Winding and Stator



- Test the excitation winding between the two carbon brushes for an open circuit using the tester 03-KDAW 9984 and 03-KDAW 9985.

Test voltage: 6V DC

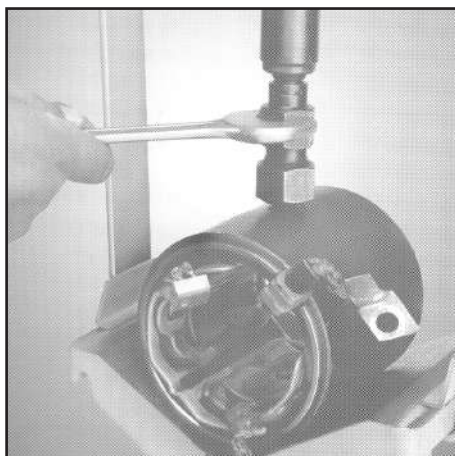
Indicator light should glow if OK.

Test the excitation winding for short circuit to ground between main terminal cable and stator body (yoke) using the above equipment.

Test voltage: 40V AC for 12V starter.

Test voltage: 80V AC for 24V starter.

Indicator light should not glow.



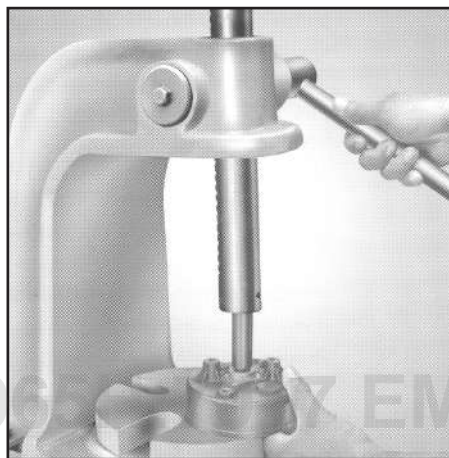
- In case the excitation winding is defective, take it out of the yoke with the pole shoes by placing the yoke on 03-KDAW 9999 and using tool 03-KDAW 9999/1, loosen the pole shoe screws (25). While assembling a new excitation winding, ensure that the main terminal connection side is on the side of the yoke wherein a recess is provided.



To use the tool 03-KDAW 9999/1, first remove the clamping piece from the universal swivelling vice. Insert the tool 03-KDAW 9999/1 on the vice shaft, insert the bit into the slot of screw (25) and tighten the shaft from the top. Use a spanner to rotate 03-KDAW 9999/1 to unscrew pole shoe screw (25).

- Replacing carbon brushes If carbon brushes are worn (min. length 8.5 mm), remove them by de-soldering and assemble the new carbon brush service parts to brush holder by screw and nut provided in the service kit (800).

#### Assembly

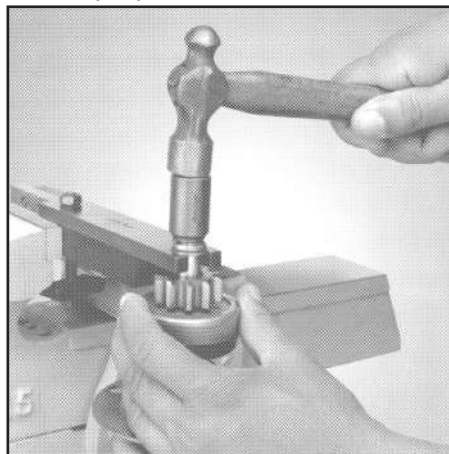


- If there is excessive play between the armature shaft and the bushes on the drive end shield/commutator end cover (7) and (30/2), press out the old bush(es) and press in new bush(es).



Before assembly, the new bush should be soaked in oil for 24 hours.

The bush should not be turned or reamed as this will cover the small pores provided on the surface for lubrication purposes.



- Assemble the intermediate bearing on to the drive end of the armature shaft (projecting step on intermediate bearing facing the armature). Assemble the overrunning clutch and the stop

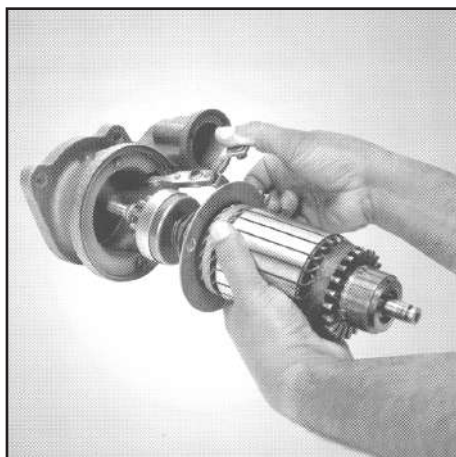


ring (flat side of stop ring facing the overrunning clutch). Assemble the spring ring (4) on the armature shaft. Suspend the armature at the stop ring on the tool 03-KDAL 5487 which is clamped to a bench vice. Force the spring ring into the stop ring using the tool 03-KDAL 5028 or 5029 and by gentle hammering.

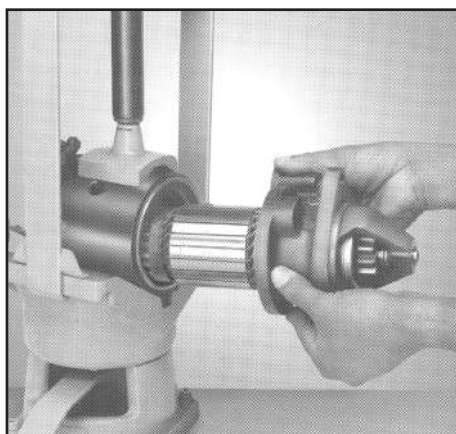
03-KDAL 5028 for armature shaft dia:12 mm

03-KDAL 5029 for 14.2 mm

- Assemble the 'O' ring (19) on to both ends of the yoke.

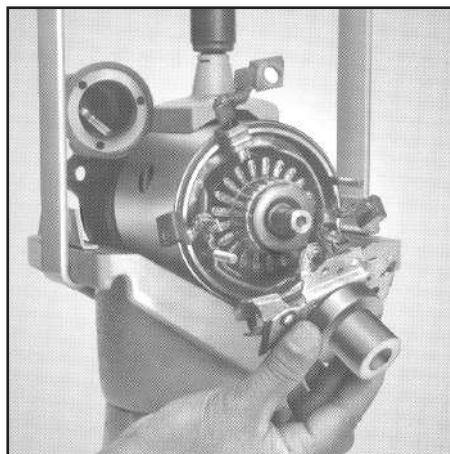


- Introduce fork lever (803) into drive end shield (805). Holding it by hand, engage the studs of the fork lever into the groove of the overrunning clutch(3) assembled on the armature shaft and push the complete assembly into the drive end shield.
- Align fulcrum hole provided on the fork lever with that on the drive end shield and assemble the screw (9), washer (10) and tighten hexagonal nut (11). Ensure proper engagement of fork lever with overrunning clutch by moving the fork lever.
- Assemble the drive end shield with the armature onto yoke. (Drive end shield to be assembled on to yoke opposite to the end wherein the main terminal connection is provided).

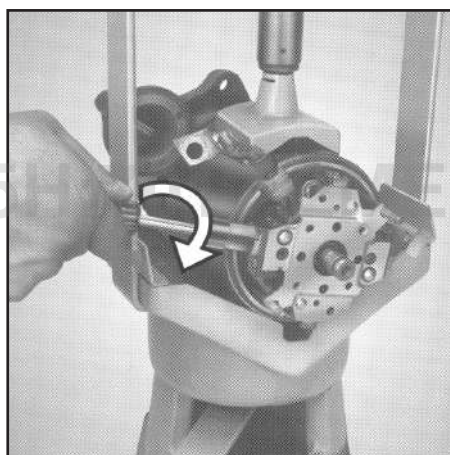


- Introduce threaded pin (14) through the gap provided in the field coil and through the

intermediate bearing holes and tighten to drive end shield. (Threaded end with step to be assembled to the drive end shield).



- Assemble the brush holder plate on to the commutator end of the armature using tool 03-KDAL 5035 such that the threaded pin (14) passes through the slot provided in the brush holder.



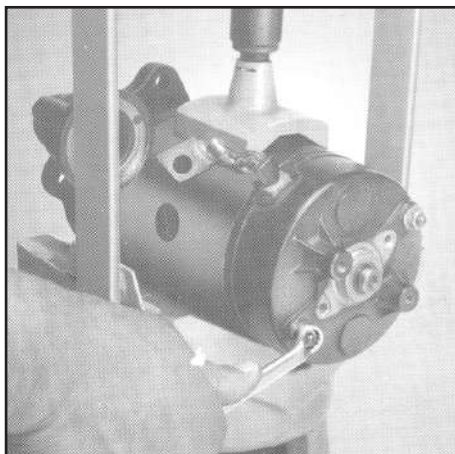
- Position the carbon brushes connected to the excitation winding in the brush holder. Press the pressure spring with tool 03-KDAL 5030 and bend the spring retaining clamp by twisting the tool such that the spring is properly held.



**Orientation of tool during assembly of spring as shown in figure.**

- Assemble the commutator end cover (30) on to the armature such that the slot provided is in line with the main terminal.





- Assemble the 'O' ring (18) and spacing washer (31) on to the threaded pin and tighten the hexagonal nut (32).



- Assemble the original set of compensating washers (33, 34) and the locking washer (35) on

to the Armature shaft and check the total axial play by using the dial gauge stand and dial gauge at the drive end side of the shaft. Select suitable compensating washers (33, 34) such that after assembly, the longitudinal play is 0.1- 0.3 mm.

3.13 Place the sealing washer (36) and the cap (37) on the commutator end cover. Assemble the 'O' ring (67), mounting flange (27), washer (68) on the cap and tighten with the cheese head screw (38).

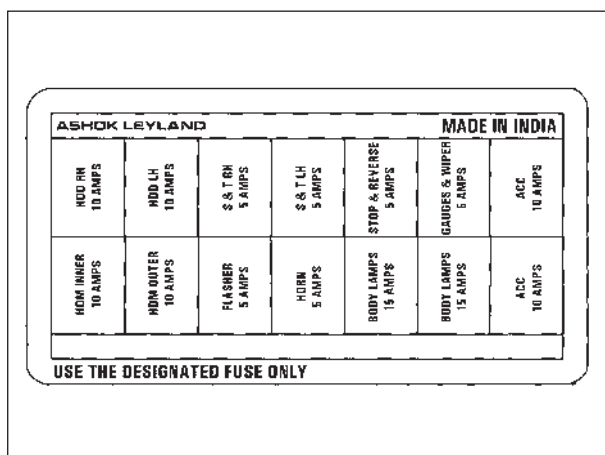
- Engage solenoid armature to the fork lever. Assemble solenoid housing on to the drive end flange. (Ensure that the supply terminal on solenoid is closer to the main terminal wire). Tighten the solenoid by countersunk screws (17).



- Connect the main terminal to the solenoid, assemble washer (39) and tighten the hexagonal nut (40). Ensure that the main terminal does not touch the stator at any point.

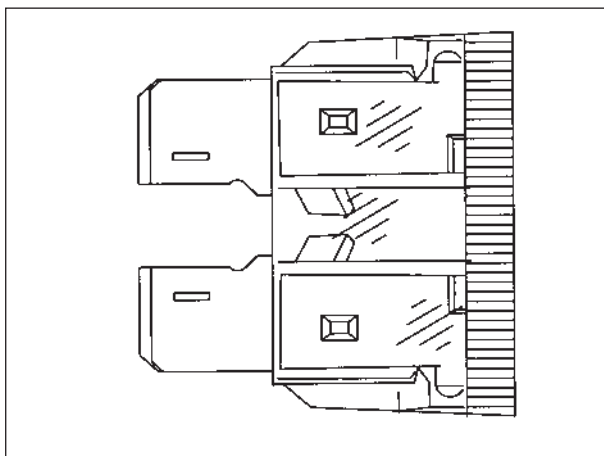
#### SERVICE TOOLS AND EQUIPMENT - IF STARTER

Sl. No.	Description	Alpha No./ Part No.	Application
1	Swivelling vice	03-KDAW 9999 9 689 033 060	For mounting the starter motor for dismantling/assembly.
2	Spring holder	03-KDAL 5030 9 689 034 123	For holding the carbon brush springs while bending brush holder ends.
3	Brush holder	03-KDAL 5035 9689034 124	For holding the carbon brushes while removing/ assembling brush holder on to commutator.
4	Ram	03-KDAL 5496 9 689 034 125	For pushing out the stop ring.
5	Test panel	03-KDAW 9984	For checking shorting/open circuit of stator/armature. Used in conjunction with 03-KDAW 9985.
6	Transformer panel	03-KDAW 9985	For supplying power to test panel 03-KDAW 9984.
7	Pole shoe screw remover	03-KDAW 9999/1 9689034 122	For removing the pole shoe screw from yoke. Used in conjunction with 03-KDAW 9999.
8	Holding tool	03-KDAL 5487 F 002 H31 104	For holding armature while assembling spring ring.
9	Sleeve	03-KDAL 5028 (for 12 mm) 9 681 033 340 03-KDAL 5029 (for 14 mm) 9 681 033 341	For assembling spring ring into the stop ring.

**60.8 FUSE BOX**

Fuse box consists of 12/23 fuses for circuit operations and two spare fuses. The lamps/units protected by the fuses and the corresponding fuse ratings are indicated on the fuse box cover.

An additional fuse box is given separately for EDC. It consists of 6 fuses namely Diagnostic fuse (5 Amps), input fuse (30 Amps) and output fuse (30 Amps) etc., A separate 15 Amps fuse is provided in the battery cable.

**Fuses Replacement/checking**

The fuses mounted in the fuse holders of fuse box are located under the dashboard. To check or replace a fuse remove the cover. Fuses can be checked without removing from their position. Refit the cover after replacement/checking.

**Relays**

The following relays are fitted in electrical system

1. Low Air Pressure
2. Directional indicators and hazard warning lamps,
3. Head lamp

The following 3 additional relays are used for EDC system.

1. Main Relay
2. Ignition Relay
3. Hold on Relay

Additional 2 more relays for vehicles with starting and stopping controlled by ECU.

## 60.9 HEAD LAMP

### DESCRIPTION

The Headlamps incorporate a 7" light unit consisting of a combined aluminised metal reflector and front lens assembly. The prefocus bulb is seated in a sleeve attached to the rear of the reflector to ensure present positioning of the filaments with respect to the focal point of the reflector.

The lamp body is water proofed, the cable inlet being sealed by means of grommet. The front rim is secured by countersunk screw. The block pattern lense light unit is clamped to seating rim by unit retaining rim and secured by three self tapping screws. The seating rim is carried on three spring loaded adjustment screws.

### LIGHT UNIT

The construction of the light unit ensures that the reflector is permanently protected with obvious advantage to its efficiency. The Discolouring effect of dirt and water ingress is obviated by lens in the reflector and fitting a flanged prefocus bulb. The outer surface of the lens is smooth to facilitate cleaning but the inner surface has formed in it a series of lens which determine the spread and pattern of the light beam. In conjunction with double filament (main and dip) bulbs, this lens produces a pre determined spread of light and the beams are designed for dipping to the left. The letters RHD (Right Hand Drive) are moulded into the glass. While dip filaments are positioned above the main filaments, they are also displaced to the right for RHD light units. It is thus important always to fit the correct replacement bulb.

### BULB

The headlamps employ, 54/44 (24 volt) bulbs the higher rated filament provides the mains or driving beam and the lower rated filament, the dipped or meeting beam, change over from one to the other beam is controlled by a suitable switch. The prefocus bulb eliminates the need for any focus device in the lamp. Prefocus bulbs are normally cylindrical in shape so as to reduce the overall diameter to a minimum, an important feature where the bulb is fitted through an aperture in the rear of the reflector. "Pre focus" bulb caps are carried on flanges accurately positioned in relation to the filaments. To ensure correct fitting of the bulbs in the light unit, a slot in the flange engages with a projection on the inside of the bulb sleeve at the rear of the reflector.

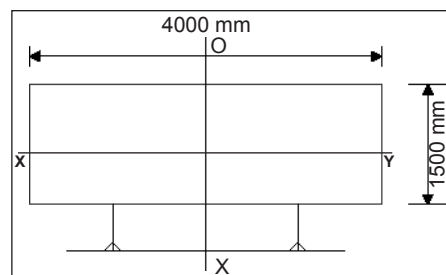
Bayonet fitting bulb holders with spring loaded supply contacts secures the bulbs firmly in position.

### REMOVAL OF RIM LIGHT UNIT AND BULB

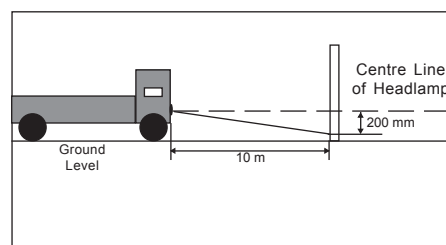
Unscrew the rim securing screw and lift off the rim and rubber dust excluder. Press the light unit against the tension of the adjustment screws and turn it in an anticlockwise direction until the heads of the screw can be disengaged through the slotted holes in the light unit seating rim. Do not disturb the screws when removing the light unit or the lamp setting will be altered.

Remove the light unit as stated above and turn the bulb holder in an anticlockwise direction until spring pressure disengages the holder locating pegs in the bulb holder. The bulb cap now be removed and the new bulb fitted.

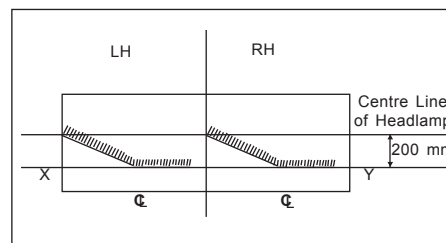
### HEAD LAMP INITIAL SETTING



A screen of 4000 x 1500 mm as shown in the sketch needs to be made out preferably with white board and suitable stand.



Park the **unladen** vehicle 10 meters away from the screen in such a way that the centre line of the vehicle is in line with screen centre vertical line OX of the screen. The screen should be in a vertical position parallel to the front of the vehicle. A dark environment near screen will assist in viewing head lamp beam position clearly.



Draw a horizontal line XY on the screen at a height of 200 mm below the centre line of the head lamp.

**Ensure that the levelling switch is kept at '0' position and vehicle is empty.**

Cover one head lamp and switch the head lamp on to dipped beam.

Head lamp dipped beam pattern, as shown in the figure will be seen in the screen. Align horizontal line of dipped beam light pattern on screen with the line XY, by adjusting head lamp mounting screws.

Repeat this initial alignment procedure for other head lamp also.

**Recheck head lamp initial alignment whenever head lamp is replaced. Also ensure the initial set value of head lamp dipped beam after any change in head lamp mounting / suspension system.**





TABLE-I: HEAD LAMP MATRIX (WITH LEVELLING DEVICES) COMPLYING TO AIS 012 - 2004 STANDARDS

SL. NO.	VEHICLE TYPE	CABIN TYPE	TYPE OF HEAD LAMP	VOLTS	BULB TYPE	SUPPLIER	BULB DESIGNATION
1	G45 - All 4x2 Tractor, Haulage (below 203" WB) & Tipper	G45 FES	With Levelling Device (Round)	24V	H4	Hella India Lighting/ Luman	H4 - 75/70W T4W - 4W
2	MAV -2516 Cargo	Cabin	With Levelling Device (Rectangular)	24 V	H4	Luman	H4 - 75/70W T4W - 4W
3	SFC Haulage and Tipper	SFC FES	With levelling Device (Round)	24V	H4	Hella India Lighting/Luman	H4 - 75/70W T4W - 4W
4	Passenger (Below 203" WB)	Pass Cowl	With Levelling Device (Round)	24V	H4	Hella India Lighting/Luman	H4 - 75/70W T4W - 4W

TABLE-I: HEAD LAMP MATRIX (WITHOut LEVELLING DEVICES) COMPLYING TO AIS 012 - 2004 STANDARDS

SL. NO.	VEHICLE TYPE	CABIN TYPE	TYPE OF HEAD LAMP	VOLTS	BULB TYPE	SUPPLIER	BULB DESIGNATION
1	All MAV	G45 FES	Without Levelling Device (Round)	24V	R2	Hella India Lighting/ Luman	R2 - 55/50W T4W - 4W
2	Passenger (203" WB and Above)	Pass Cowl	Without Levelling Device (Round)	24V	H4	Hella India Lighting/Luman	H4 - 75/70W T4W - 4W (Water Proof connector)
3	12m Bus	Pass Cowl					

TABLE-III: HEAD LAMP DIPPED BEAM ORIENTATION - SWITCH POSITION  
(Applicable for models with Head lamp Levelling Devices)

SN	VEHICLE TYPE	CABIN TYPE	SWITCH POSITION TO MEET THE AIS 008 REQUIREMENTS	
			UNLADEN CONDITION	LADEN CONDITION
1	G45 (All 4 x 2 Tractor, Haulage & Tipper)	G45 Cowl	0	1
2	MAV (Cargo Cabin)	Cabin	0	1
3	SFC Haulage and Tipper	SFC FES	0	1
4	Passenger (All models below 203"WB - 193"/176"/170.5"/154")	Passenger Cowl	0	1

**60.10 TIGHTENING TORQUE**

	Nm	lb-ft	kgm
Through stud nut	9-11	6.7 - 8.2	0.9-1.1
Solenoid fixing screw	6.2	4.6	0.62
Earth stud (BG) bottom nut	7-8	5.2 - 6	0.7 - 0.8
Earth stud (BG) top nut	Hand tight		
Pivot pin nut	20.8	15.4	2.08
Starter terminal top nut	5.2	3.9	0.52
Battery terminal top nut	Hand tight		
Solenoid top terminal nut	Hand tight		



## 60.11 MAINTENANCE SCHEDULE

MAINTENANCE ACTIVITY		PDI	Daily	Weekly	Every km x 1000	Remarks
1	Check the battery electrolyte level. Top up if necessary with distilled water only	✓		✓	8	
2	Check all the electrical connections	✓		✓	8	
3	Check battery terminals. Apply petroleum jelly	✓		✓	8	
4	Check all lights, switches, gauges, wiper and horn for correct functioning, rectify if necessary		✓			
5	Check battery cells - voltage and specific gravity, rectify if necessary				16	

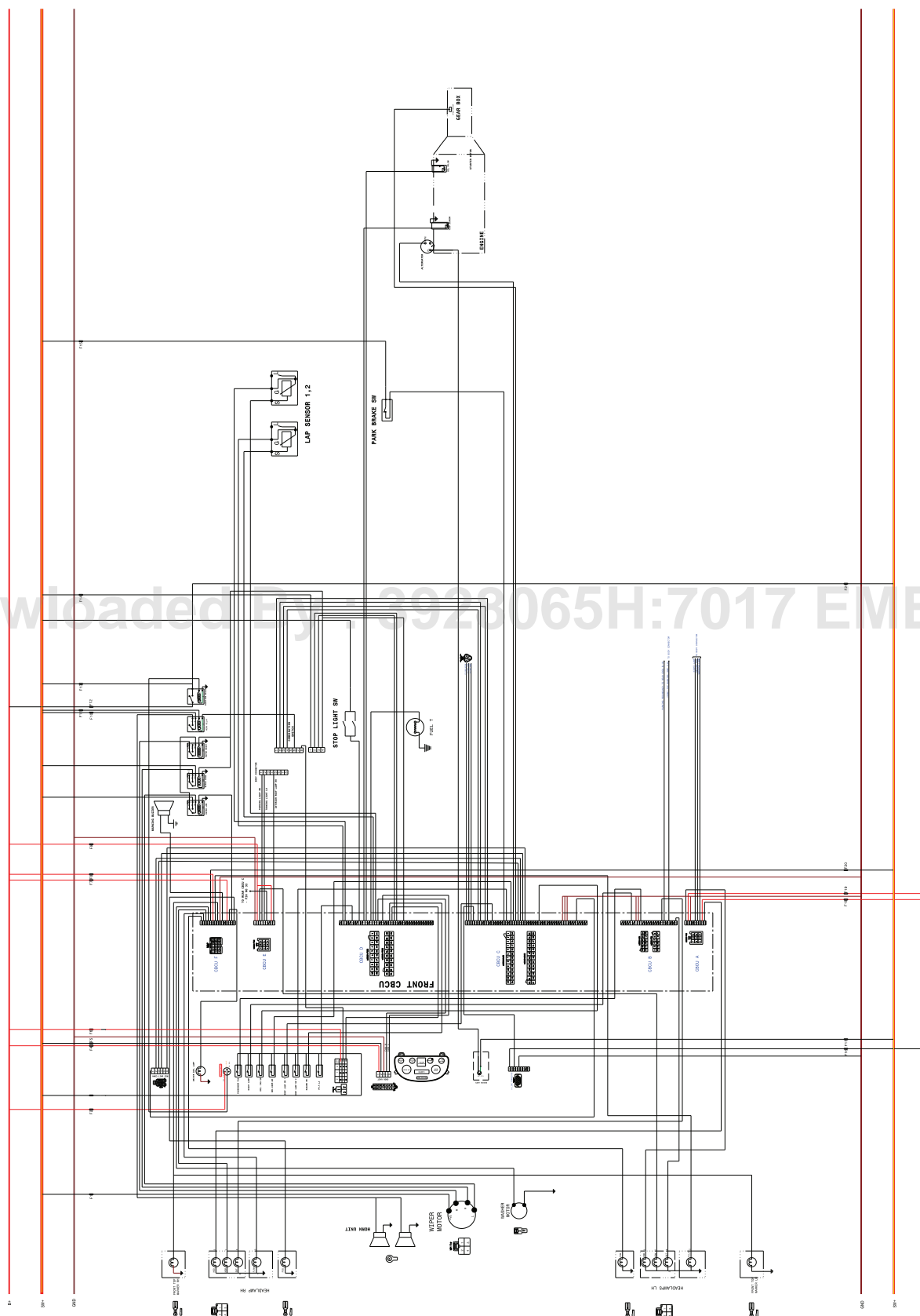
Downloaded By : 3928065H:7017 EME Bn

Downloaded by 3912050177 EME Bn

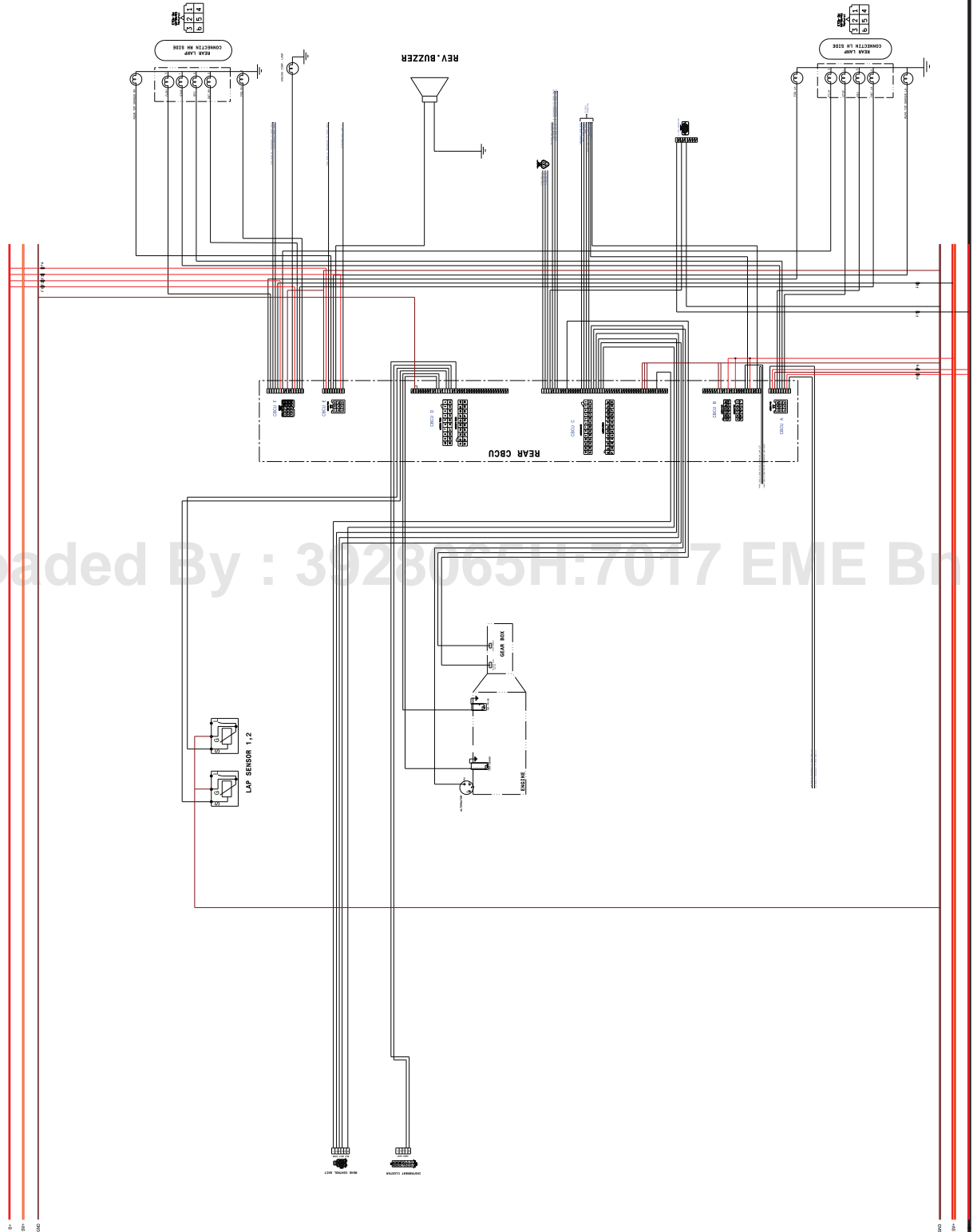
# **ANNEXURE**

## **WIRING DIAGRAM**

## FRONT CBCU SCHMATIC FOR RESLF DIESEL BUS - BSIII

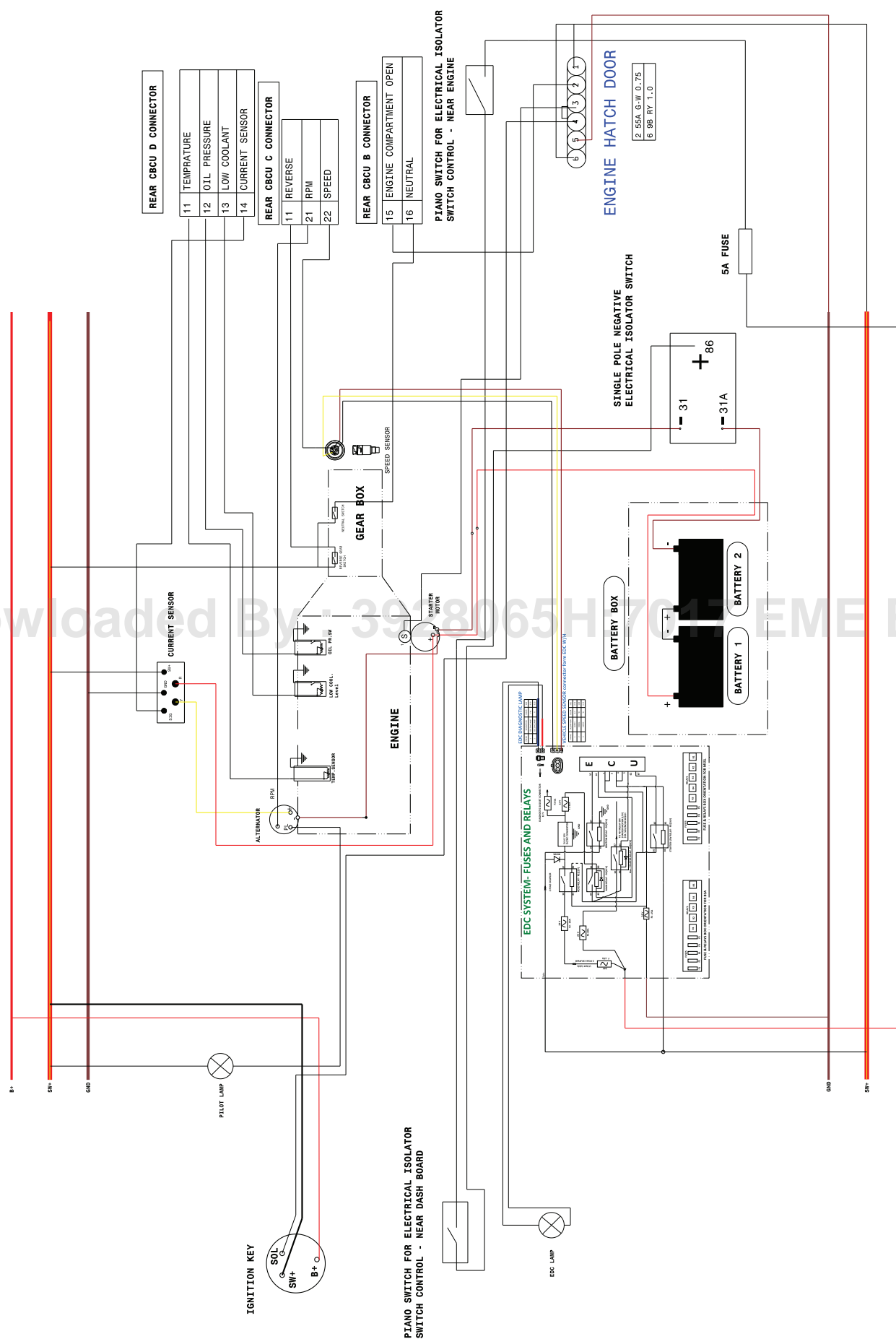


# **REAR CBCU SCHMATIC FOR RESLF DIESEL BUS - BSIII**

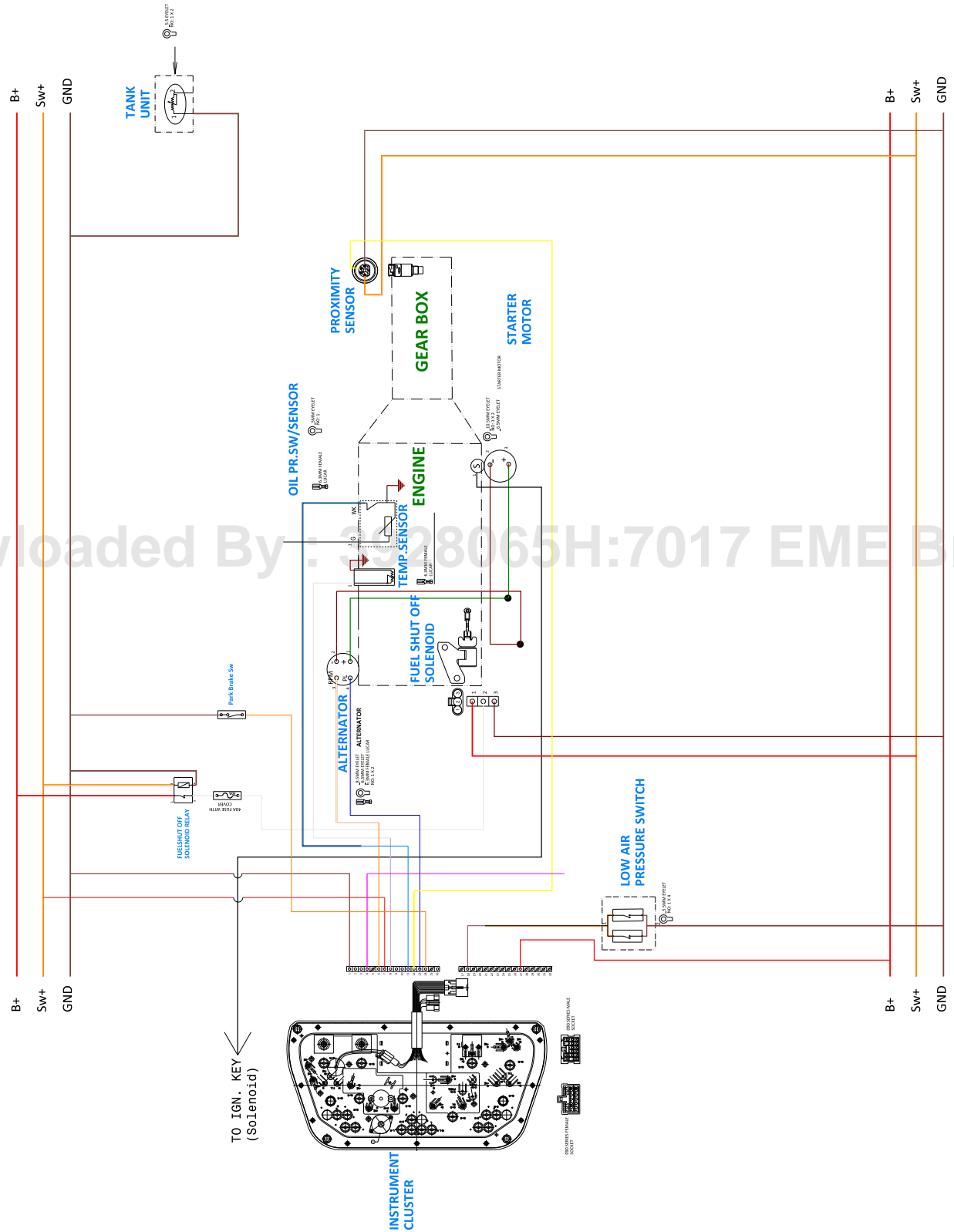




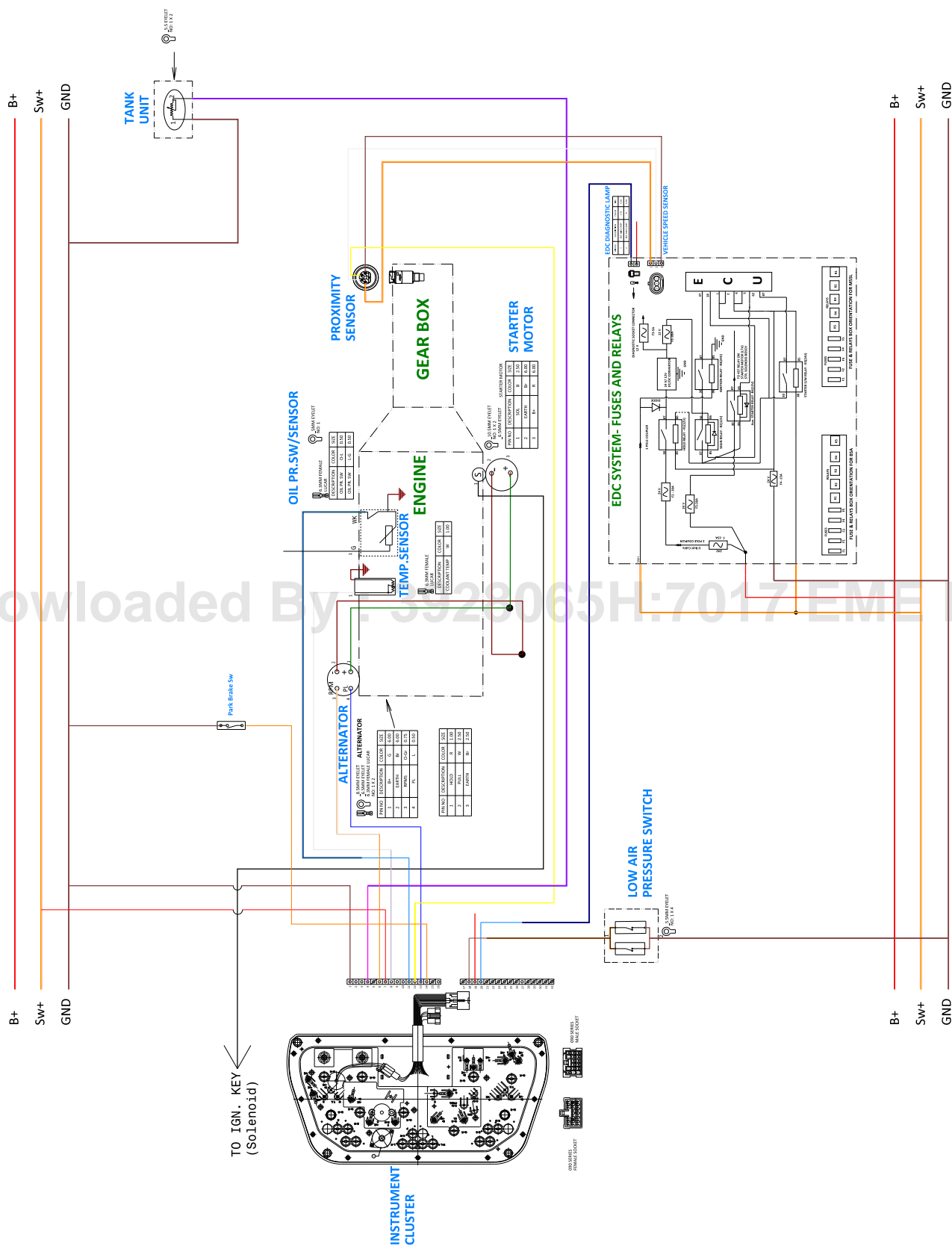
The diagram illustrates the electrical connections for the current sensor and starter motor. A red wire from the positive terminal of the battery (+) connects to the positive terminal of the starter motor. Another red wire connects the negative terminal of the battery (-) to the negative terminal of the starter motor. The current sensor is connected in series with the positive line leading to the starter motor. Labels include "CURRENT SENSOR", "STARTER MOTOR", and "BATTERY BOX".



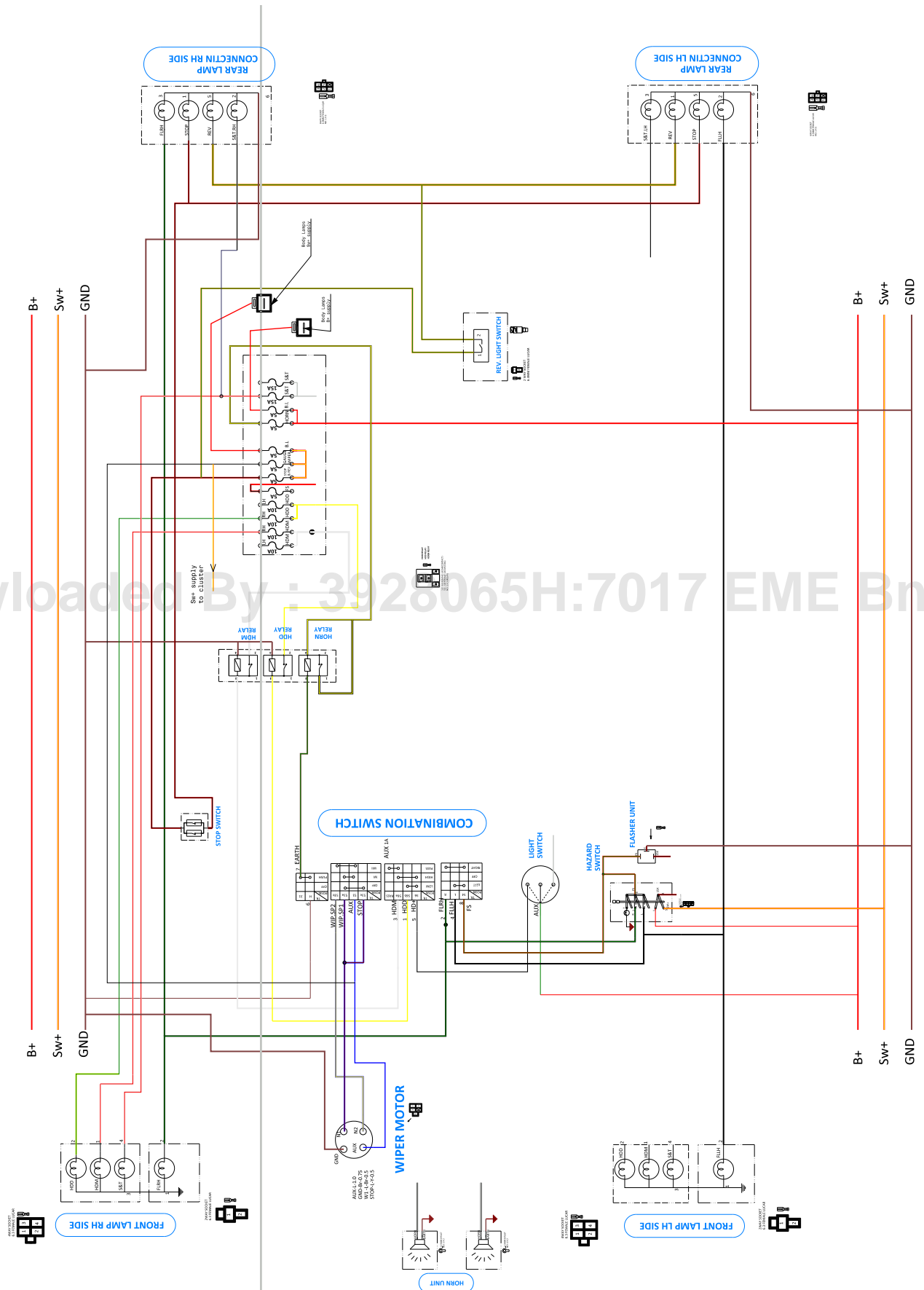
# CIRCUIT STARTING, CHARGING, SENSORS AND GAUGES, FOR PASSENGER WITH INLINE PUMP



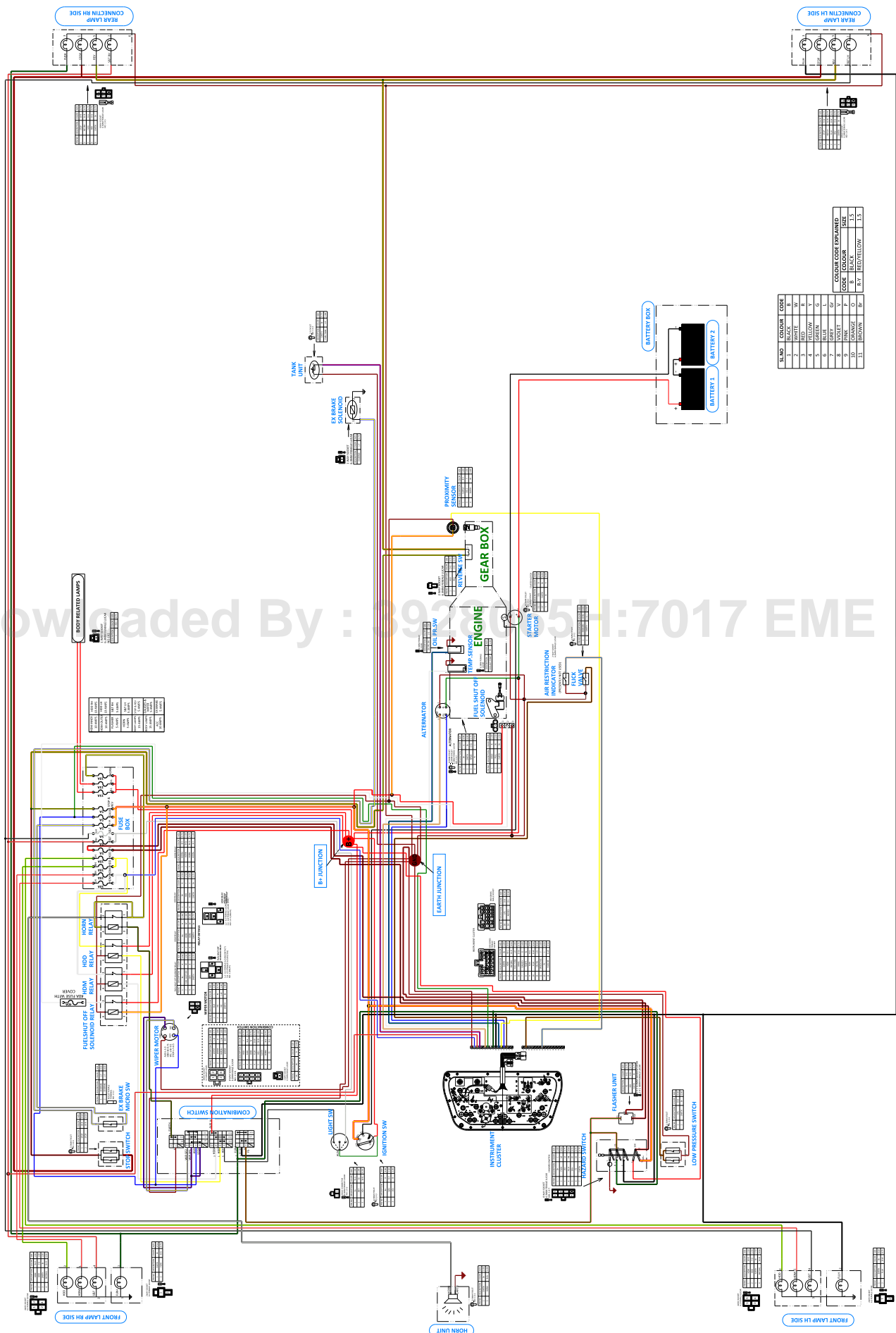
## CIRCUIT STARTING, CHARGING, SENSORS AND GAUGES, FOR PASSENGER WITH VP37 PUMP



# LAMPS AND WIPER MOTOR CIRCUIT FOR PASSENGER

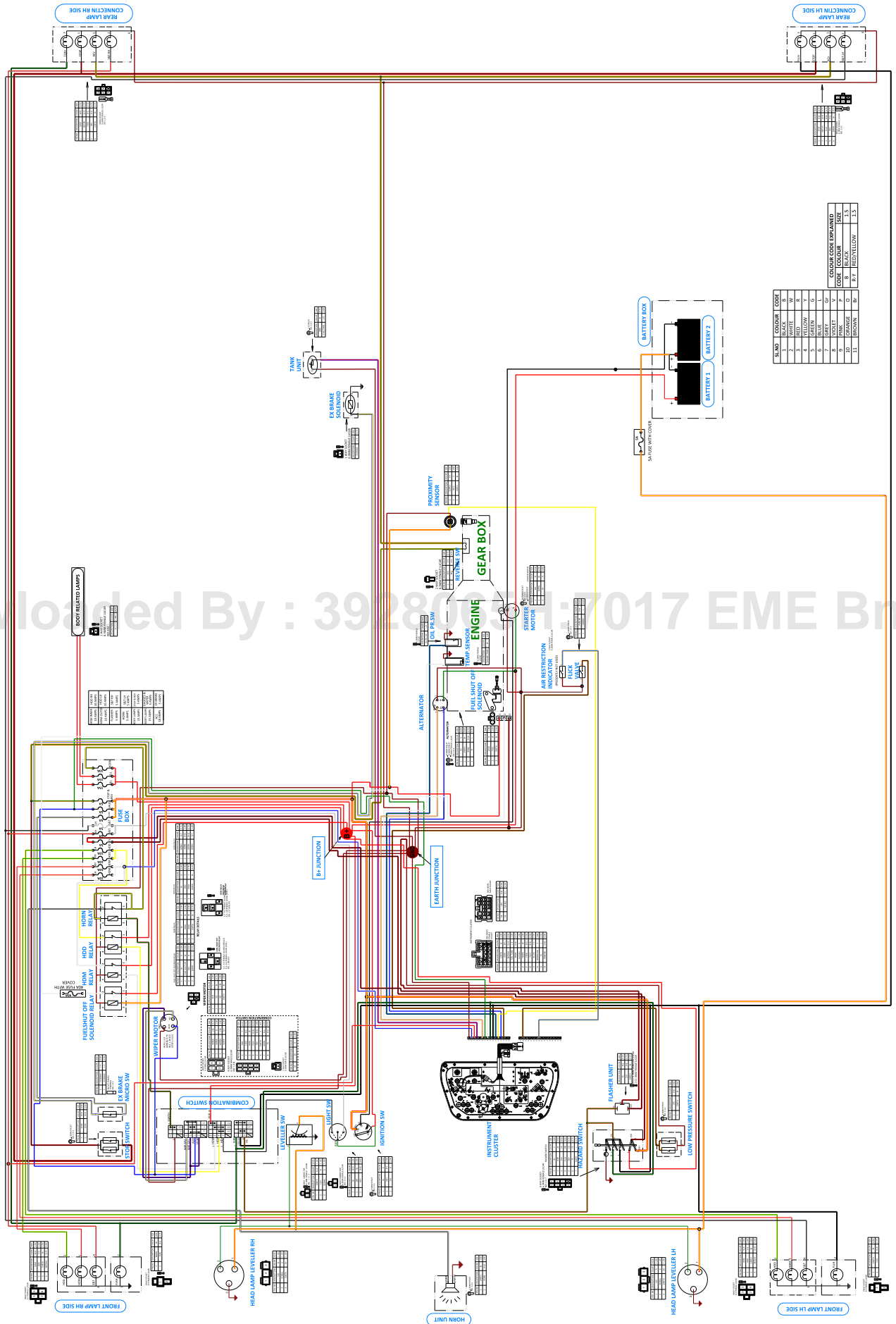


# CIRCUIT DIAGRAM - 2516IL WITHOUT HEADLAMP LEVELLER

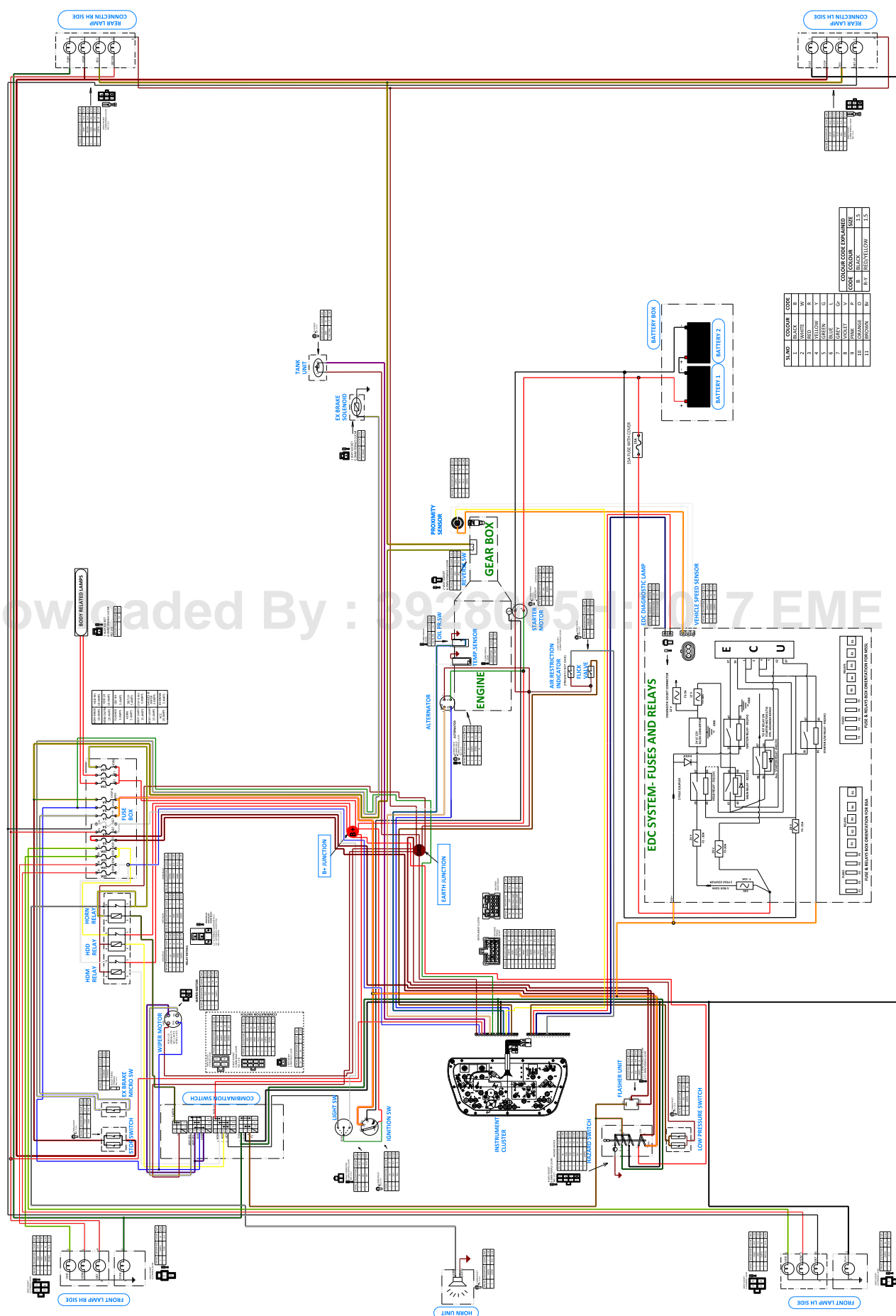




# CIRCUIT DIAGRAM - 3116IL AND 1616IL WITH HEADLAMP LEVELLER



## CIRCUIT DIAGRAM - 2518 WITHOUT HEADLAMP LEVELLER - EDC15



# CIRCUIT DIAGRAM - 3118 AND 1616 EDC15 WITH HEADLAMP LEVELLER

