



सत्यमेव जयते
GOVERNMENT
OF INDIA
MINISTRY OF
RAILWAYS

एसी.ईएमयू एवं एमईएमयू की टैक्शन मोटर
की
अनुरक्षण की लघुपुस्तिका

**MAINTENANCE HANDBOOK
ON
TRACTION MOTOR OF AC EMU & MEMU**

**TARGET GROUP - AC EMU/MEMU MAINTENANCE STAFF AND
SUPERVISORS**

CAMTECH/E/2004/EMU-TM/1.0

कैमटेक/ई/2004/ईएमयू-टीएम /1.0

March, 2004

मार्च 2004

**Centre
for
Advanced
Maintenance
TECHnology**



Excellence in Maintenance

ॐ श्रीगणेशाय नमः, म. रेलवे मंत्रालय -

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FOREWORD

With increasing passenger traffic, reliability and availability of AC EMU/MEMU has become very important. Proper maintenance of traction motor is vital to ensure good reliability and availability of AC EMU/MEMU.

CAMTECH has prepared this handbook to cover all essential aspects of maintenance and overhauling of traction motor. It describes various maintenance schedules, overhauling procedure and trouble shooting for common failures.

I am sure the book will prove to be very useful for our maintenance staff in AC EMU/MEMU Car sheds and workshops.

CAMTECH, Gwalior
Date :25th March, 2004

C.B.Middha
Executive Director

PREFACE

Traction motor is one of the most important equipment of AC EMU/MEMU which provides driving power to the wheel. Its proper upkeep and maintenance is necessary to ensure good reliability and availability of AC EMU/MEMU.

This handbook on maintenance of traction motor has been prepared by CAMTECH with the objective of making our maintenance personnel aware of correct maintenance and overhaul techniques to be adopted in field.

It is clarified that this handbook does not supersede any existing provisions laid down by RDSO or Railway Board and it is not a statutory document.

I am sincerely thankful to Director (PS & EMU) RDSO/LKO for his valuable comments. I am also thankful to all field personnel who helped us in preparing this handbook.

Technological upgradation and learning is a continuous process. Hence feel free to write to us for any addition/modification in this handbook. We shall highly appreciate your contribution in this direction.

CAMTECH, Gwalior
Date :24th March, 2004

Randhawa Suhag
Director Electrical

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ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows :

CAMTECH/2004/E/EMU-TM/C.S. # XX date-----

Where “XX” is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

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CHAPTER 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

Traction motor is one of the most important equipment of AC EMU/MEMU. In AC EMU/MEMU, Traction Motor type 4601 AZ/BZ/BY/BX manufactured by BHEL is used. It is a D.C. series wound, four poles, self ventilated motor arranged for axle mounting on sleeve bearings and supported on the opposite side by resilient suspension unit. The flanges of the axle suspension bearings limit transverse movement. Since this is a D.C. series motor, it is having commutator and brush assemblies, therefore it requires regular maintenance.

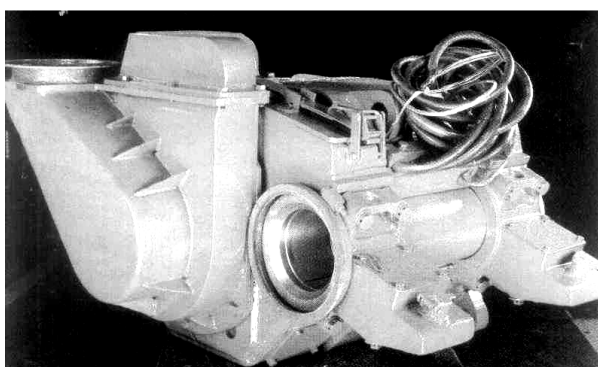


Figure 1.1 TRACTION MOTOR 4601 AZ

1.2 TECHNICAL DATA

1.2.1 Rating

	Continuous	One hour
Voltage	535 V	535 V
Current	340 A	380 A
RPM	1260 rpm	1182 rpm
Power	167 KW	187 KW

1.2.2 Resistance Values (Average at 25 deg. C in ohms)

Armature winding	0.0186
Series field winding	0.0103
Commutating field winding	0.009

1.2.3 Armature

Core Diameter	457.2 mm
Core length	260.50 mm
Distance between bearing end faces	575.35 mm
Overall length of armature	975.00 mm

1.2.4 Armature Permanent Banding Res-I-Glass

Material	0.33t k x 20mm wide Res-I-glas Tape
Turns on PE winding	100
Turns on CE winding	105
Banding tension	190 – 205 Kg

1.2.5 Commutator

Length of working face	99mm
Diameter – New	324/325.5 mm
Diameter-min. permissible	305 mm
Mica thickness	1.14mm
Depth of Mica undercut	0.8 to 1.3mm
Permissible ovality	0.03 mm

1.2.6 Insulation Class

Armature	H
Field	F
Insulation level	1000V

1.2.7 Brush Gear

No. of brush arms	4
Brush holders per arm	1
No. of brushes per arm	2
Type of brush	Half width, split Rubber top.
Brush grade	EG 14D (I) ACPL (Morgan), E88 x (I) ELCA (S&E), EG 7097 Lecarbhone
Brush length	60 mm New
Width	44.45 mm
Thickness over two halves	25.4 mm
Minimum scrapping length (condemn size)	32.0 mm
Clearance between brush holder and commutator	1.6 to 3.2 mm
Brush holder spring tension	2.7 – 3.65 kg
Arc horn gap (in maintenance)	11 to 12 mm

1.2.8 Pole Bores – Average

Mainpole (at centre)	463.0mm
Compoles (at centre)	467.6 mm

1.2.9 Liner at Back of Poles

Main pole	1 liner 1.6 mm brass
Com-pole	1 liner 2.5 mm brass
	1 liner 1mm steel

1.2.10 Armature Bearings

Armature bearings	Pinion end	Commutator end
Manufacturer	SKF/FAG/NSK/NTN	SKF/FAG/NSK/NTN
Type	NU 326M/C4 VA 301	NUP 318 VA 301
Diametrical clearance of free bearing when new	0.145 to 0.190 mm	0.105 to 0.140 mm
Diametrical clearance after assembling	0.03 to 0.13 mm	0.03 to 0.10 mm
Fit between inner race and shaft	0.035 to 0.08 mm interference	0.025 to 0.06 mm interference
Fit between outer race and bearing housing	0.025 mm interference to 0.35 mm clearance	0.020 mm interference to 0.030 mm clearance
Main permissible radial clearance when assembled	0.03 to 0.13 mm	0.03 to 0.10 mm
Housing dimensions	279.97 – 279.99 mm	189.98 – 190.00 mm

1.2.11 Earth Return Brushes

Brush grade	BE 14Z1 (ELCA) CM1S (Morgan OEM)
Size	New – 53.5 mm Condemn – 34.4 mm

1.2.12 Weights (Approximate)

Motor complete with gear & gear case	2035 Kg
Motor complete including axle caps, axle bearings & pinion but without gear wheel gear case	1812 Kg
Armature	520 Kg
Gearcase	85 Kg
Pinion	9 Kg

1.2.13 Lubrication

1.2.13.1 Armature Bearing

	PINION END	COMMUTATOR END
Type of grease	Esso Andok-BR,	Esso Andok-BR,
Alternative grease	Lithon-3 (HPC), Servogem RR3 (IOC)	Lithon-3 (HPC), Servogem RR3 (IOC)
Quantity for first fill	550 Gms	315 Gms
Replenishment period	During POH	During POH

1.2.13.2 Axle Suspension Bearings

Recommended lubricant	SERVO-SYSTEM-57 (SS 57)
Quantity of lubricant in each cap	2.4 litres

1.2.13.3 Gears

Recommended lubricant	Geartak-2 (HPC), Caltex Crater No. 2 or Bharat Camex Compound-F (BPC)
Quantity of lubricant in gear case	1.7 Kg at min. level 3.4 kg at max. level

1.2.14 Torque Spanner Settings

The values specified are for bolts with lubricated threads

Axle cap bolts, M24		62-64 Kg.m.
Gear case mounting bolts, M36		97-99 Kg.m.
Gear case joints bolts, M30		50-55 Kg.m.
Main pole bolts M24 (For 2 bolts fitting)		40-42 Kg.m.
Com pole bolts M24 (For 2 bolts fitting)		30-32 Kg.m.
Main pole bolts M20 (For 3 bolts fitting)		28-32 Kg.m.
Com pole bolts M20 (For 3 bolts fitting)		25-27 Kg.m.
Commutator bolts during seasoning –		
	Hot	16.5 Kg.m.
	Cold	14.0 Kg.m.
End shield PE M20		25-27 Kg.m.
Bearing cartridge M12		6-7 Kg.m.
Brush holder to frame		15-16 Kg.m.
Gear case joint bolt M20		16-18 Kg.m.

1.2.15 Gear ratio**20 : 91 (4.55)****1.2.16 Magnet Frame Bore**

PE side	469.94/ 469.90 mm
CE side	254.032/254.00 mm

1.2.17 Axle Cap/Way Bore

206.477/206.375 mm

1.2.18 Distance between axle centre line and main bore centre line

393.70/393.94mm

1.2.19 Axle Cap Jaw/Spigot

323.850/323.901 mm

1.3 POWER SUPPLY ARRANGEMENTS

All 4 motors are permanently connected in parallel by the four motor contactors M1 to M4. The output from the rectifier assembly is taken through a smoothing reactor and is fed to the motor circuits. Each motor is protected by an overload relay which trips the motor contactor in case of overload. The direction of rotation of the traction motor is reversed by reversing the connections to the motor field windings with the help of reverser. Motors are cooled with filtered air taken from the coach interior.

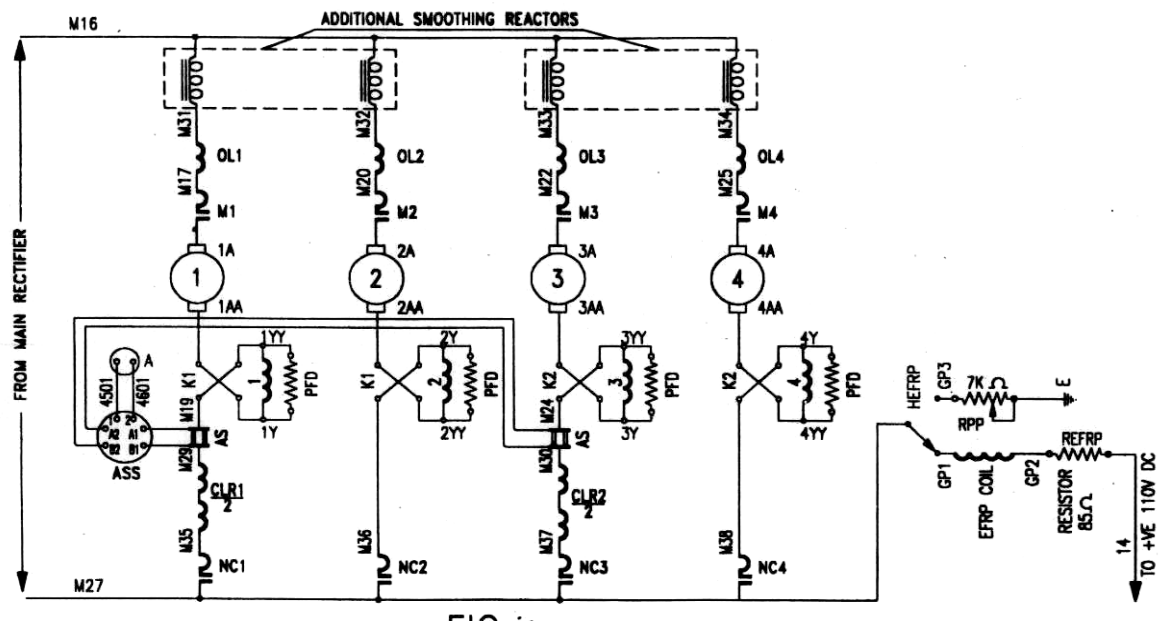


Figure 1.2 TM POWER CIRCUIT DIAGRAM

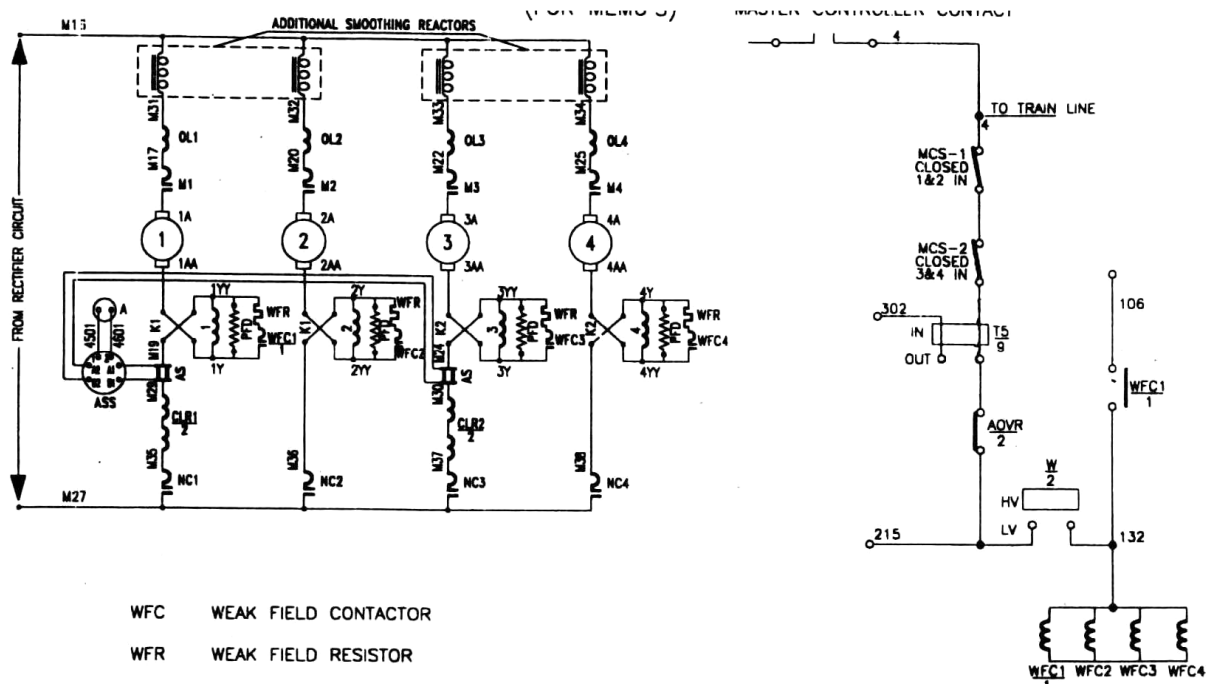


Figure 1.3 TM WEAK FIELD CIRCUIT DIAGRAM FOR MEMU

1.4 CONSTRUCTIONAL FEATURES

Following are the main parts of traction motor type 4601 AZ/BZ/BY/BX.

1.4.1 Armature

It is the rotating part of the motor, consisting of a number of copper conductors suitably placed and connected so as to form a closed winding. Armature core is built up from electrical quality varnished sheet steel laminations assembled on the shaft with interference fit and consolidated under pressure.

The armature has a 40% (80% from traction motor s.no. 4514981, Sept.99 onwards, modified by BHEL) equalization. The armature coils are kapton covered. The armature and equalizer coil leads are TIG welded to commutator risers. The armature coils are held down in the core slots by Epoxy glass wedges and the end windings are secured by Res-I-glass bands. The vacuum pressure impregnated with solventless polyester resin insulating varnish.

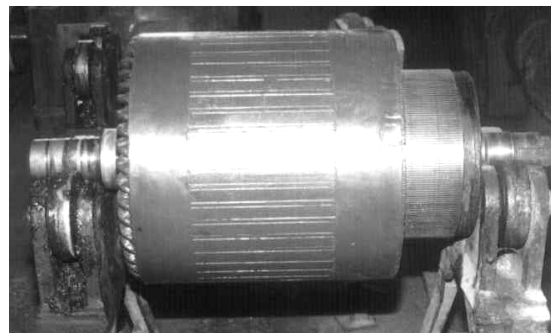


Figure 1.4 ARMATURE

1.4.2 Commutator

The commutator is of arch bound construction built up with hard drawn silver bearing copper segments which are insulated with micanite segments and are assembled with moulded mica insulation between between steel V-rings. After assembly, the commutator is statically and dynamically seasoned to ensure stability. The complete armature is dynamically balanced. The commutator outer mica V-ring is protected with anti-creepage PTFE tape/ring.

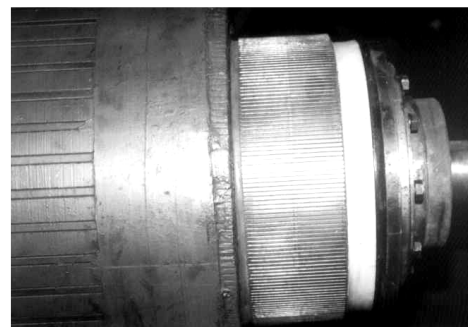


Figure 1.5 COMMUTATOR

1.4.2.1 Commutation

The function of the commutator in d.c. motor is to reverse the direction of current in each conductor as it passes from one pole to another, it helps to develop a continuous and unidirectional torque.

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The function of the commutator in d.c. motor is to reverse the direction of current in each conductor as it passes from one pole to another, it helps to develop a continuous and unidirectional torque.

The current in a particular conductor is in one direction when the conductor is moving under the North pole and in the opposite direction, when it is moving under South pole. This reversal of current in a coil will take place when the two commutator segments to which the coil is connected are being short circuited by a brush. This process of reversal of current in coil is termed as commutation. The period which coil remains short circuited is

very small. If the current reversal is completed by the end of short circuit then the commutation is ideal. If reversal is not completed by that time, then sparking is produced between the brush and the commutator which results in progressive damage to both. The rapid reversal of current in the armature core sets up a self induced emf, generally called reactance voltage, which hinders the reversal of current and tends to decay the current reversal in the coil. As a result, the current in the short circuit coil does not attain its full value in the reversed direction by the end of short circuit. This is the basic cause of sparking at commutator.

1.4.2.2 Method of improving commutation

Arrangement is made to neutralize the reactance voltage by producing a reversing e.m.f. in the short circuited under commutation. For this purpose, special commutating poles (inter poles) are placed mid way between the main poles and wound with comparatively few heavy gauge Cu wire turns, and are connected in series with the armature so that they carry full armature current. The polarity should be opposite to the next main pole in the direction of rotation. The field produced by the interpole winding opposes the armature field.

The mmf developed by the interpole must be stronger than the armature mmf in the neutral zone, because this mmf has to cancel the armature mmf and in addition induce an emf in short circuit coil which opposes reactance voltage and the voltage drop at the brushes.

1.4.3 Stator (Magnet Frame)

The high permeability cast steel of fabricated magnet frame is machined to ensure alignment of the end shields, pole bores and axle way bores. It consists of main poles and interpoles fixed to it which are built from steel laminations riveted together.

Mainpole and compole coils are epoxy insulated and bonded to pole bodies using epoxy resin. This improves heat dissipation.

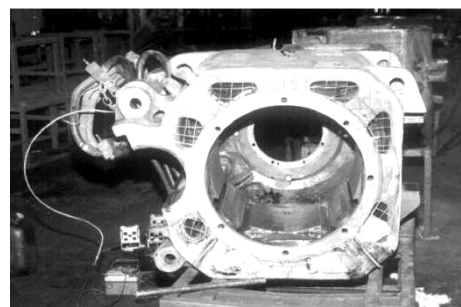


Figure 1.6 STATOR

1.4.4 Brush Holder

There are four brush holders per motor, each carrying two split carbon brushes. The brush holder is an internal casting having a single adjustable spring for each brush to provide the correct brush pressure. The brush holders are secured to the magnet frame by FRP moulded insulated pins. The rubber top carbon brushes are split type to ensure better contact with the commutator.

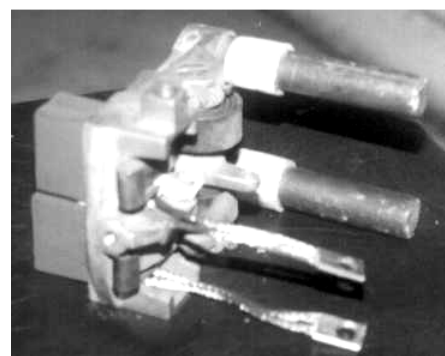


Figure 1.7 BRUSH HOLDER

1.4.5 Arcing Horns

Arcing horns are provided near the brush holders to minimise the damage in an event of a flash.

1.4.6 Armature Bearings

The armature is supported on two grease lubricated roller bearings. Bearing assemblies are sealed type, thereby lubrication is only required during o/H (18 months). The armature is located axially by the commutator end bearing, while the pinion end bearing is capable of taking care of any axial play between armature and frame.

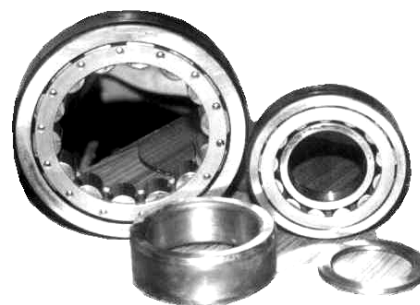


Figure 1.8 ARMATURE BEARING

1.4.7 Suspension bearing

The axle suspension bearing is high leaded bronze shell type. One half of the bearing is keyed to axle cap to prevent rotation and to again the oiling window. The oil lubrication is provided by spring loaded wick assembly of the axle lubricator.

1.4.8 Pinion

The pinion which is shrunk fitted on the armature shaft, drives the EMU/MEMU axle through a spur gearwheel which is pressed onto the axle, it is made of high speed carbon steel and having 20 teeth.



Figure 1.9 PINION

1.4.9 Gear case

The gearcase is of welded steel construction and is in two halves, which are bolted together. The complete gearcase is supported on the motor frame and end shield PE. The joints between the gearcase halves are baffled and grooved to carry felt sealing rings so as to prevent ingress of dust and any other foreign material and the escape of the gear lubricant.

1.4.10 Cooling system

The motor is self ventilated and the fan is mounted on C.E. shaft extension. Air enters the motor through a duct system connected to an opening provided in fan chamber and assembled on the motor frame at the commutator end. The cooling air then sucked by fan flows in two parallel paths, one under the commutator through the armature core ducts and the other along the outside of the armature and between the field coils and is discharged through the opening provided at the pinion end of the frame.

CHAPTER 2

MAINTENANCE SCHEDULE

2.1 TRIP INSPECTION (10 DAYS)

Carry out the following inspection and fill up the proforma:

S.No.	Inspection & work to be carried out	Standard value	Actual value
1.	Open inspection covers of all traction motors and make a quick inspection for flash marks, broken brushes, damaged pig tails or other damages.	No flash mark No other abnormality	
2.	Secure the inspection covers properly.	Secure	
3.	Check the cables of all traction motors visually for any rubbing or damages.	No damage	

2.2 IA SCHEDULE (45 DAYS)

Carry out the following inspections and fill up the proforma.

S. No.	Inspection & work to be carried out	Standard value	Actual value
1.	Clean commutator covers before removing them.	Clean	
2.	Clean and inspect brush gear, insulator, v-rings and insulation over the risers, using fluff-free cloth, moistened with a suitable solvent, if necessary.	Clean No abnormality	
3.	Check the commutator for a uniformly coloured, well polished surface, free from bar marking.	Well polished	
4.	Remove copper beads from the commutator surface with fine cloth.	Clean	
5.	Clean hands with suitable solvents & cloth.	Clean	
6.	Check the carbon brushes for wear, mechanical damage and breakage of flexible leads.	No damage.	
7.	Change the brushes which are likely to wear beyond the permissible limit before the next maintenance schedule.	New 60mm Condemn 32mm	
8.	Check that flexible leads are firmly secured to the brush holder.	Secure	
9.	Check each brush is free in its guide. If it is sticking, wipe the brush with a fluff-free cloth moistened with a suitable solvent, and also clean the brush guide.	Free	

S. No.	Inspection & work to be carried out	Standard value	Actual value
10.	If a brush appears to be excessively slack in the guide, check the clearance on thickness between a new brush and the guide and if this clearance exceeds 0.5 mm, fit a new brush holder.	Clearance less than 0.5 mm	
11.	Examine the motor for signs of flashover, overheat, loose connections and damaged insulation.	No abnormality	
12.	Check the cables of all traction motors visually for any rubbing or damages.	No damage	
13.	Check the tightness of pole shoe bolt, fan chamber, end shields air ducts, bellows etc.	Intact	
14.	Clean air suction filter.	Clean	

2.3 IB SCHEDULE (90 DAYS)

Carry out the following inspections and fill up the proforma.

S. No.	Inspection & work to be carried out	Standard value	Actual value
1.	Clean commutator covers before removing them.	Clean	
2.	Blow out the interiors of the motors.	Blown	
3.	Clean and inspect brush gear, support pin, insulator, v-rings and insulation over the risers, using fluff-free cloth, moistened with a suitable solvent, if necessary.	Clean No abnormality	
4.	Check the commutator for a uniformly coloured, well polished surface, free from bar marking.	Well polished	
5.	Remove copper beads from the commutator surface with fine cloth.	Clean	
6.	Clean hands with suitable solvents & cloth.	Clean	
7.	Check that the brush springs sit correctly on the brushes, function freely & tensions are correct.	2.7 to 3.65 kg	
8.	Check the carbon brushes for wear, mechanical damage and breakage of flexible leads.	No damage.	
9.	Change the brushes, which are likely to wear beyond the permissible limit before the next maintenance schedule.	New 60mm Condemn 32mm	
10.	Check that flexible leads are firmly secured to the brush holder.	Secure	

S. No.	Inspection & work to be carried out	Standard value	Actual value
11.	Check each brush is free in its guide. If it is sticking, wipe the brush with a fluff-free cloth moistened with a suitable solvent, and also clean the brush guide.	Free	
12.	If a brush appears to be excessively slack in the guide, check the clearance on thickness between a new brush and the guide and if this clearance exceeds 0.5 mm, fit a new brush holder.	Clearance less than 0.5 mm	
13.	Examine the motor for signs of flashover, overheat, loose connections and damaged insulation.	No abnormality	
14.	Lubricate commutator cover latches.	Lubricate	
15.	Check the tightness of brush gear bolts.	Tight	
16.	Check external cables of traction motors for wear and any rubbing mark.	No damage	
17.	Check the air inlet bellows of all traction motors for crackness fit new bellows if necessary.	No damage	
18.	Check connections to earthing brushes and earth brush gear bolts.	Intact	
19.	Check tightness of junction box connection.	Intact	
20.	Check the tightness of pole shoe bolt, fan chamber, end shields air ducts, bellows etc.	Intact	
21.	Clean air suction filter.	Clean	

2.4 IC SCHEDULE (180 DAYS)

Carry out the following inspections and fill up the proforma.

S. No.	Inspection & work to be carried out	Standard value	Actual value
1.	Clean commutator covers before removing them.	Clean	
2.	Blow out the interiors of the motor.	Blown	
3.	Clean and inspect brush gear, support pin, insulator, v-rings and insulation over the risers, using fluff-free cloth, moistened with a suitable solvent, if necessary.	Clean No abnormality	
4.	Check the commutator for a uniformly coloured, well polished surface, free from bar marking.	Well polished	
5.	Remove copper beads from the commutator surface with fine cloth.	Clean	
6.	Clean hands with suitable solvents & cloth.	Clean	
7.	Check that the brush springs sit correctly on the brushes, function freely & tensions are correct.	2.7 to 3.65 kg	

S. No.	Inspection & work to be carried out	Standard value	Actual value
8.	Check the carbon brushes for wear, mechanical damage and breakage of flexible leads.	No damage.	
9.	Measure the length of each carbon brush and record in format "A". Replace them which are likely to wear beyond the permissible limit before the next maintenance schedule.	New –60 mm Condemn 32 mm	
10.	Check the flexible leads are firmly secured to the brush holder.	Secure	
11.	Check each brush is free in its pocket. If it is sticking, wipe the brush with a fluff-free cloth moistened with a suitable solvent and also clean the brush guide.	Free	
12.	If a brush appears to be excessively slack in the guide, check the clearance on thickness between a new brush and the guide and if this clearance exceeds 0.5 mm, fit a new brush holder.	Clearance less than 0.5 mm	
13.	Examine the motor for signs of flashover, overheating, loose connections and damaged insulation.	No abnormality	
14.	Lubricate commutator covers latches.	Lubricate.	
15.	Check tightness of brush gear bolts.	Intact	
16.	Check external cables of traction motors for wear and any rubbing mark.	No damage	
17.	Check the air inlet bellows of all traction motors for crackness, fit new bellows if necessary.	No damage.	
18.	Check connections and measure the length of earth return bush and record.	New – 53.5mm Condemn – 34.4 mm TM-1 TM-2 TM-3 TM-4 TM-5 TM-6	
19.	Check the tightness of junction box connections.	Intact	

S. No.	Inspection & work to be carried out	Standard value	Actual value
20.	Meggar all traction motors with 1000v meggar and record.	1 Mega ohm (min.) TM-1 TM-2 TM-3 TM-4 TM-5 TM-6	
21.	Check brush spring pressure of each brush spring.	2.7 to 3.65 kg	
22.	Check the tightness of pole shoe bolt, fan chamber, end shield air ducts, bellows etc.	Intact	
23.	Clean air suction filter.	clean	

FORMAT “A” - Size of carbon brushes (in mm)

New	– 60mm
Condemn	- 32 mm

TM carbon Brush No.	ACTUAL VALUES			
	TM1	TM2	TM3	TM4
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

CHAPTER 3

OVERHAULING

(POH Periodicity – 18 Months)

Overhauling of Traction motor is to be carried out during every POH.

3.1 GENERAL

- First of all remove the bogie from the behicle.
- Remove us must dirt as possible particularly around the commutator covers, the axle cap filter pipes and the armature bearing caps on position.
- Remove the motor from the bogie and brought it to the TM section for overhauling.

3.2 TOOLS REQUIRED

Following tools are required for the maintenance & overhauling of traction motor. Special tools are shown in overhauling procedure.

3.3.1 Tools

- Spanner : 19, 24 & 30 A/F.
- Allen keys : 5, 8 & 10mm
- Chisel, Spirit level, wooden blocks, Meggar 1000 V, Oven, Light hammer, Copper drift, Screw press etc.

3.3.2 Special Tools

Description	Tool No.
Hydraulic ram, hollow, 20T, 100m stroke with pump, EPCO make	Std.
Hydraulic ram, solid, 20T, 100mm stroke with pump, EPCO make	Std.
Forcing scres for PE outer bearing cap & CE bearing cartridge (3 off)	1405975
Forcing screw for endshield (2 off)	1405975
Guide studs for endshield (2 off)	1405976
Guide studs for CE brg. Cartridge	1405976
Lifting shackle (2 off)	1405977
Eye bolt M 20	1405978
Spacer	1405979
SKF oil pump	1405980
Injector sttachment for SKF oil pump (Type 227982)	1405981
Stud	1405982
Thrust pad	1405983
Pressing tackle for CE bearing	1405341
Pressing tackle for CE outer wiper	1405342

Spanner for fan nut	1405343
Extractor for armature fan and CE bearing wiper	1405344
Extractor for details	1405390
Extractor for CE bearing & Cartridge	1405391
Extractor for CE bearing from Cartridge	1405392
Protecting sleeve CE	1405393
Lifting cap CE	1405394
Pinion injection safety plate	1405395
Pinion positioning gauge	1405396
Retaining ring PE	1405397
Lifting cap PE	1405398
Extractor from bearing wiper PE	1405399
Protection sleeve for PE bearing	1405400
Extractor for PE brg. Outer race from endshield PE	1405401
Extractor for PE bearing inner race	1405402
Extractor for PE brg. Sleeve	1405403
Retaining plate for CE bearing	1405461

3.3 GENERAL CLEANING

3.3.1 Cleaning material

3.3.1.1. Cloth

- Cloth used for cleaning of traction motor parts should be non-fluffy, clean and dry, unless it is moistened with a recommended solvent.
- Cotton waste or fluffy cloth should not be used for cleaning brushgear, commutator etc. since left over fluffs or fibres may cause failures.

3.3.1.2 Compressed air

Dry compressed air should be used to blow out traction motor.

3.3.1.3 Cleaning solvents

Warning

- As all solvents are toxic to a varying degree, the minimum amount of solvent should be used and the workshop area should be well ventilated.
- Some solvent when heated become more toxic and therefore, the cleaning of hot surface should be avoided.
- Smoking should be prohibited in all areas where solvents are used, since some are highly inflammable.

- When using solvents, the operator should wear plastic gloves and not rubber, since some solvents can be absorbed through the skin with harmful results.
 - i. Following are the some solvents which meet the required conditions and may be applied to all insulation and paints on traction machines for cleaning.
For silicon based, class 'H' insulation ORION 77 may be used.
For Class 'B' insulation.
In addition to the above solvent following solvents may be used.
 - White spirit Gr. 145/205 to IS 1745 – 1978
 - A solution of white spirit with 5% trichloro ethylene to IS 245 – 1970 (type –2)
 - Xylene (Xylol) to IS 359 – 1965.
 - ii. For cleaning of mechanical parts ORION 510 diluted with kerosene oil in the ratio of 1:6 may be used.

Note : Ensure that oil based cleaning colutions used for general body cleaning are not allowed to come in contact with windings.

3.3.2 Cleaning methods

- Cleaning of accessible parts of traction motor should be carried out by wiping the parts with a dry cloth or, if necessary, with a cloth lightly moistened with the above recommended solvents.
- Cleaning of inaccessible parts of machines, for example behind the field coils should be carried out by spraying the part with a solvent. The spray of solvents must be kept moving over the surface.
- The spray cleaning of the field system of a traction motor should not exceed 15 minutes and spray rinse 3 to 5 minutes.

3.4 OVERHAULING PROCEDURE

3.4.1 Pre-Inspection

3.4.1.1 Run test

Before dismantling the motor, connect variable d.c. supply to its terminals (connecting armature and field in series) and run the motor at 1500 – 2000 rpm to check the bearings noise and vibrations.

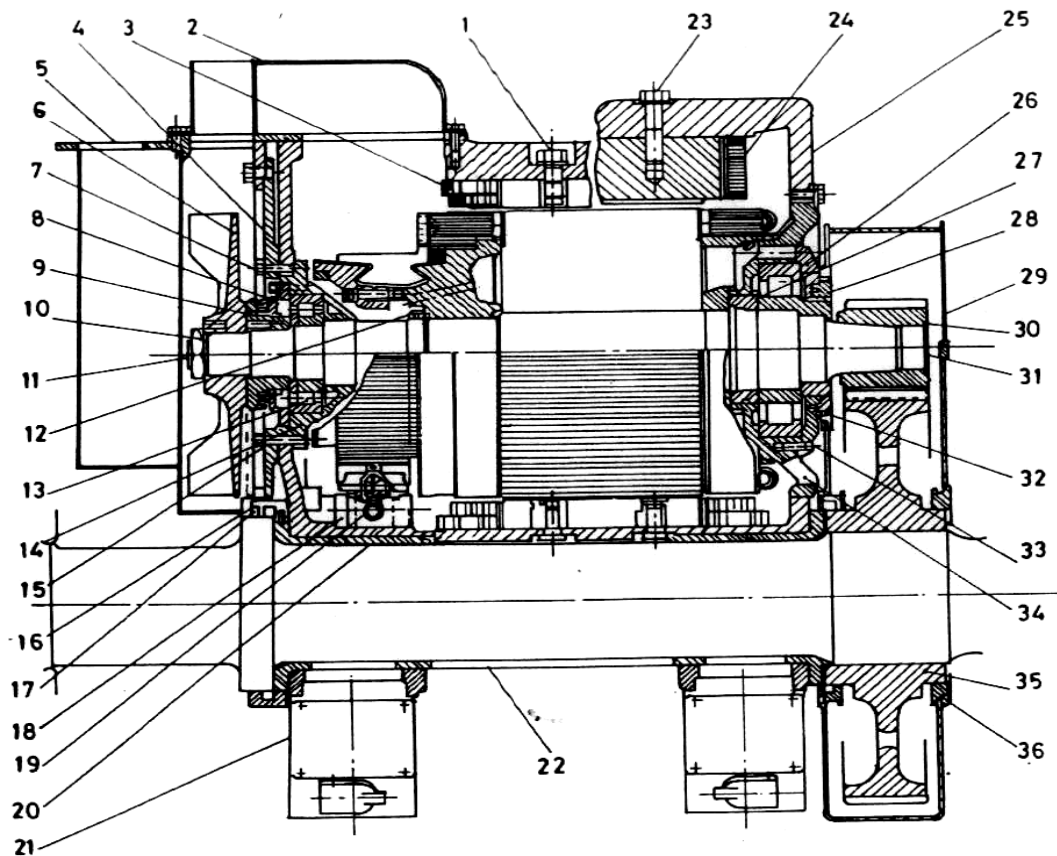
3.4.1.2 Meggaring

Meggar the connection terminals of T.M. with 1000 V meggar & record the IR values as follows.

S.No.	Description of the item	Permissible value	Actual value found
1.	A, AA cables	1 M Ω (min.)	
2.	Y, YY cables	1 M Ω (min.)	

If the IR values are less than 1 M Ω , bake the armature/ stator at 90° C for removing moisture.

3.4.2 Dismantling of Traction Motor



LIST OF DIFFERENT PARTS OF TM 4601

1.	Main pole bolt	19	Brush holder clamp bolt
2	Air duct	20	Axle suspension bearing
3	Main field coil	21	Axle cap
4	Adapter plate	22	Axle shield
5	Fan chamber	23	Compole bolt
6	Armature fan	24	Compole coil
7	CE outer bearing cap bolt	25	Magnet frame
8	Outer bearing cap CE	26	PE bearing cap
9	Bearing wiper CE	27	PE inner bearing sleeve
10	Fan nut	28	PE bearing wiper
11	Fan nut locking washer	29	Gear case
12	Armature nut	30	Pinion
13	Armature bearing CE	31	Shaft
14	Bearing cartridge CE	32	Armature bearing PE
15	Bearing cartridge bolt	33	PE bearing cap socket screw
16	Axle flange dust guard	34	End shield PE
17	Wiper felt seal	35	Gear wheel
18	Brush holder clamp	36	Gear case felt seal

3.4.2.1 Removing of Pinion

3.4.2.1.1 By oil injection method

A groove is machined around the armature shaft extension on the pinion seating and is connected by vertical drilled hole to a hole tapped 6.35 dia. (1/4 inch) BSP parallel nut in the end face of the shaft. These are provided for the removal of the pinion by oil injection, oil under high pressure being supplied by a oil injector pump.

The tapped hole in the shaft is sealed with a Nylon screwed plug to prevent gear lubricant from entering and blocking the oil ways.

Following tools are required for removing the pinion :

Tools	Tool no.
SKF oil pump	1405980
Injector attachment for SKF pump	1405981
Pinion injection safety plate	1405395

- Remove all traces of gear lubricant from the pinion, the shaft end and the oil injection plug using a solvent, such as white spirit.
- Remove the plug which seals the oil injection hole, using the plug driver or, in the case of the nylon plug, a large screw driver.
- Remove gear lubricant if found its way past the plug.
- Mount the pinion injection safety plate on the shaft, allowing a gap of about 5.0mm for the removal of the pinion.

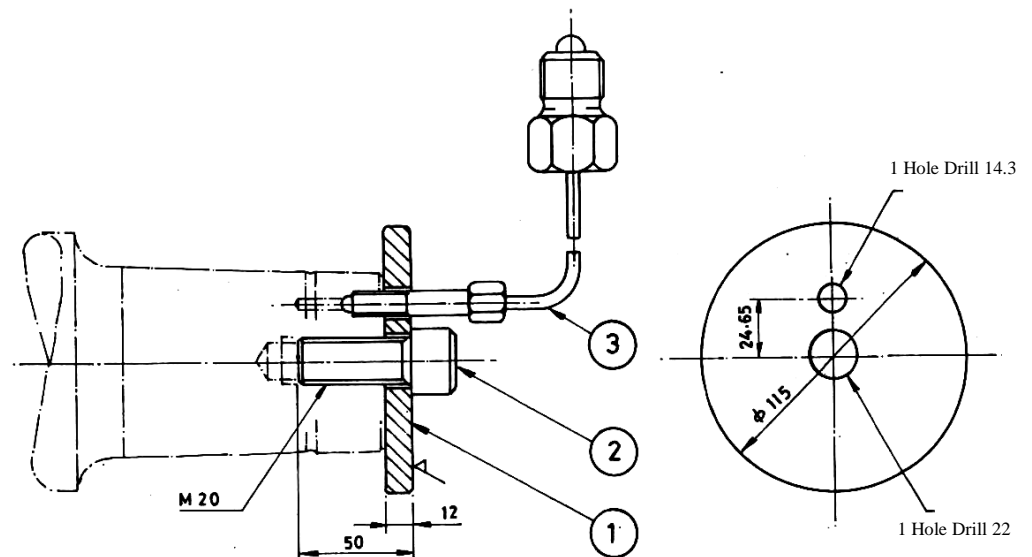
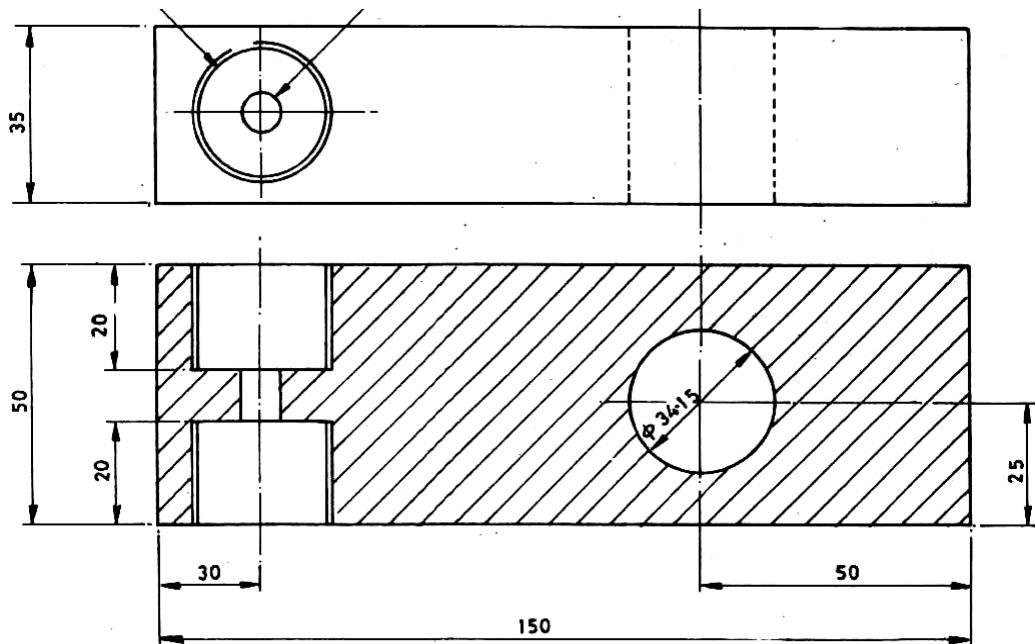
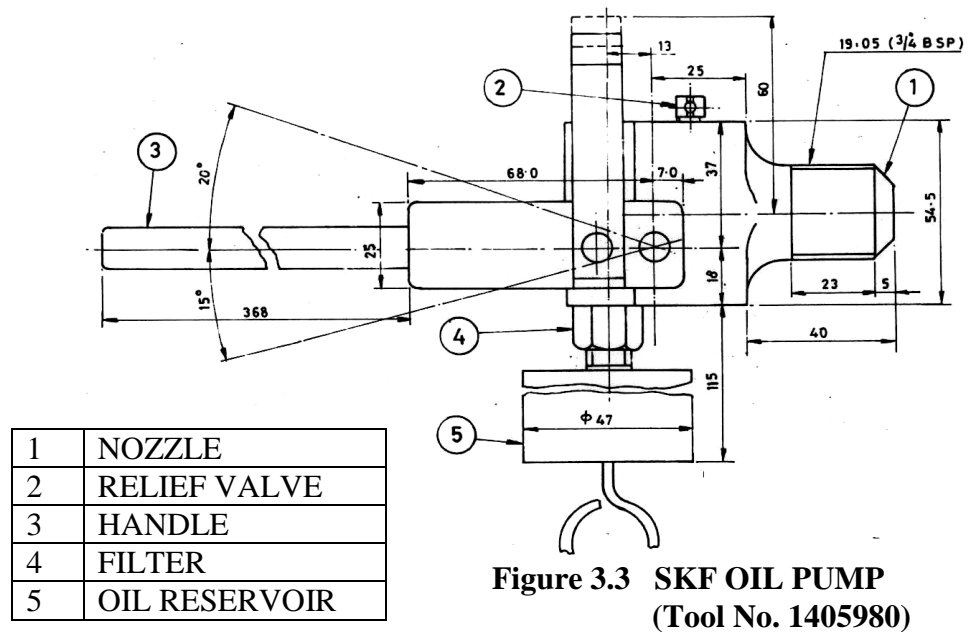


Figure 3.2 PINION EJECTION SAFETY PLATE (Tool No. 1405395)

1	Safety plate 14 TK x 120 dia
2	Cap screw M 20 x 50 LG P 12.9
3	High pressure pipe SKF type

- Assemble the Skefko pump and injector attachment, fit the high-pressure pipe and fill the pump reservoir.



- Do not fit the pump handle at this stage.
- Open the pump relief valve using the fingers.
- Operated the pump until air bubbles cease to the expelled with the oil.
- Close the relief valve again.

- Operate the pump handle socket with the fingers until system is full of oil and resistance of pumping is felt.
- Fit the pump handle and continue pumping raising the pressure gradually and pausing after each stroke to let the pressure built up at the pinion seating.
- A sudden loss of pressure accompanied by movement of the pinion indicates its release.

3.4.2.1.2 Method for removal of pinion when pinion extraction fails due to leakage of oil (As per BHEL service bulletiv no. SB/GENL/055 Feb., 89)

In some cases, difficulties may be faced in removing the traction motor pinion from shaft due to leakage of oil during extraction of pinion by oil injection method. In such type of case, follow the methods, mentioned below respectively.

■ Material and equipment required

- i. 'M' seal putty : For sealing the oil leakage.
- ii. Hot oil : For heating the pinion.
- iii. Oil injection equipment
- iv. Hydraulic Ram

■ Procedure = I

By applying 'M' seal putty

1. Clean the face of the pinion & shaft with petrol or suitable cleaning solvent.
2. Wipe and clean the pinion faces & shaft with dry cloth.
3. Apply thick layer of 'M' seal putty on both side faces of the pinion at the mating points of pinion bore periphery and shaft, to seal the same.
4. Allow the putty to cure at room temperature for 12 hours.
5. After the putty gets cured, heat the pinion slightly with the gas torch.
6. Extract the pinion with oil injection method which is explained earlier.
7. If oil still leaks out through 'M' seal putty, repeat the process as per clauses 1 to 6.

■ Procedure – II

By heating the pinion :

1. Clean the faces of the pinion & shaft with petrol or suitable cleaning solvent.
2. Apply Hydraulic Ram for pulling out the pinion.
3. While applying extraction force, pour hot oil (200 deg. C approx.), over the pinion.
4. If the pinion is not getting extracted, apply oil pressure simultaneously by using oil injection. For this purpose, a small metallic spacer may be used in between shaft end and ram of the puller so as to enable fitting of oil injection plug into the shaft.

NOTE

- i. The procedure II of pulling and heating the pinion to be used only after oil injection with 'M' seal fails repeatedly.
- ii. The use of excessive pressures may cause the pinion to be ejected violently, it may then rebound and reseal itself on the shaft.
- iii. Excessive pressures may also cause permanent distortion of the pinion bore.
- iv. Refit the plug in the oil injection hole immediately after removal of the pinion to prevent the ingress of foreign material.
- v. Protect the pinion bore and shaft extension from damage and corrosion.

3.4.2.2 Removing the armature and armature bearings

3.4.2.2.1 Clean the motor externally.

3.4.2.2.2 Remove the air duct.

3.4.2.2.3 Remove the fan nut chamber, assembled with adapter plate.

3.4.2.2.4 Unlock the fan but locking washer, using a chisel & hammer. Remove fan nut, using spanner 1405343.

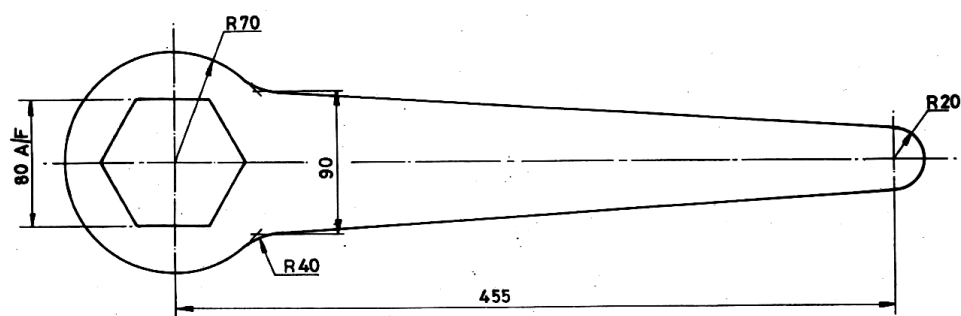


Figure 3.5 SPANNER FOR FAN NUT (Tool No. 1405343)

- 3.4.2.2.5** Remove the fan. Use 5 off M12 tapped holes, using extractor 1405344. remove the fan kay.

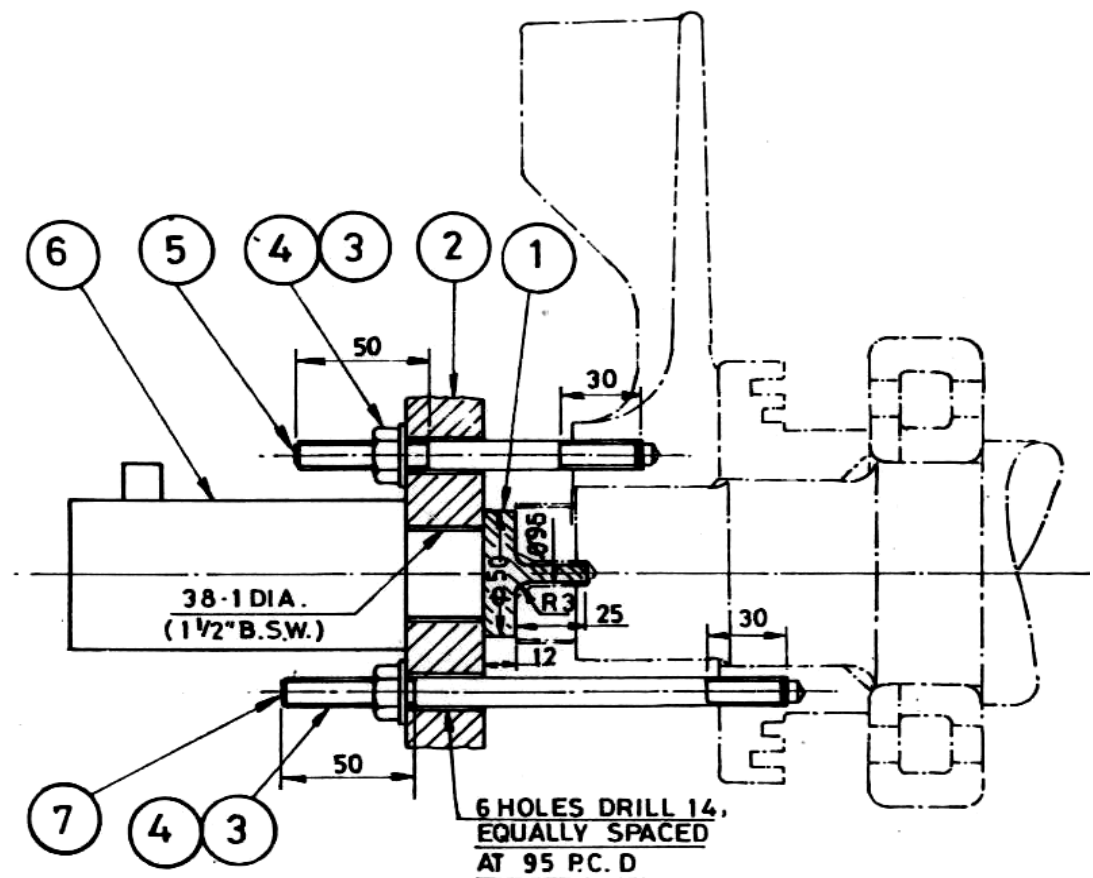


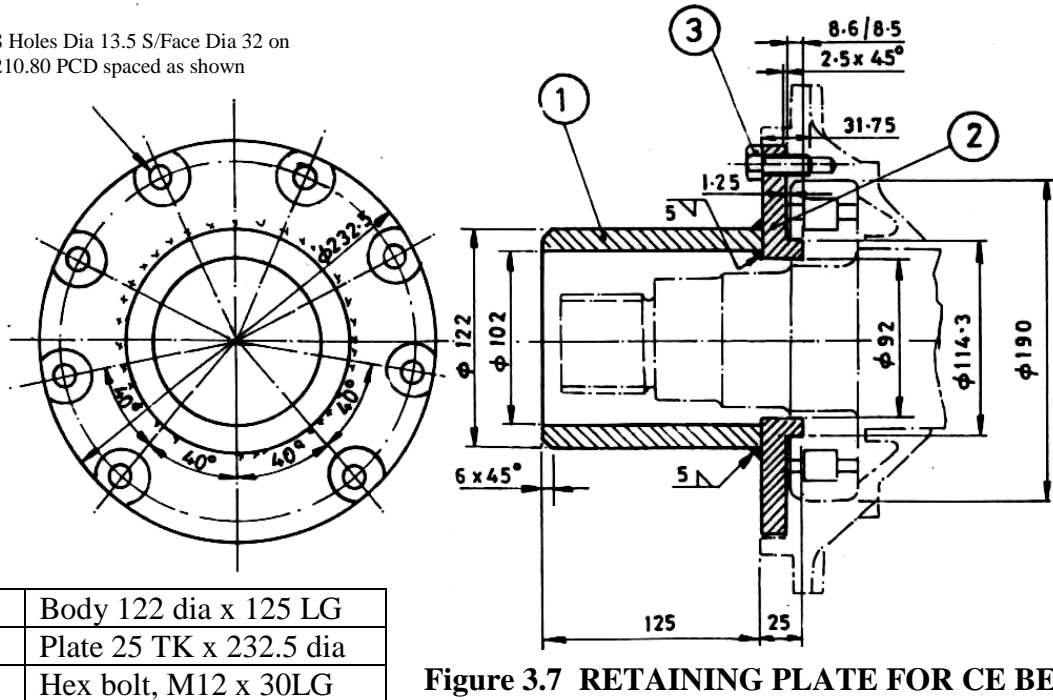
Figure 3.6 EXTRACTOR FOR ARMATURE FAN & CE BEARING WIPER (Tool No. 1405344)

1	THRUST PAD	5	STUD M12 X 130 LG
2	THRUST PLATE	6	HYDRAULIC RAM
3	WASHER M12	7	STUD M12 X 190 LG
4	HEX NUT, M12		

- 3.4.2.2.6** Remove the outer grb. Wiper CE. Use 6 off M12 tapped holes using extractor 1405344 as shown above.
- 3.4.2.2.7** Dismantle the outer brg. Cap by unscrewing 8 nos. of M12 bolts and using 3 off M12 tapped holes provided in outer brg. Cap.
- 3.4.2.2.8** Remove the bearing lip of CE bearing and store it to same bearing.

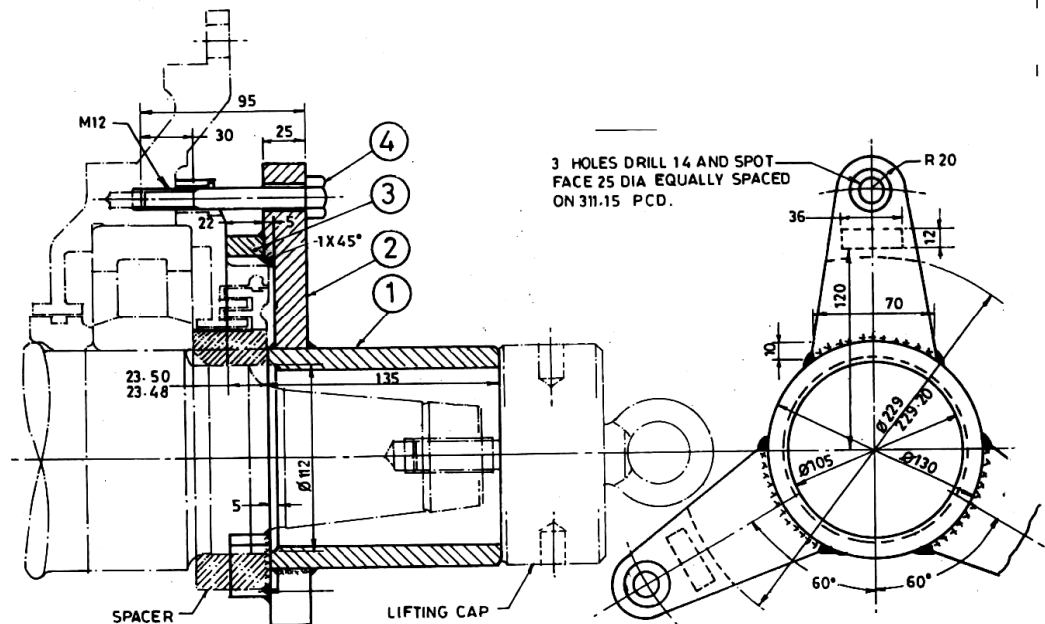
- 3.4.2.2.9** Fit the CE bearing plate 1405461. The object of this plate is to provide a means of pivoting the armature on a wooden block when turning it from the vertical to the horizontal position or vice-versa, and thus to protect the bearing labyrinths and the commutator.

8 Holes Dia 13.5 S/Face Dia 32 on
210.80 PCD spaced as shown



**Figure 3.7 RETAINING PLATE FOR CE BEARING
(Tool No. 1405461)**

- 3.4.2.2.10** Remove three bolts equally spaced from the PE bearing cap. Assemble the retaining ring PE 1405397 over the shaft and apply the end shield PE using three holes.



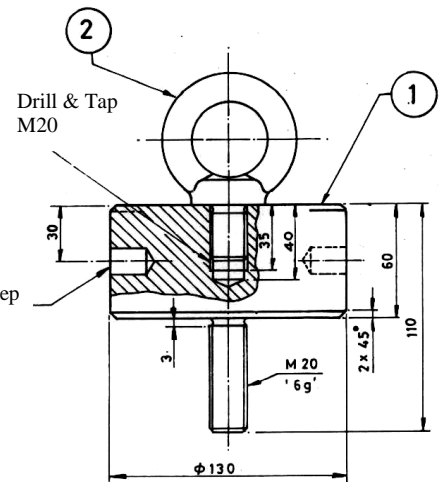
**Figure 3.8 RETAINING RING PE
(Tool No. 1405397)**

- 3.4.2.2.11** Fit the lifting cap PE 1405398, screw tightly so that the retaining ring PE 1405397 butts against the bearing wiper PE. Tighten the retaining ring bolts uniformly with just sufficient force to avoid any slackness between the bearing cap PE and the retaining ring.

1	Cap dia 135 x 120 LG
2	Eye bolt M20

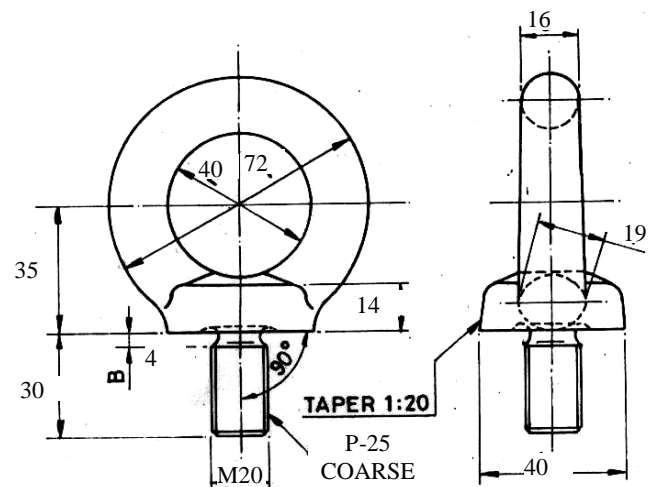
2 Holes Drill 13 x 20 deep

Figure 3.9 LIFTING CAP PE
(Tool No. 1405398)



- 3.4.2.2.12** Remove two bolts from the PE end shield and replace them with two M20 eye bolts 1405978, ensuring that the eye bolts are aligned correctly, use packing washer if necessary.

Figure 3.10 EYE BOLT M20
(Tool No. 1405978)



- 3.4.2.2.13** Using these eye bolts and lifting shackle 1405977 (safety work load = 2.0 tonnes) turn the motor and place it on suitable wooden blocks 300 mm height keeping its armature auxiliary vertical with CE down. Use spirit level to check that the a

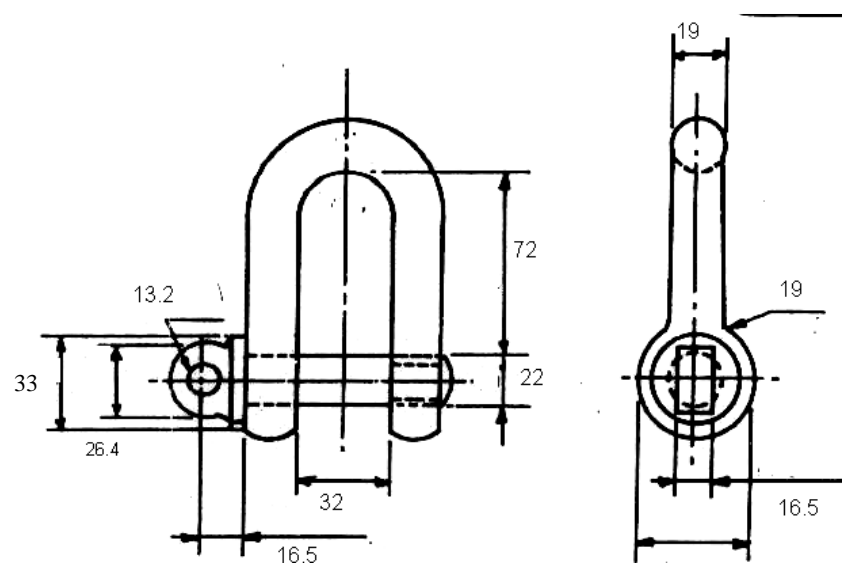


Figure 3.11 LIFTING SHACKLE (Tool No. 1405977)

- 3.4.2.2.14** Lift the carbon brushes and protect the commutator with pressboard. Disconnect the brush flexible and remove brushes.
- Disconnect the brush holder leads so that the bottom and axle side connections are accessible through the axle side inspection opening.
- Top brush holder lead must be disconnected from the brush holder through the top commutator opening and then remove brush holder.
- The connection to the nose side brush holder is then accessible through the top commutator opening. Disconnect the lead.
- Remove the nose side, axle side and bottom side brush holders.
- 3.4.2.2.15** Recheck tightness of the bolts of retaining ring 1405397 and tighten them uniformly to take up any slackness that may have developed owing to the downward movement of the armature.
- 3.4.2.2.16** Remove the remaining end shield bolts and the two eyebolts insert two guide studs 1405976 diametrically opposite in the magnet frame.

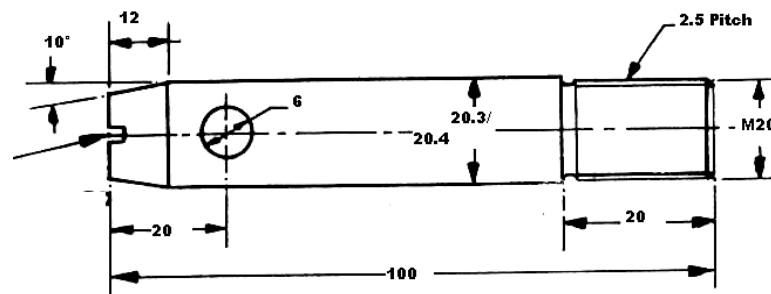


Figure 3.12 GUIDE STUD M20 (Tool No. 1405976)

- 3.4.2.2.17** Insert three forcing screws 1405975 into the withdrawal holes of the endshield to force it out of its fit.

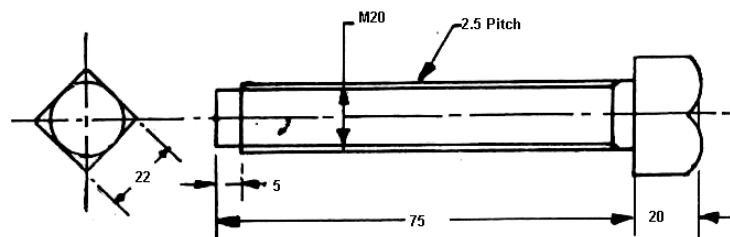


Figure 3.13 FORCING SCREW M20 (Tool No. 1405975)

- 3.4.2.2.18** Remove the end shield PE and bearing cartridge CE off their spigots uniformly by tightening the forcing screws a little at a time. Carry out this operation carefully so as to avoid any damage to the CE bearing.
- 3.4.2.2.19** Carefully and gradually lift the armature vertically from the frame and lower it horizontally on to wooden 'V'-block. The height of the wooden blocks should be high enough to ensure that the armature is clear out of the ground.
- 3.4.2.2.20** Turn the frame in horizontal position using lifting shackle 1405977 and eye bolts 1405978 screwed onto the bolts holes meant for PE end shield.
- 3.4.2.2.21** Dismantle the lifting cap 1405398 and retaining ring 1405397.

3.4.2.2.22 Remove the bearing wiper PE using extractor 1405399.

1	Thrust plate
2	Thrust pad
3	Stud M12 x 225 LG, P-4.8
4	Hex nut, M12 P- 4.8

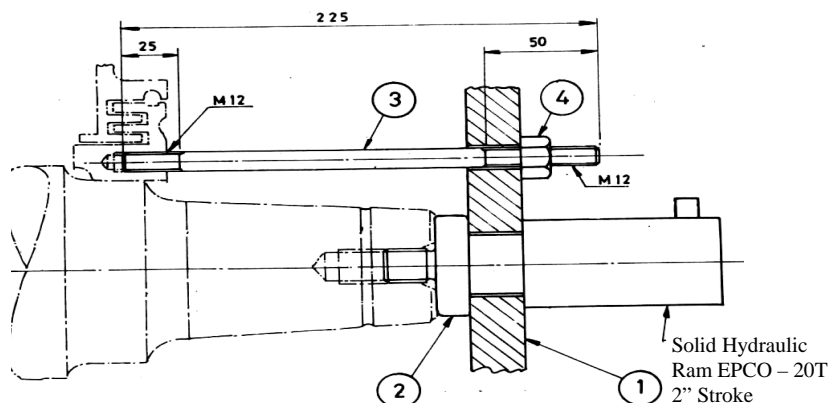


Figure 3.14 EXTRACTOR FOR BEARING WIPER PE (Tool No. 1405399)

3.4.2.2.23 Unscrew the bolts and remove PE outer bearing cap using three forcing screws 1405975. (M12)

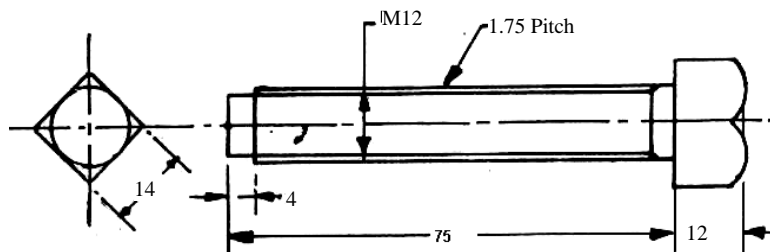


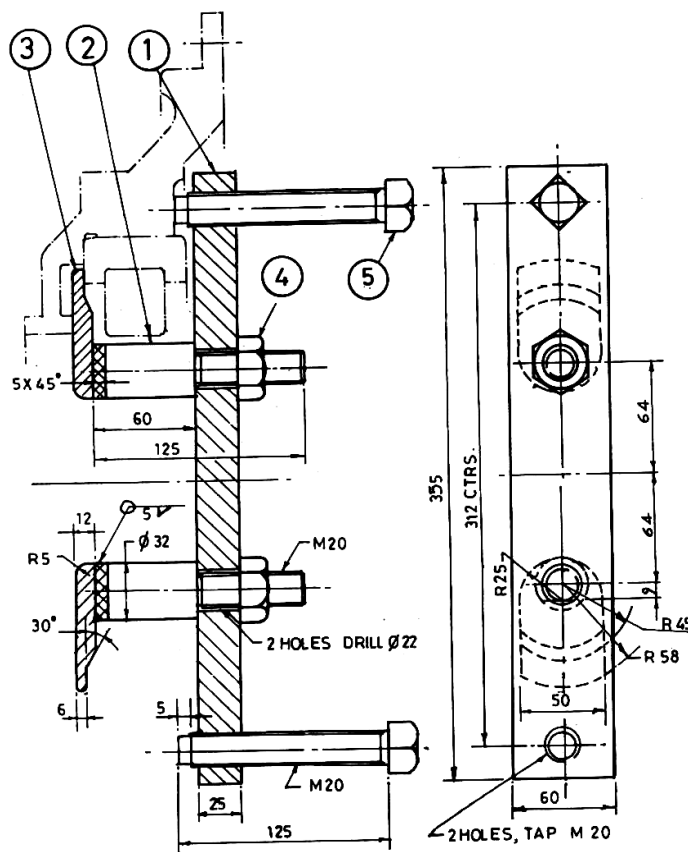
Figure 3.15 FORCING SCREW M12 (Tool No. 1405975)

3.4.2.2.24 Using lifting shackle 1405977 and suitable lifting sling carefully remove the endshield from the armature together with PE bearing.

3.4.2.2.25 Withdraw the PE bearing from the endshield using extractor 1405401.

1	Thrust plate 25 x 60 x 355
2	Pulling bar dia 32 x 60LG
3	Pulling plate 12TK x 80 x 50
4	Hex nut M20
5	Forcing screw M20

**Figure 3.16 EXTRACTOR
FOR PE
BEARING
OUTER RACE
FROM END
SHIELD PE
(Tool No. 1405401)**



3.4.2.2.26

Clean PE bearing inner race & sleeve PE in position if it is not necessary to remove these components. Smear the components with clean oil and cover the PE bearing inner race with protecting sleeve 1405400.

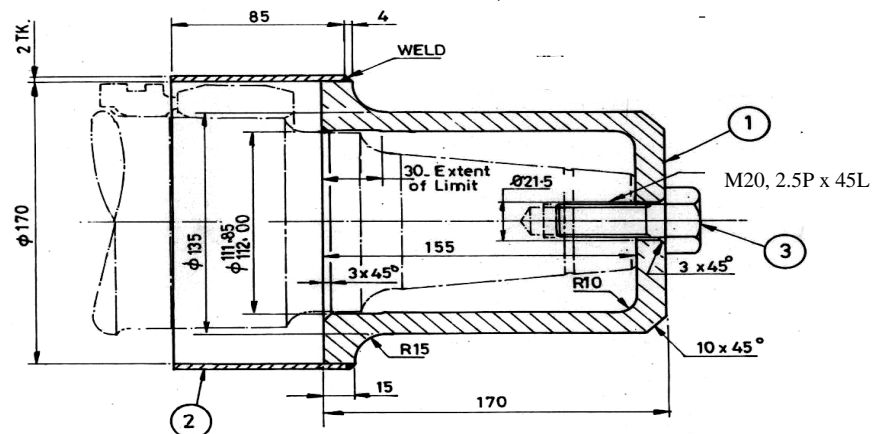


Figure 3.17 **PROTECTING SLEEVE FOR PE BEARING (TOOL NO. 1405400)**

1	Bush
2	Sleeve 2.5 TK x 85 x 540
3	Hex bolt M20 x 25LG

3.4.2.2.27

Remove CE bearing cartridge together with CE bearing from the armature shaft using extractor 1405391.

1	Thrust plate
2	Thrust pad
3	Stud M12 x 225 LG
4	Hex nut M12 P4.8
5	Solid hydraulic ram

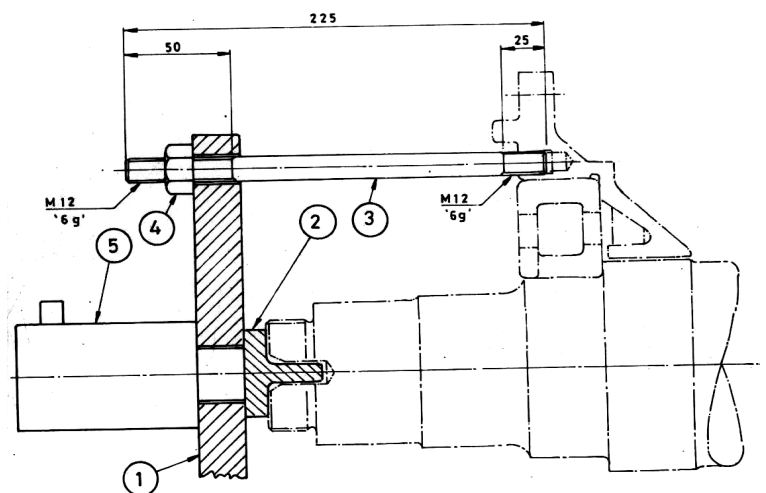


Figure 3.18 EXTRACTOR FOR CE BEARING AND CARTRIDGE (Tool No. 1405391)

3.4.2.2.28

Extract CE bearing to avoid any damage while lifting the armature. To avoid damages use lifting cap 1405394.

1	Cap dia 80 x 70LG
2	Eye bolt, M20

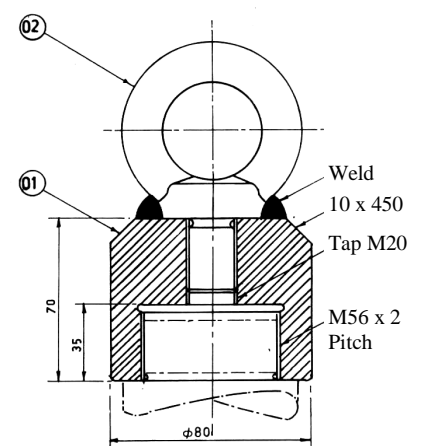
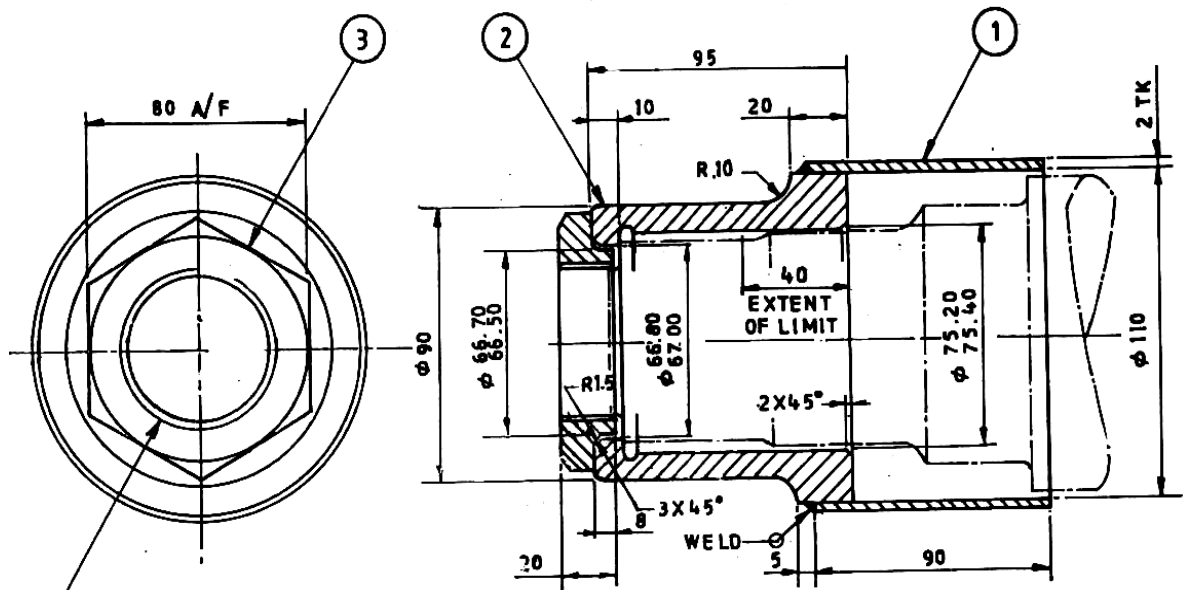


Figure 3.19 LIFTING CAP CE (Tool No.1405394)

- 3.4.2.2.29** Withdraw CE bearing inner race if required and Assemble protecting sleeve 1405393 to protect the surfaces of the shaft for any damage while lifting the armature. To avoid damages use lifting cap 1405394.



1	Sleeve 2 TK x 90 x 360LG
2	Bush dia 110 x 95LG
3	Special hex nut

Figure 3.20 PROTECTIVE SLEEVE CE
(Tool No. 1405393)

- 3.4.2.2.30** Clean the PE & CE bearings and bearing components thoroughly with jet spray of white spirit or ORION 510 diluted with kerosene in the ratio of 1 : 6 or suitable solvent and examine them for any damage. If fit for service, dry them and dip them in a clean mineral oil for a couple of minutes. Wrap and store with some identification of the armature serial number from which these were removed.

3.4.3 Cleaning of armature and stator

- Clean the armature thoroughly by clean and dry compressed air.
- Metallic portion of armature shaft to be cleaned with white spirit or ORION 510 diluted with kerosene in the ratio of 1 : 6 by spray gun.
- After the cleaning the solvent should be wiped off with clean cloth.
- Stator (magnet frame) should also be cleaned thoroughly by clean dry compressed air.
- Cleaning of spaces between & behind the field coils is to be done when magnet frame (stator) stood on end, so that dirt to drop out freely.

3.4.4 Insulation Resistance checking

- Bake armature & stator into a oven 90°C to remove moisture.
- After drying, check the insulation resistance with 1000 V meggar while the machine is still hot, and record. This should be at least one Mega-ohm.

3.4.5 Checking of armature bearings

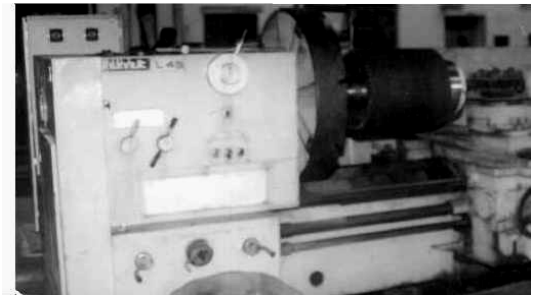
- Check visually for roughness, scratch, discoloration, rust etc.
- Check while moving the rollers for wear of retainer, looseness of rivets and ensure that there is no abnormality. Replace with new set if required.

3.4.6 Checking of commutator

3.4.6.1 Commutator resurfacing

- If any following defects found in commutator, then machining or resurfacing to be carried out.
 - i. Ovality beyond specified limits i.e. 0.03 mm where distributed uniformly over the circumference.
 - ii. Grooves in commutator surface.
 - iii. Signs of flats and high bars.
 - iv. Burrs or redges.
- For resurfacing procedure & tool, follow instructions given in special maintenance instruction no.RDSO/ELRS/SMI/6 dt. 30.12.77 & SMI/29 Aug. 1978.
- Check the surface finish it should be 0.3 to 0.8 microns.
- After resurfacing, commutator mica under cutting & chamfering the segments to be done.

Figure 3.21 RESURFACING



3.4.6.2 Mica undercutting & chamfering

- Check the depth of under cutting of the mica between bars, it should be between 0.8 to 1.3mm, if it is less than 0.8mm, mica under cutting & chamfering to be done then also mica under cutting & chamfering to be done. This should be done as per instruction given in SMI no. RDSO/ELRS/SMI/31 dt. 24.10.1978.



Figure 3.22 MICA UNDERCUTTING & CHAMFERING

3.4.6.3 Bar to bar conductor resistance & Equiliser resistance tests

- One of the most important “condition monitoring” tests is the bar to bar resistance check on traction motor. This is very important test to detect defective joints in commutator risers, open or short circuited coils. This test should be done with a precision digital resistance meter with least count of a few micro ohms.
- This test is to be carried out as per instructions given in SMI no. RDSO/ELRS/SMI/51 dt. 30.04.1979.

3.4.6.4 Millivolt drop test

- This test is carried out for detecting cross connection of leads, short circuits or open circuits in the armature winding coils and behind the commutator riser.
- This test is to be carried out as per instructions given in the RDSO SMI no. ELRS/SMI/25 dt. 24.07.78.

3.4.6.5 Ten-Delta measurements on armature

- The measurement of tan-delta (dissipation factor) is carried out for checking insulation between armature shaft and winding. The measurements should be carried out between the commutator (with all segments shorted by a copper wire) and the armature shaft.
- For carrying out this test refer SMI no. RDSO/ELRS/SMI/128 dt. 19.06.1985.
- This should be recorded in armature history card.

3.4.7 Checking of brush holder

- Remove the brush holders from the magnet frame and thoroughly clean.
- Inspect for damages and recondition if necessary.
- Check the condition of the springs and measure the spring tension on the test bench by spring balance. It should be 2.7 to 3.65 kgf as shown in figure 3.19.
- Check the clearance between a new carbon brush and the brush holder and if this is greater than 0.50mm, scrap the holder, & provide new brush holder.
- Inspect the brushes for wear, damage, breakage of flexible leads and freedom in the brush holder.
- Renew the brushes, if necessary, by same grade & size.
- Bed new brushes on to the commutator.



Figure 3.23 CHECKING OF SPRING TENSION

3.4.8 Inspection of magnet frame (stator)

- Check the wear plates on the nose suspension for wear & measure the gap, it should be between 241.30 to 242.06 mm.
- Check axle ways & the axle caps for wear, distortion and cracks.
- Examine all cables, fit a new cable in place of any damaged cable.
- Check field coils & the connections for tightness and their condition. If all are in good condition, repaint the whole of the interior with silicon grey finishing paint.

3.4.9 Ultrasonic testing of Armature Shaft

Ultrasonic testing of armature shaft is to be carried out to detect any flaw etc. to avoid the failures of armature shaft. This test is to be carried out as per the ultrasonic testing report no. MC.41 dt. 18.02.92 issued by M&C Directorate of RDSO.

3.4.10 Checking of pinion

- Clean the pinion with kerosene XYLOL or similar solvent with a brush and wipe with a cloth.
- Examine the pinion visually for any damage, excessive wear of any other defect.
- Pinion should be checked with red dye penetrating test (RDPT) for any crackness on its teeth/body.
- Measure dimension 'K' over the specified teeth i.e. 3 teeth and note the average value of 8 different measurements by a micrometer of suitable size. It should be 56.210/56.083mm for new pinion and 54.48mm is serviceable limit. If 'K' value is found less than 54.48mm then scrap the pinion and fit new pinion.

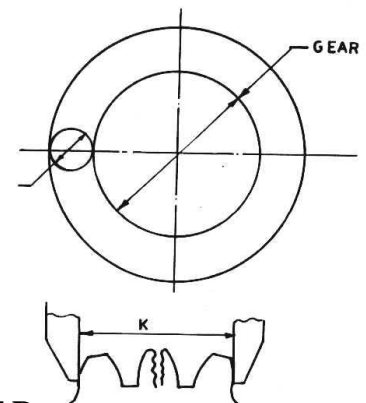
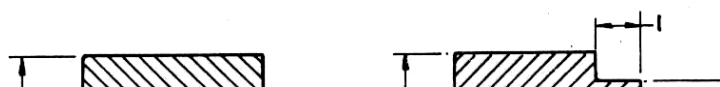


Figure 3.24 MEASUREMENT OF 'K' VALUE OF P

3.4.11 Reassembling of Traction Motor

- Check and ensure that the distance between the CE bearing abutment face & PE bearing sleeve face is 575.35/575.70 mm.
- Grease PE bearing forcing the grease between rollers, bage and outer race. Press the bearing into the end shield using a screw press. Ensure that the identification mark on the bearing is facing towards the outside of the machine.
- Lift the end shield PE using lifting shackle 1405977 and assemble it into the bearing inner race, taking care not to damage the inner race with edges of rollers.
- Slide PE spacer 1405979 onto the shaft butting against the PE bearing inner race. The spacer is temporarily used in place of the bearing wiper PE to facilitate run outs and



diametrical clearances checks on the PE bearing after assembling the armature in the magnet frame.

D1	D	L	C	A
111.85	154.00	42.00	8.0	45°
112.00		41.85		

Figure 3.25 SPACER (Tool no. 1405979)

- Fit retaining ring PE 1405397 and bolt it on to the End-shield. At this stage do not fully tighten the studs, 1405976. bolt lifting shackle 1405977 on to the shaft end and fully tighten its bolts. Now fully tighten the studs 1405976.

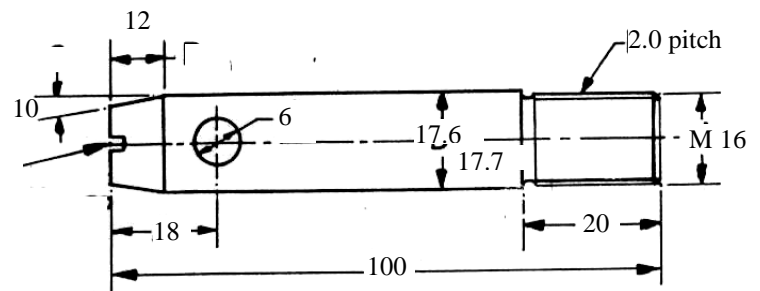
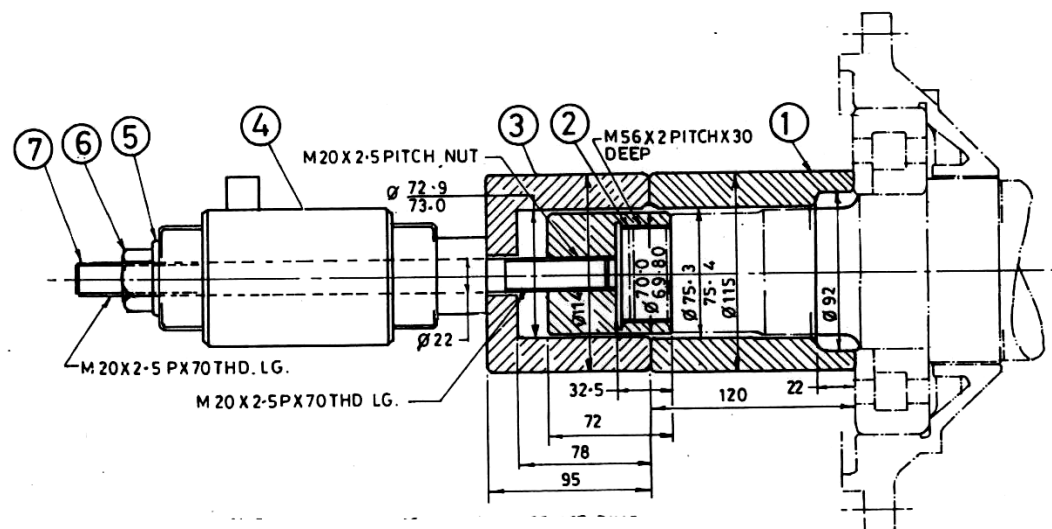


Figure 3.26 GUIDE STUD M 16 (Tool No. 1405976)

- Grease CE bearing cartridge, grease CE bearing, forcing the grease between rollers, cage outer race and labyrinths. Assemble CE bearing along with the cartridge onto the shaft using pressing tackle 1405341.



1	Sleeve 115 dia x 120 LG	4	Hollow hydraulic ram 10 ton x 2" stroke
2	Nut 70 dia x 72 P 4.8	5	Washer M20
3	Sleeve 114 dia x 95 LG	6	Hex nut M 20 x 2.5P
		7	Stud M20 x 370 LG

Figure 3.27 PRESSING TACKLE FOR CE BEARING (Tool No. 1405341)

- Grease the outer bearing cap CE and assemble on the bearing cartridge and tighten the bolts using new lock washers.
- Screw two guide studs 1405976 any two diametrically opposite tapped holes in the CE bearing cartridge spigot into the magnet frame during assembly of the armature.
- Screw two eye bolts M20, 1405978 in the tapped holes of magnet frame meant PE end shield. Up-end the frame and place it CE down on three wooden blocks of 300 mm high, level the frame in true vertical position, by using spirit level. Remove the eye-bolts and fit two guide studs 1405976 M 20 for guiding the PE end shield during armature assembly.
- Lift the armature vertically using lifting cap PE 1405398 already mounted earlier and lower it carefully and gradually ensuring that the CE bearing cartridge and armature winding are not damaged.
- Fit and tighten the PE end shield bolts uniformly and a little at a time. Also, replace guide studs 1405976 with eye bolts 1405978. this operation will also force the CE bearing cartridge into its seating. If, however the cartridge to frame fit is tight, insert the cartridge bolts and tighten them uniformly in steps with the end shield bolts.
- Using one of the lifting eyes cast on the motor frame and two eye bolts 1405978 M 20, turn the frame to a horizontal position, resting the pinion end of the frame on wooden block 100mm high.
- Remove retaining ring PE 1405397, lifting cap 1405398 and PE spacer 1405979.
- Measurements of bearing Run Outs & Clearances

Measure the bearing run outs and diametrical clearance as follows, taking great care to prevent dirt from falling into the grease and the bearing.

- a. Attach a armature with a magnetic base, with the end of the armature shaft and arrange the pointer to bear against the bearing outer race as near the centre as possible, but avoiding all identification marks on the outer race.
- b. Rotate the armature and read the run out of the bearing outer race cage, ensuring that the armature is kept forward (on the wooden block 100mm high under the PE assisting in this respect to eliminate any end play). The maximum permissible run out for bearing outer race is:

CE 0.10mm

PE 0.10mm

If the run out exceeds the above limit, carefully examine the assembly for burrs or for dirt under the fits of the cartridge, end shield or frame.

- c. Fit the dial gauge to the outer race of the bearing or a flat portion of the end shield and arrange the spindle to bear against the inner race face of the bearing as near the centre as possible, but avoiding all identification marks. Rotate the armature and read the run out of the inner race. The maximum permissible run out for bearing inner race is:

CE 0.013 mm

PE 0.013 mm

- d. Check the diametrical clearance between each roller and inner race at the bearing. Place the edge of the filler gauge against the roller and the inner race where they make contact with each other.

Turn the shaft just sufficiently, to roll the top roller on the filler gauge. Insert different filler gauges until the clearance is established. The maximum diametrical clearance is:

CE 0.03 mm

PE 0.03 mm

- Fit the PE outer bearing cap and tighten the bolts fully. Shrink fit the PE outer bearing wiper onto the shaft by heating it to 90 to 100 deg. C above ambient. When cold, tap it with light hammer and copper drift to ensure its proper fitting.
- Fit the CE bearing separate lip. Fill the grease in CE outer bearing cap and assemble it by using new lock washers and bolt. Smear grease on outside labyrinths of cap. Ensure that no metal swarf remains in the bearing. Replace cartridge guide studs 1405976 with bolts.
- Shrink fir the CE outer bearing wiper onto the shaft by heating it to 90 to 100 deg. C above ambient. Press the wiper while hot by pressing tackle 1405342. Tap the bearing wiper CE using light hammer and copper drift when it is cold to ensure that sleeve is fully butting against the bearing lip.

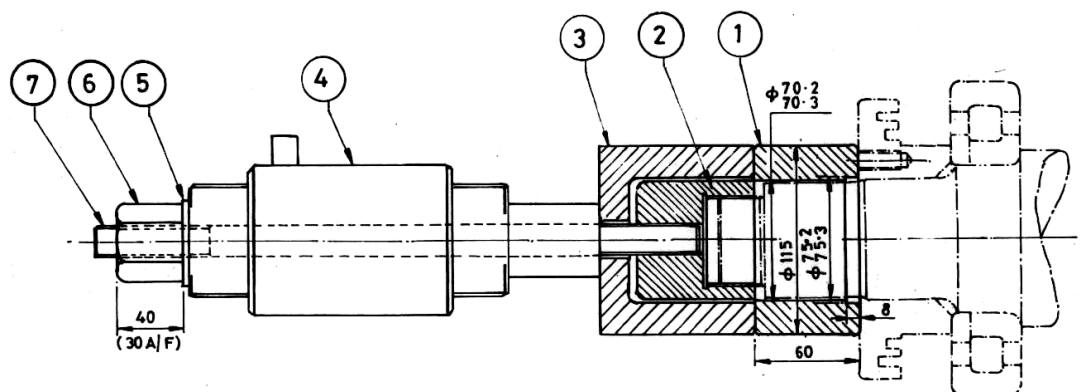


Figure 3.28 PRESSING TACKLE FOR CE OUTER BEARING WIPER (Tool No. 1405342)

1	Sleeve 115 dia x 60 LG	5.	Washer M20
2	Nut	6	Hex nut M20 x 2.5P
3.	Sleeve	7	Stud M20 x 370LG
4	Hollow hydraulic ram 10 ton x 50mm stroke		

- Fit the key onto the shaft key way.
- Fit the fan onto the shaft by heating it at 90°C to 100°C above ambient.
- Apply the fan nut and lock washer quickly but do not lock it, follow up with nut as the fan cools, tightening with the spanner 1405343. finally lock, when cold.

3.4.12 Refitting the pinion

- Examine the shaft extension, pinion bore for burrs or other superficial damage. Trim any such defects with a fine stone and finish with very fine emery cloth.
- Ensure that any rectification extends to the pinion that will be finally occupied by the pinion.
- Wipe clean the pinion and shaft extension.
- Apply a thin film of marking compound to the pinion bore.
- Pass the pinion over the shaft to within 25mm of its forward position and then push it smartly home without the use of excessive force.
- When the pinion is withdrawn, evidence of bedding should be apparent over not less than 90% of the area of the pinion seating. For checking bedding, use a plain white paper & roll it on the shaft extension & press gently by hand around the surface & remove it & check the marking on paper. It should be more than 90% of the area of pinion seating.

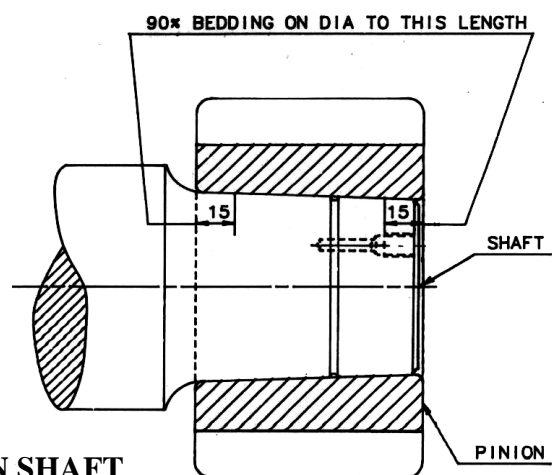
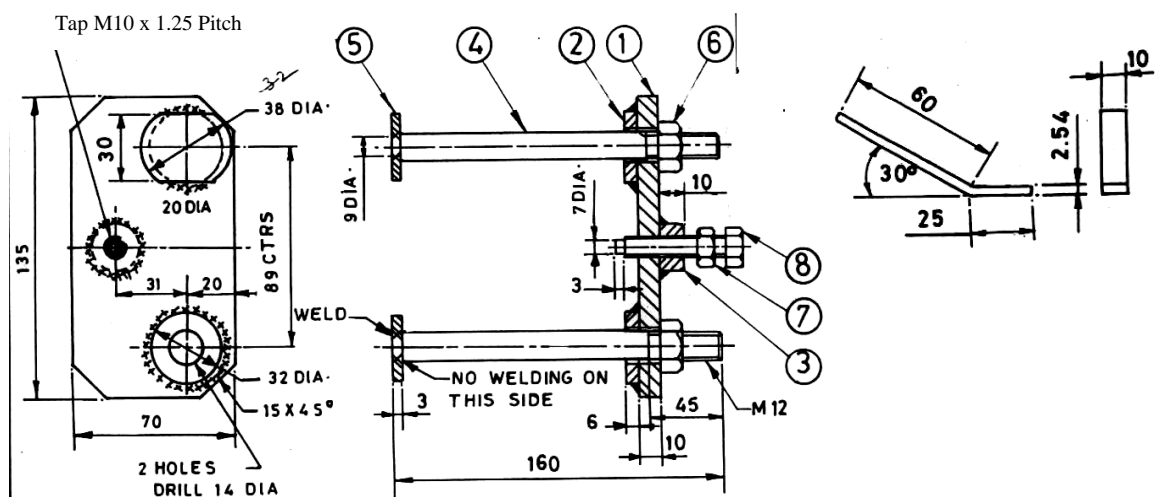


Figure 3.29 FITMENT OF PINION ON SHAFT

- If satisfactory marking is not obtained, the shaft or pinion should be dressed with a fine oil stone to spots indicated by the marking compound.
- Apply the rectification only to the defective surface.
- Clean the pinion bore and shaft extension and repeat the bedding check.
- Thoroughly clean the surface of the shaft, including oil injection hole and pinion, using a solvent such as white spirit. Wipe dry using a clean dry cloth.
- To establish the cold pinion position, pass the pinion onto the shaft push it 'home' without using excessive force. The amount of force is such that, when the pinion is 'home' it should be possible to turn the armature with it. Make a corresponding line on the pinion and shaft end faces with chalk and carefully measure, with a depth micrometer or vernier gauge, the position of the pinion face in relation to the shaft end at the chalk line. Record this distance.

- Application of R.C. compound
(As per service bulletin of M/s BHEL, BPL no. TME/SB/AC/EMU/026B nov., 99)
 - Material
Special compound : for application on the shaft and pinion bore.
 - Source of supply
 - I. M/s NALCO CHEMICAL CO. USA (Indian Representative – M/S NALCO CHEMICAL INDIA, C/O IEL LTD. P.O. NO. 107, Hamilton House, New Delhi – 110 001.)
 - II. M/S ALLCHEM LTD., 1055 Trumen Street, P.B. 5002 L7 R3 Y9 Burlington, ONTARIO, CANADA
 - III. BHEL – BHOPAL
 - The special compound has short life of 3 months and starts to gel. It is, therefore recommended that the date of manufacture/expiry may be checked before use of the special compound.
 - Stir the compound thoroughly and apply a coat of compound with brush on the shaft and pinion bore.
 - Wipe clean the shaft and pinion bore with dry lintless cloth or blotting paper before the compound dries of its own to leave only a thin film on the surface.
 - Do not touch or allow any contamination of the treated surface.
- Mount the pinion positioning gauge 1405396 onto the pinion, taking care that there is 5.0mm of clearance between the back of the setting tackle and the pinion end bearing cap to allow for the advance of the pinion without fouling. Adjust the setting screw, placing a gauge of the street of the correct thickness between the point of the screw and the shaft end.



1	Plate 10 TK x 75 x 135 LG	4	Trhreaded bar dia 12 x 157	7	Hex lock nut M10 x P1.25
2	Boss 6TK x 32 dia	5	Pad 3TK x 28 dia P4.8	8	Special hex screw M10 x 50 x P1.25
3	Boss 10TK x 20 dia	6	Hex nut M12 P4.8	9	Feeler 2.5 TK x 85 LG

Figure 3.30 PINION POSITIONING GAUGE (Tool No. 1405396)

- Lock the setting screw in position, mark the position of pinion on the shaft. Remove the pinion.
- Heat the pinion still with positioning gauge attached, in an oven of induction heater capable of providing uniform heating. The oven must be so constructed that the pinion is not in direct contact with surface of heat and can operate at temperature approximately 20 deg. C higher than that required for the pinion. Under no circumstances must be oven temperature exceed 220 deg. C.
- Heat the pinion to a point at which the temperature differential between shaft and pinion is 115 deg C. this is sufficiently higher than calculated fitting temperature to ensure that the pinion has complete freedom to advance to the positioning gauge screw.



Figure 3.31 HEATING OF PINION ON INDUCTION HEATER

- When the pinion and positioning tackle have reached the required temperature, quickly transfer them to a position conveniently near to the shaft, and place the pinion over the shaft end 25mm from its final position, with the chalk marks coincidental. Quickly press the pinion as far onto the shaft as the setting screw on the positioning gauge will allow. Hold the pinion in position until it cools sufficiently to grip the shaft, and then remove the positioning tackle.

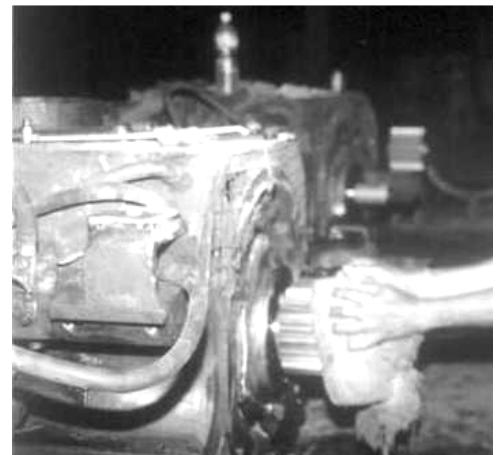


Figure 3.32 SHRINK FITTING OF PINION ON SHAFT

- Check the advance of the pinion at the marked position using a depth micrometer or vernier gauge. The advance must be between the limits specified i.e. 2.9 to 3.1 mm.
- If the advance is correct, allow the pinion to cool. After cooling again check and record the final pinion advance which should remain within the specified range.

NOTE

If a suitable oven or induction heater is not available, the pinion may be heated in an oil bath, but all traces of oil must be removed from the pinion before fitting. In such case, R.C. compound should not be applied on the shaft & pinion bore. This may effect the bonding quality of the compound.

3.4.13 Test the Motor on No-load As Follows:

- Run the motor at a speed of 1500 RPM. After the motor has been running for a few minutes, check whether the run is smooth. If so, continue to run the motor and record the temperature of the bearing, the steady state temperature rise should not exceed 35 to 40 deg C above ambient.



Figure 3.33 RUN TEST OF TRACTION MOTOR ON NO LOAD

- Increase the speed to about 2000 rpm. After 15 minutes, increase the speed to 2725 rpm for short period. During this test, the peak temperature rise should not exceed 50 to 60 deg C above ambient.

NOTE

- Do not run bearing at high speed under no load condition for long period because of the possibility of rollers skid which can cause scuffing of the track and roller surface, and premature bearing failure.

3.4.14 Fit the fan chamber on its mounting plate and fit the air duct on its position.

3.5 INSPECTION AND TESTING PROFORMA FOR OVERHAULING OF TRACTION MOTOR

A. Stage: Pre-Inspection

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1.	A, AA cables	IR value	Meggar (1000V)	1 M Ω (min.)	
2.	Y, YY cables	IR value	Meggar (1000V)	1 M Ω (min.)	

B. Stage: Overhauling of Armature

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1.	Armature	IR value	Meggar (1000V)	1 M Ω (min.)	
2.	Commutator	Ovality	Dial gauge	0.03 mm	
3.	Commutator	Diameter	Outer calliper	324 to 305 mm	
4.	Commutator	Depth of under cut	Depth gauge	0.8 to 1.3 mm	

C. Stage: Overhauling of Stator

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1.	Y, YY Cables	IR value	Meggar (1000V)	> 2 MΩ	
2.	A, AA cables	IR value	Meggar (1000V)	> 2 MΩ	
3.	Nose plates	Nose gap	Vernier	242.06 mm max.	
4	Brush holder	IR value	Meggar (1000V)	> 2 MΩ	
5	Earth return brush	Length	Vernier	34.4 mm min.	
6	Cable condition	Any damage	Visually	No damage or rubbing	

D. Stage: Overhauling of Bearings

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1	PE bearing	Diametrical clearance	Filler gauge	0.145 to 0.190 mm	
2	CE bearing	Diametrical filler gauge	Filler gauge	0.105 to 0.140 mm	
3.	PE bearing	Grease quantity	Weight	550 gm.	
4	CE bearing	Grease quantity	Weight	315 gm.	

E. Stage: Assembling of Traction Motor

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1	Brush holder to commutator	Gap	Feeler gauge	1.6 to 3.2 mm	
2	Arc horn	Gap	Internal gauge	11 to 12 mm	
3	Brush holder spring	Tension	Spring balance	2.7 to 3.65 kgf	

F. Stage: Testing of Traction Motor

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1	Speed	Rpm	Tachometer	1500 rpm	
2	PE bearing	Condition	Echo pulse meter (SPM)	Green	
3	CE bearing	Condition	Echo pulse meter (SPM)	Green	
4	PE bearing	Temperature rise	Digital temperature indicator	35 to 40 deg C + ambient temp.	
5	CE bearing	Temperature rise	Digital temperature indicator	35 to 40 deg C + ambient temp.	

G. Stage: Pinion Mounting

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1	Pinion surface	Temperature rise	Digital temperature indicator	115°C + ambient temp.	
2	Shaft edge	Advancement	Vernier	2.9 to 3.1 mm	

H. Stage: Final Testing

S.N.	Description of the item	Parameters verified	Mode of inspection/ testing	Permissible value	Actual value
1	A, AA cables	IR value	Meggar (1000V)	1 MΩ (min.)	
2	Y, YY cables	IR value	Meggar (1000V)	1 MΩ (min.)	

I. Stage: Fitment of Traction Motor

Critical dimensions to be maintained during fitment of T.M.

S.N.	Description	New Dimension (in mm)	Condemning Dimension (in mm)	Actual value
1	Axle suspension bearing lateral clearance at each end.	0.75	4.00	
2	Axle suspension bearing diametrical clearance	0.35	1.5	
3	Particulars of sandwich unit			
3.1	Free height of rubber sand witch unit	157/ 158	153.5	
3.2	Two, top and bottom spring	76.2	These plates normally do not wear	
3.3	Two extreme top & bottom spring plates (2 x 9.5 mm)	19.0	18.0	
3.4	Overall free assembled height	252.2/ 253.2	247.7	
4	Traction motor nose dimensions between wear plates	241.30/ 242.06	243.50	
5	Dimensions between bogie transom noses	240.506/ 239.710	243.00	

CHAPTER 4

COMMON FAILURES

S.N.	Failures	Possible Cause	Suggested Remedies
1.	Commutator Flashed/poor commutation	<ul style="list-style-type: none"> i. Carbon brushes of different grades & sizes. ii. Sticking of carbon brushes in brush holder. iii. Chattering/vibration of carbon brushes. iv. Unbalance of brush current i.e. colour change in pig tail of brush. v. Carbon brush slack in its housing. vi. Defect in commutator i.e. ovality, high bar, burrs, unequal oxygenated film etc. vii. Vibration in traction motor. 	<p>Replace with the same grade and size.</p> <p>Clean the brush holder and remove the dust etc.</p> <p>Check the spring tension & correct it.</p> <p>Clean the commutator surface and polish it with epoxy paper belt.</p> <p>Check the clearance between new carbon brush and its housing, it should be less than 0.5mm, if it is more, replace the brush holder.</p> <p>Check the commutator surface and if required, replace the traction motor, commutator defect to be removed.</p> <p>Examine lateral (diametrical) clearance of axle bearing, vibration of motor and unbalance of armature. Abnormality shall be adjusted according to the maintenance data.</p>
2.	Circuit breaker tripping due to earth fault in Traction Motor	<ul style="list-style-type: none"> i. Armature insulation level less or IR value zero. ii. Field coil insulation damaged or IR value less/zero. iii. IP coil insulation damaged or IR value less/zero. 	<p>Replace the traction motor, check the armature for earth fault and rectify the same & TM O/H to be done.</p> <p>Replace the traction motor, and check the field coils and rectify the defect & TM O/H to be done.</p> <p>Replace the traction motor and attend the IP coil & TM O/M to be done.</p>

S.N.	Failures	Possible Cause	Suggested Remedies
		<p>iv. Carbon brush holder spring broken & carbon brush hanging & touching the metallic surface of TM.</p> <p>v. Carbon brush pig tail broken & flashed.</p> <p>vi. Traction motor inter connection leads insulation damaged.</p> <p>vii. Traction motor power cable insulation damaged due to rubbing with metallic body.</p> <p>viii. Traction motor IR less due to moisture & dust.</p> <p>ix. Traction motor cable connection flashed in junction box due to loose connection etc.</p> <p>x. Creepage or insulation damage of brush holder legs.</p>	<p>Replace the concerned brush holder & clean the commutator flashed area.</p> <p>Check the carbon brush grade & replace with correct grade & clean the flashed area.</p> <p>Replace the traction motor and rectify the defect.</p> <p>Check and attend the damaged cable and secure all the cable properly providing the proper rubber gaskets.</p> <p>Clean the concerned traction motor & blow it with dry compressed air and improve its IR value, if require, replace the traction motor.</p> <p>Check the junction box and replace it if required. Tightness of cable connections to be checked.</p> <p>Check and apply insulating varnish or replace the brush holder if required.</p>
3.	Overload relay tripping due to more current drawn by traction motor.	<p>i. Armature winding short circuited or commutator segments shorted.</p> <p>ii. Traction motor axle suspension bearing white metal out & traction motor rotating jam.</p> <p>iii. Traction motor armature bearing seizure.</p> <p>iv. Axle box bearing seizure or bearing damaged.</p>	<p>Replace the defective traction motor and rectify the defect.</p> <p>Replace the concerned traction motor. Check the suspension bearing white metal quality and oil condition, white metal may also out due to starvation of oil.</p> <p>Replace the traction motor. Check the armature bearing clearance, grease condition and roller condition etc. and replace the bearing set.</p> <p>Check the axle box bearing and grease condition for metal contacts & replace the axle box if required.</p>

S.N.	Failures	Possible Cause	Suggested Remedies
4.	Abnormal noise coming from traction motor.	i. Traction motor cooling fan loose on shaft or fan blades damaged. ii. Pinion teeth broken or damaged. iii. Pinion free on shaft or pinion slack. iv. Armature shaft locking but broken. v. Any foreign material in the traction motor. vi. Armature bearing clearances more or damaged.	Replace the traction motor and check the fan bore & shaft dia, and if fan damaged, replace the fan. Fan locking nut tightness to be done with proper torque by proper spanner. Replace the traction motor and check the pinion fitting & pinion teeth, if required, pinion to be replaced. Proper procedure to be followed for removing & fitting of the pinion. Replace traction motor and check the pinion bore & shaft dia and also check the bedding, pinion fitting advancement to be checked & R.C. compound to be used while refitting the pinion. Replace the traction motor and attend the defect, proper locking nut to be provided. Replace the traction motor and remove the foreign material and check the health of traction motor and attend the defect. Replace the traction motor and overhaul. Check all the bearings carefully and replace with new one if required.
5.	Traction not effective i.e. particular wheel not rotating.	i. Armature winding coil or field coil or IP coil open circuited. ii. Stator MP & IP connection strip broken flashed or burnt. iii. Pinion free on shaft. iv. Traction motor cable connection flashed & parted in junction box.	Replace the traction motor and check the defect and attend the same. Check the motor and attend the defect, if required, traction motor to be replaced. Replace traction motor and check the pinion bore & shaft dia and also check the bedding, pinion fitting advancement to be checked & R.C. compound to be used while refitting the pinion. Check and attend the defect on position, replace the junction box, cable lugs etc., if required.
6.	Armature shaft broken	Armature shaft may broken/sheared off due to existence of any flaw previously.	Ultrasonic testing of armature shaft to be carried out during every overhauling to prevent such type of failure.

CHAPTER 5

DO'S AND DON'TS

5.1 DO'S

1. Add a few drops of mineral oil to the solvent while cleaning the bearings and their components to protect them from rust.
2. Always use torque wrench for tightened nuts & bolts as per recommended, tightened torque value.
3. Always ensure that the modification/special maintenance instructions are being followed.
4. Ensure that the new carbon brushes are of the same grade, as the old ones, while replacing the carbon brushes.
5. Ensure that the cables are secured properly and not rubbing with any metal parts.
6. Ensure that the washers and locking plates are properly provided while assembling the traction motor parts.
7. Ensure that the oven/induction heater is working at the recommended temperature.
8. Always use shock pulse meter (SPM) for monitoring the condition of bearings and keep a record of the bearings.
9. Ensure that the all specified clearances are maintained properly.
10. Ensure that the carbon brushes are removed before application of solvent for cleaning the traction motor.
11. Always slip a thin clean press board between brush holder and the commutator while replacing a brush holder to prevent damage to the commutator surface.
12. Always check the clearance between the under side of the brush holder and the commutator when refitting a brush holder.
13. Ensure that the lubricating oil/compound of approved make are in use.

5.2 DON'TS

1. Don't use carbon waste or fluffy cloth for cleaning brush gear, commutator since left over fluffs or fibres may cause electrical or mechanical failures.
2. Don't reuse used grease or lubricant oil.
3. Don't carry any alteration or modification without the approval of component authority.
4. Don't overtight cable cleats because cable insulation may damage.
5. Don't use carbon brushes of different grades on same traction motor.
6. Don't use higher voltage meggar than specified.
7. Don't use detergent or any other volatile cleaning solvent/agent, for cleaning inside the traction motor, junction box, insulator etc.
8. Don't mix up the greases of same grade but different make.
9. Don't compromise resurfacing/ turning unless grooves or stepped wear or ovality is found.
10. Don't carry out the commutator resurfacing/turning unless grooves or stepped wear or ovality is found.
11. Don't allow the wearing of carbon brushes beyond specified condemning size.
12. Don't conduct high voltage test at 1.5 kV after overhauling of traction motor.
13. Don't soak the carbon brush in solvent as solvent will gradually ooze out, effecting the commutation and will cause the brush to jam in the grade.
14. Don't run motor at high speed under no load condition for long period because of the possibility of rollers skid which can cause scuffing of the track and roller surface and premature bearing failure.
15. Don't forget to refit the plug into the oil injection hole immediately after removal of the pinion to prevent the ingress of foreign matter.
16. Don't touch or allow any contamination after the application of R.C. compound while fitting the pinion.
17. Don't overtight the setting screw against the gauge while fitting the pinion as this will give a false reading of pinion advancement.
18. Don't apply R.C. compound on the shaft & pinion bore when pinion is heated in an oil bath.

APPENDIX 'A'**List of Modification/Special Maintenance Instruction Issued by RDSO for Traction Motor of AC EMU & MEMU.**

SN.	SMI No.	Brief Description of SMI
1	ELRS/SMI/25 dt. 30.12.77	Resurfacing of commutator to be carried out periodically for correcting ovality and removing grooves, high bars ridges, burrs. Commutator should machined only if defects mentioned above are observed.
2	ELRS/SMI/29 dt. 24.07.78	Mili volt drop test to detect cross connection of leads, short circuits & open circuits in the Coil and behind the commutator riser.
3	ELRS/SMI/29 dt. 16.09.78	Recommending the speed, feed and type of tools to used in the machining/resurfacing operation of the traction motor commutators.
4	ELRS/SMI/31 dt. 24.10.78	Regarding undercutting of Mica & chamfering of commutator segment.
5	ELRS/SMI/51 dt. 30.04.79	Bar to bar conductor resistance & equaliser resistance checks on traction motor with a precision digital resistance meter with least count of a few micro ohms.
6	ELRS/SMI/52 dt. 05.05.79	Reduction in the entry of gear compound into the bearing of 253 BX/133 AY T.M.
7	ELRS/SMI/60 dt. 19.06.85	Discontinue the dielectric tests at 1.5kV AC in all traction motor after overhauls.
8	ELRS/SMI/128 dt. 11.06.85	Tan delta measurements on traction motor armature for the evaluation of quality of insulation of armature between commutator and the armature shaft.
9	ELRS/SMI/140 dt. 11.02.92	To ensure the clearances of bogies (to be maintained for arresting the premature failure of Nose Sand witch block).
10	ELRS/SMI/182 dt. 04.06.96	The skin that forms on the surface of the commutator should be removed with cloth soaked in carbon tetrachloride and black spot can cleaned with glass fibre stick.
11	EL/3.2.85 dt. 6.8.99	Use of leather bellows for traction motor EMU motor coaches.
12	ELRS/SMI/141 dt. 4.92	Diametrical clearance of suspension bearing on BG AC EMU axle.

REFERENCES

1. AC Traction Maintenance & Operation Manual (ACTM) Vol.III 1994.
2. Maintenance Manual for 25 kV Board gauge AC and Main Line Electrical Multiple Unit (Electrical Equipment) issued by BHEL/Bhopal.
Book no. MM/AC-M/EMU/003, Jan., 2001.
3. Papers presented during the seminar on “Maintenance of Traction Motor of AC EMU/MEMU” on 12.12.2003 at CAMTECH.

OUR OBJECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity, performance of all Railway assets and manpower which inter-alia would cover reliability, availability, utilisation and efficiency.

If you have any suggestions and any specific Comments please write to us.

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