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MAINTENANCE HANDBOOK
ON
TRACTION MOTOR COOLING BLOWER AND ITS MOTOR

CAMTECH/2001/MVMT/1.0

AUGUST 2001

Centr*e*
for
Advanced
Maintenance
TECHnology

Excellence in Maintenance

Maharajpur, GWALIOR - 474 020

MAINTENANCE HANDBOOK
ON
TRACTION MOTOR COOLING BLOWER
AND ITS MOTOR

FOREWORD

The proper maintenance of Traction Motor Cooling Blower and its Motor is necessary for trouble free operation of Electric Locomotive and avoids failure enroute. CAMTECH has prepared this handbook to cover all essential aspects of maintenance of traction motor cooling blower and its motor to ensure their reliability.

The handbook describes various maintenance schedules along with their periodicity and detailed procedure to be adopted for each component during repair and overhauling. A very useful compilation of list of common defects and their remedies is included in the handbook. The staff in maintenance depots will benefit from these, which in turn will be reflected in improved reliability and availability of Electric Locomotives and thus economy in operation.

CAMTECH, GWALIOR *M.L.GUPTA*
8th OCTOBER' 2001 ***EXECUTIVE DIRECTOR***

PREFACE

The traction motor cooling blower and its motor is used in all WAM4, WAG5, WAG7, WAP1 and WAP4 class of AC electric locomotives. It is vital equipment and its proper upkeep and maintenance is necessary to ensure reliability and availability of AC electric locomotive. This handbook on "Maintenance of traction motor cooling blower and its 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 in the “Maintenance manual of electric locomotive” and “AC traction manual” or instructions issued by Railway Board/ RDSO.

I am sincerely thankful to all officers and staff of electric loco directorate of RDSO/ LKO for their 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 or if you have any ideas. We shall highly appreciate your contribution in this direction.

CAMTECH, GWALIOR
16TH AUGUST’ 2001

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/2001/MVMT/C.S. # XX date-----------

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

CORRECTION SLIPS ISSUED

Sr. No.	Date of issue	Page no. and Item no. modified	Remarks

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CHAPTER 1

INTRODUCTION

An electric locomotive consists of various equipment. Traction motor cooling blower and its motor is one of the important auxiliary machine. There are two traction motor cooling blowers fitted in a locomotive. Each for cooling of one group of three traction motors. Failure of one unit results into isolation of three traction motors. Therefore it is very essential to have both traction motor cooling blower units in healthy working condition.

Power supply arrangement and control circuit for MVMT is shown in figure 1.1(a) and 1.1(b) on page 2 and page 3 respectively.

1.1 BRIEF DESCRIPTION

Traction motor cooling blower unit comprises of following three major components:

- Motor (MVMT)
- Housing (Casing) with inlet cone
- Impeller

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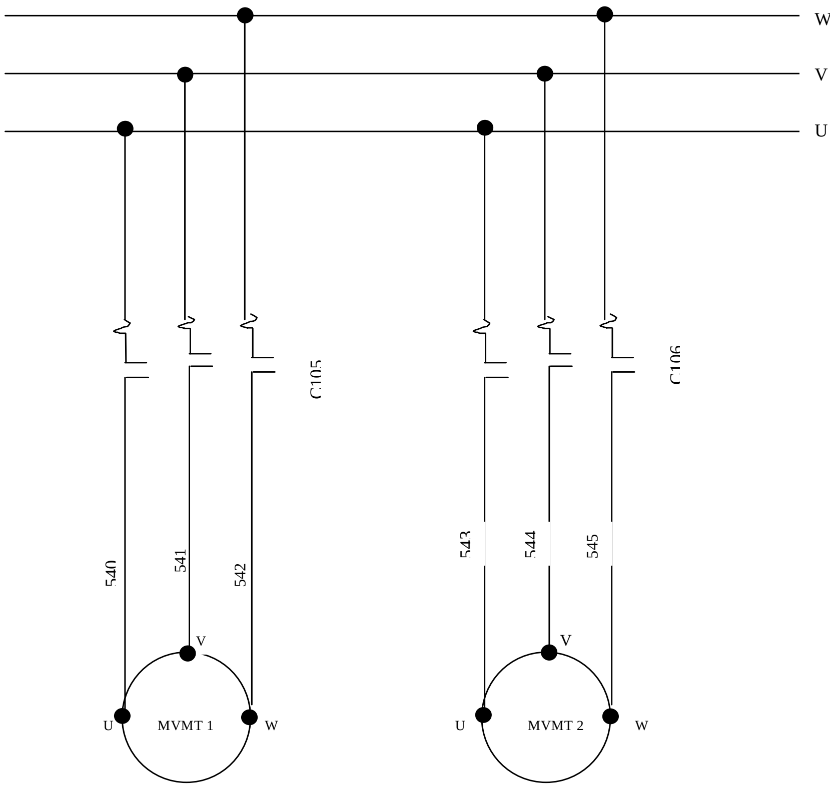

Figure 1.1(a) Power supply arrangement for MVMT

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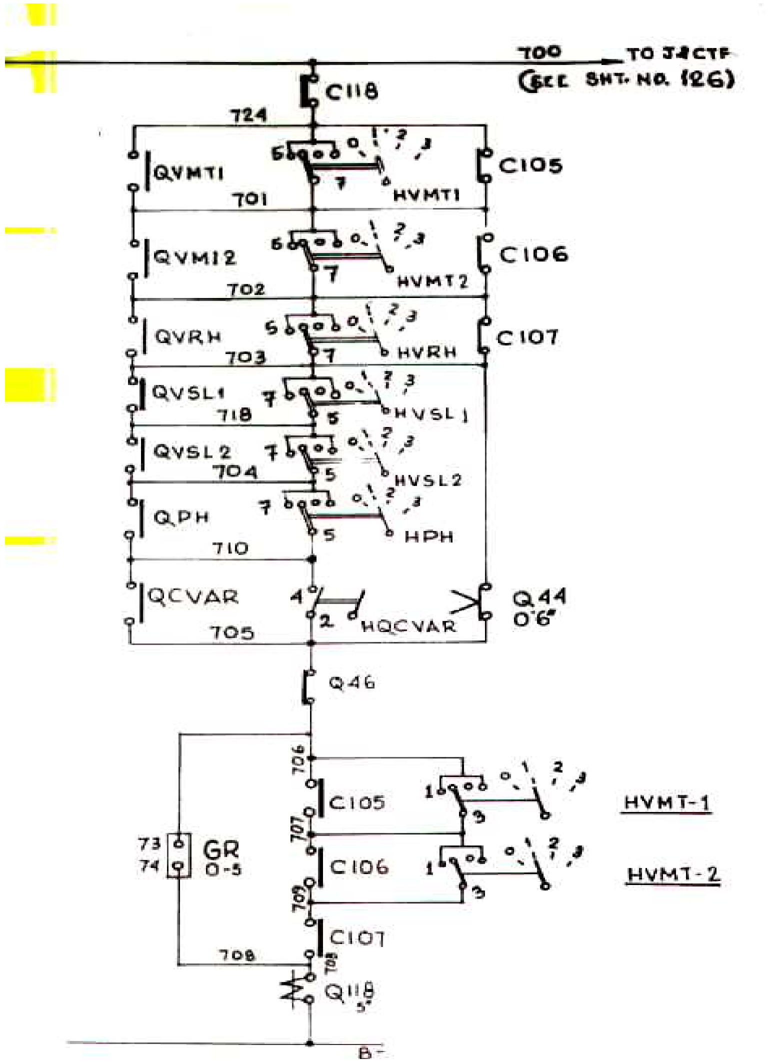

Figure 1.1 (b) Control circuit for MVMT

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1.1.1 **Motor**

This is a three-phase squirrel cage induction motor in accordance with IS:325 designed for use in tropical climates. Motor manufactured by M/s Siemens, M/s ABB, M/s CGL and M/s BBL are in use. MVMT is shown in figure 1.2.

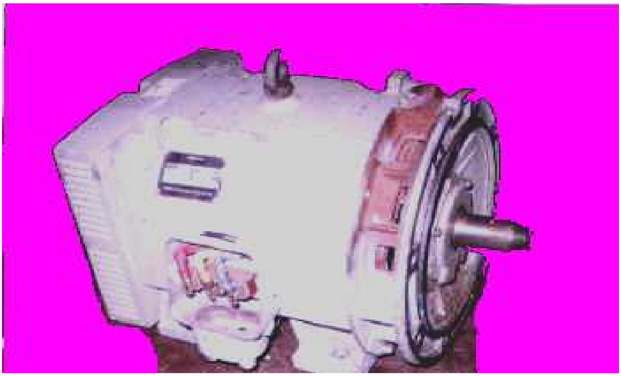

Figure 1.2 MVMT

1.1.1.1 **Technical details of MVMT**

Rating	
kW/HP	26/35
Poles	2
Voltage	290 – 415 – 500 volt
Connection	Star
Frequency	50± 3% Hz
Synchronous Speed	3000 rpm
Current at rated voltage 415 V at lowest voltage 290 V	46 Amps 66 Amps

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Bearing Details	
Type	Single row deep groove ball bearing
Make	SKF/ FAG/ NSK imported
Grease type	LL3 Balmar Lawrie, Servogem RR3 of IOC or equivalent
Quantity/ Bearing	220 Grams
Radial air gap between stator and rotor	1.0 mm

Rewinding Details		
Rewinding Parameters	Crompton Greaves	Siemens Ltd.
Wire type	Dual coated as per IS:13730 part-13.	Dual coated as per IS: 13730 part -13.
Type of winding	Double layer concentric	Double layer concentric
Connection	Star	Star
No. of coils/ No. of slots	48	48
No. of turns/ coil	8 and 9	8
No. of turns/ phase in series	64	68
Cold pitch	1- 22, 2- 21, 3- 40, 4-19	16/ 24
Slot area	229 mm^2	226 mm^2

Conductor size bare/ area Insulated diameter/ area	1.25/ 6.14 mm^2 1.35/ 7.17 mm^2	1.12/0.985 mm^2 1.217/1.163 mm^2
No. of conductor per slot	17/ 85	2 x 8
No. of wires in parallel	5 x 1.35	6 x 1.217
Copper weight	24 Kg	23 Kg
Resistance/ phase at 20° C.	0.100 Ohm	0.097 Ohm
Cold resistance at 25° C between two phases	0.209 Ohm	For BBL make 0.128 Ohm

Insulation Paper Details	
Insulation Class	H
Insulation Paper	Nomex-Kapton-Nomex (NKN)
Varnish	Dobckon - FT 2005/500 EK or Elmotherm H 71 A of M/s Schenectady Beck India Ltd.
Anti - tracking varnish on overhang etc.	Becktol Red of M/s Schenectady Beck India Ltd.
Impregnating Process	Vacuum pressure impregnation
Routine Test Value	
No load Current	13.5 Amps.
No load Power	1800 watts

1.1.2 **Housing**

Housing with inlet cone shown in figure 1.3 is a stationary part covers the impeller and guides the natural air for cooling traction motors circulated by impeller. Inlet air protection screen and airflow relay is provided on the housing. The housing is attached with motor. Inlet cone of housing is more susceptible to damage due to chances of fouling with impeller therefore proper clearance between impeller and inlet cone is to be maintained.

Fig. 1.3 Housing

1.1.2.1 **Technical Details of the blower unit**

i)	Air quantity	278m^3/ minute
ii)	Specific weight of air at 80°C	1.06 Kg/m^3
iii)	Specific weight of air at 20°C	1.20 Kg/m^3
iv)	Total pressure at 20°C	308 mm WG
v)	Impeller diameter	544 mm
vi)	Impeller tip speed	82.5m/second
vii)	Fan speed	2910 RPM
viii)	GD^2 Value of impeller	4.56 kgm^2
ix)	Full Load torque of impeller	6.72 Kg-m
x)	Weight of blower complete with motor	333 Kg.
xi)	Impeller weight	28 Kg.

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1.1.3 **Impeller**

Impeller shown in figure 1.4 is a rotating part. It is made out of AISI-304 stainless steel. It is press fitted directly on the shaft of the motor covered by the housing.

Figure 1.4 (a) Impeller

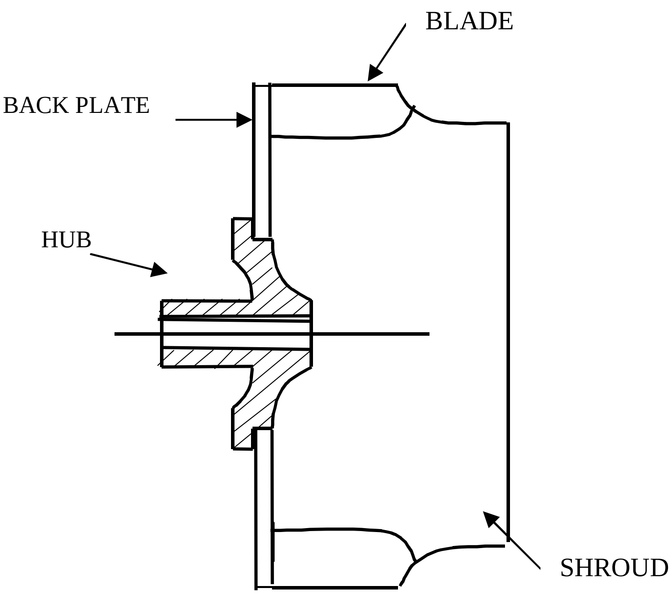

Fig. 1.4(b) Construction of Impeller

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Its physical and chemical properties are given below:

1.1.3.1 **Physical properties**

UTS (N/mm^2)	Yield Stress (N/mm^2)	% Elongation
515 (Min)	205 (Min)	35 (Min)

1.1.3.2 **Chemical properties**

C %	S %	Mn %	Si %	Cr %	Ni %
0.08 max	0.03 max	2.0 max	1.00 max	18-20	8-12

The thickness of back plate and blade for impeller is 3.15 mm and 2.5 mm respectively whereas shroud is made of 2-mm/ 2.5 mm thick.

1.2 WINDING SURGES

Voltage surges with steep wave fronts are produced by lighting strokes, by switching and by intermittent short circuits etc.

The ability of a given insulation system to withstand short time over voltage is significantly greater than its ability to withstand long time over voltage. However, repeated over voltages, even of short duration by tripping or switching off of locomotive circuit breaker, line breakers and auxiliary circuit contactors will have a cumulative effect in weakening insulation and can ultimately result in failure.

When a surge enters into a phase winding it propagates along the conductor, decreasing its velocity in the slot portion and increasing its velocity in the end-turn portion of the winding. The time required for the wave to propagate to the neutral end of the winding varies from 100 microseconds to a fraction of that time. If the neutral is ungrounded the wave is reflected back towards the terminal end of the phase at double peak value and at the same velocity. At the terminal end part is reflected toward the neutral again but with a change in sign. This process continues until the surge is dissipated through successive loss at each reflection and through eddy currents within the magnetic core.

If the neutral end of the phase is grounded the behavior of the surge is essentially the same except that reflections which occur at the neutral end reverse their signs and do not double in peak value.

Maximum turn-to-turn surge voltage usually occurs in the terminal coil of the phase winding. The terminal coil is the first one to experience the surge wave and the distributed turn-to-turn capacitance of that coil tends to absorb the voltage of the surge.

A shunt capacitance of 0.5 microfarad per phase will prevent significant reflections from occurring and also prevent excessive turn-to-turn voltage. Subsequently these shunt capacitors will also limit the peak value of voltage to ground.

1.3 VOLTAGE IN AUXILIARY MACHINES

The magnetic cores of the stator and the rotor are charged with energy when the magnetic flux is at its peak value. During normal operation this energy flows to and fro between the supply system and the core 100 times per second.

When the supply lines are disconnected, the residual energy in the magnetic circuit will be converted into electrostatic energy in the inter-turn capacitance, the relevant equation being.

$$\frac{1}{2} L .I^2 = \frac{1}{2} C. V^2$$

Where L = The inductance of the winding
I = The current at the instant of disconnection.
C = The inter-turn capacitance
V = The peak surge voltage.

The energy will then flow to and fro between the capacitance C and the inductance L until it is dissipated as heat in the winding resistance. It is estimated that the surge voltage developed in this manner can have a peak value of the order of 5000 volt.

The insulation between turns and between the leads and turns must be capable of withstanding these surge voltages. Where there is any weakness, low energy discharges will take place causing some damage to the insulation. Since these surges develop after the supply connection is disconnected there is no power flow through core and failure is not an immediate consequence.

However, the insulation gets damaged progressively until it becomes so weak that a short circuit occurs at normal operating voltage. This then could be the explanation for the fact that machines, which are switched off more often, have a higher failure rate.

Surge voltage distribution is usually not uniform. It is highest at the leads and the turns connected directly to the leads. There is a more apparent reason for higher failure rate on the overhang than in the slots. In the slot, the maximum voltage between turns is V/Ns, where V is the total voltage per phase and Ns is the number of slots per phase. This worst case occurs when the first and last turn comes adjacent to each other in a slot.

In the overhang portion wires get transposed in the mesh winding and it is quite possible that the first turn of one-slot group lies adjacent to the last turn of the next slot group. The voltage between turns will now be 2 x V/Ns.

If we take a machine where the surge voltage is 5000 volt and the number of slots per phase per pole are 4; the maximum inter-turn voltage would be between adjacent turns:

1250 volts in the slot and

2500 volts in the overhang.

The normal insulation strength between two enameled wires is usually of the order of 6000 volts when new and as drawn from the bobbins. This gets reduced due to the following factors:

a. Mechanical damage at a few points during winding.

b. Effects of elevated temperature during service.

c. Effects of vibration and thermal expansion/ contraction during service.

It is not in every motor that the inter-turn failure during surges can occur. It will depend on the manner in which the turns get mixed or transposed during winding. This explains how more than 50% motors survive ten years of service without inter-turn fault.

CHAPTER 2

MAINTENANCE

Various maintenance schedules are to be carried out at regular intervals according to service and type of the locomotives to keep equipment in healthy condition always. Maintenance schedules for AC electric locomotives are given below:

SCHEDULE	TIME PERIOD	
	GOODS LOCO	COACHING LOCO
IA	After 45 days	After 30 days
IB	After 90days	After 60 days
IC	After 135 days	After 120 days
AOH	After 18 months	After 12 months
IOH	After 4.5 years or 6 lakhs kms. whichever is earlier	After 3 years or 3 lakhs kms. whichever is earlier
POH	After 9 years or 12 lakhs kms. whichever is earlier	After 6 years or 8 lakhs kms. whichever is earlier

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The work to be carried out on traction motor cooling blower unit during different schedules is given below.

2.1 IA & IB Schedule

- Check for abnormal noise, vibration, burning smell.
- Check for looseness and crack of motor cooling fan blade.
- Check and tighten the foundation bolts.
- Check and tighten the terminal connections.
- Check the condition of terminal lugs.
- Check the impeller blades, dome and jallie for cracks, looseness etc.
- Check the earthing connections of the motor body.
- Ensure working of program switches and contactors QTD 105 & 106.

2.2 IC Schedule

In addition to IA and IB schedule following work to be carried out during IC schedule.

- Blow out dust with compressed air.
- Ensure intactness of duct jointing felt, tightness of foundation bolts.
- Check the insulation resistance. It should not be less than 1 mega ohm by 500-volt megger when machine is cold.

- Check the alignment.
- Check the bearing condition using SPM.
- Where bearings are found to be giving abnormal vibrations and noise by SPM, the clearance of the bearings to be measured and balancing of impellers to be checked.
- Check grease nipples for cracks.
- Lubricate motor bearing by approved grease.
- RDPT/ Magnaflux to be done to check any cracks in impeller, dome and foundations.

2.3 AOH Schedule

2.3.1 Pre testing

- Lift assembly with the help of crane and sling and put on testing bench.
- Remove motor terminal box cover by removing 3 nos. bolts and washer.
- Check the insulation resistance of motor winding with the help of megger.
- Give three-phase supply and start motor to check starting and running current.
- Check and note down the defects and abnormality if any.
- Check the bearing noise with the help of SPM. Check vibration if any.

2.3.2 **Dismantling**

- Remove two terminal connection of QVMT
- Remove relay from foundation by unscrewing bolts.
- Remove protection jallie by unscrewing 12 nos. bolts.
- Remove impeller cover by unscrewing bolts.
- Remove locking of impeller check nut.
- Remove check nut and locking plate.
- Fit screw puller to the impeller as shown in figure 2.1.

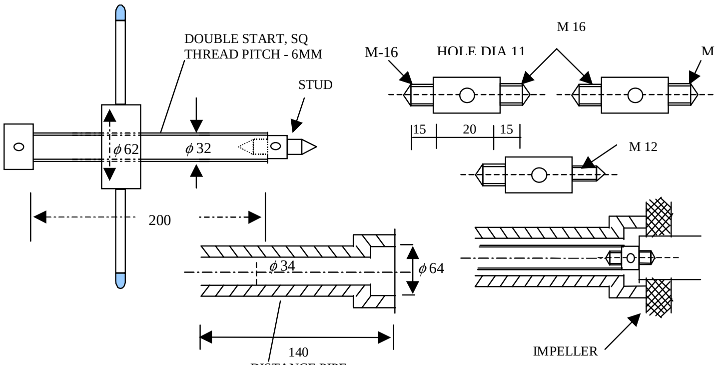

Fig. 2.1 Details of Screw Puller

- Tight the screw puller and remove impeller.
- Remove locking key from shaft.
- Remove duct by unscrewing bolts from driving end side end cover.
- Remove motor protection jallie.
- Remove grease.

- Remove grease cups.
- Remove steel ring.
- Remove both end covers by screw puller.
- Remove circlip from motor shaft.
- Remove both side bearings by suitable puller.
- Remove grease cups from both sides.
- Remove rotor.
- Remove terminal box of stator

2.3.3 **Cleaning**

- Lift duct, impeller, cover, and jallie by crane and blow with compressed air and then put into the caustic soda tank.
- Clean the motor parts i.e. stator, rotor, bearing, grease cup (both outside and inside), end cover, protection jallie, steel ring by kerosene oil.
- Blow rotor and stator with compressed air.
- Remove duct, impeller, cover, and jallie from tank and wash with fresh water.
- Check the impeller with Red Dye Penetrate Test (RDPT) or Megnaflux test and fit in rotor shaft.

2.3.4 Stator varnishing

- Replace existing terminal block by epoxy moulded terminal block of improved design.
- Stator varnishing to be done as per SMI 86.
- Put stator into oven.
- Remove stator after baking.
- Apply varnish to stator winding.
- Put stator into the oven for baking up to 8 hours.
- Remove stator from oven.
- Clean extra varnish.

2.3.5 HV Testing

- Bring the stator and do connection for HV test.
- Conduct HV test.
- Remove connection after HV test.
- Measure resistance of stator winding.
- Bring stator in surge testing booth and do surge testing (SMI-149)
- Disconnect the connection and shift the stator on workbench.
- Check the rotor bar crack with growler test SMI-163.

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2.3.6 Motor assembly

- Ensure fits and limits on bearing (SMI 16).
- Measure bearing clearances of free bearing (SMI 23).
- Fit the outer race bearing in bearing housing (SMI 78).
- Adjust the rotor into the stator.
- Fit inside grease cups of both side to the rotor shaft.
- Fit the bearings to the rotor shaft by induction heating.
- Fill the grease into the both bearings.
- Fit circlip to rotor shaft at non-driving end side.
- Fit both side end covers.
- Fit steel ring.
- Fit out side grease cups.
- Fit terminal box.
- Put the sleeve to the terminal leads.
- Replace the lugs of terminal leads if required.
- Fit duct jallie of motor.
- Fit the grease nipples.
- Fit the wooden cleat on terminal box.
- Clean and fit the earthing plate.

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2.3.7 Light run test of motor

Before starting the motor for the first time, it is advisable to check that:

- The motor is connected correctly in compliance with connection diagram pasted inside the terminal box cover.
- The motor is properly earthed.
- All terminal screws are firmly tightened.
- All live parts are covered.
- All switchgears are in the 'OFF' position.
- The relevant safety regulations are complied with.
- Connect the terminal to three-phase supply.
- Check the noise and defects (SMI-58).
- Measure starting and running current of motor.
- Check the rpm of the motor.
- Check the bearing temperature by thermometer/ heat tracer.

2.3.8 Assembling of blower

- Adjust and fit casing (duct) with packing (high permanite sheet) to the motor end cover.
- Fit locking key to the rotor shaft.
- Fit the impeller over rotor shaft.
- Fit and lock the check nut.
- Fit the cone to the casing (duct).
- Fit the impeller jallie cover.
- Fit relay with gasket to the casing.

2.3.8.1 **Assembly procedure of impeller on motor shaft**

Before fitting of impeller on the motor shaft following check must be done.

1. Bore of Hub with a "Go or no-go gauge" must be checked.
2. Keyway width should be checked as follows:
    - Take out key of motor and push into keyway of hub and ensure that it goes freely.
    - File keyway of hub if it does not move.
    - Key should not loose in the keyway.
    - If key is loose, another new key to be used.
    - Check keyway depth with the help of vernier caliper.
    - Place the key properly in keyway of motor.
    - Check H and H1 dimensions.
    - Maintain H1 - H = 0.05 to 0.1 mm. as shown in figure 2.2.

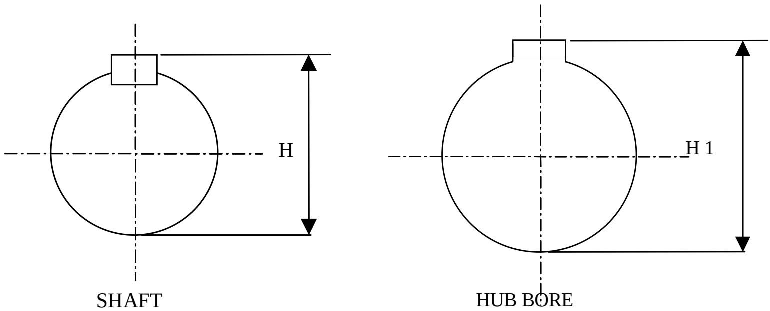

Fig. 2.2 DETAILS OF HUB AND SHAFT

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After carrying out above checks, the impeller should be pushed on the motor shaft after oiling the hub bore and the motor shaft. Special jack/ pusher or puller should be used to push in and pull out the impeller. The details are given in appendix C.

Following important precautions should be taken while assembling the impeller on motor shaft.

1. Never exert force on any other part of the impeller except hub boss for pulling out or pushing in the impeller.
2. Do not use hammer for pushing in the impeller.
3. Never try to pull out impeller by holding shroud with a puller. This can damage the impeller to unrepairable extent. Shroud may deform or a prestress will be developed which can cause failure in service.
4. Some times motor footings are broken or outlet flange damaged due to mis-handling. Plane difference of motor and outlet flange causes assembled unit to rest on edge of outlet flange of casing and rear part of the motor foot which sometime results in "Broken motor foot" or outlet flanged twisted/ damaged/ welding crack. To avoid this, blower motor assembly may be fitted on a dummy wooden stool, which shall be removed only at the time of fitment in the loco. Assembled unit should not be kept on floor without stool.
5. All artisan staff should be given training in regard to the special features of design, maintenance and rewinding practices, which are relevant to reliability. These training courses which should be conducted in sheds need not be of duration more than 2 days. The course material should cover both know how and know why.

2.3.9 **Dynamic Balancing**

To achieve G2.5 grade of ISO - 1940 dynamic balancing of every impeller to be carried out on a calibrated dynamic balancing machine and marked with a number. Experienced staff to be engaged to do dynamic balancing. Balancing is done by "Weight addition method". Weight of similar metal to be welded to outer surface of back plate and shroud, which are chosen as correction planes. Correction radius to be taken at 25 to 30 mm away from tip towards centre. Welding at tip or over welding of correction weights should not be done. This may cause development of prestress and failure during service. After carrying out of dynamic balancing impeller is ready for assembly with motor.

2.3.10 **Load testing**

- Lift the assembly and put on testing bench.
- Connect the three-phase supply to the motor terminals.
- Start on load and check abnormal noise.
- Check vibration, which should be within 25 micron on motor body and 40 micron on casing.
- Measure starting and running current.
- Check the bearing temperature by thermometer/ heat tracer after 2 hours.
- Check the bearing noise by SPM (SMI-58).
- Disconnect the supply.
- Fit the terminal box cover.
- Apply paint on the assembly.
- Do numbering of the assembly and put on ready stand.

2.4 CHECK SHEET FOR OVERHAULING

Overhauling date: ....

MVMT S.No. .... Make ....

Dome No. .... Make ....

Removed from Loco no. ....Fitted on loco No. ....

Following items to be checked during overhauling of MVMT.

SN	TEST	STANDARD	ACTUAL
1.	**Incoming Test** After testing of the motor check the following: a. Abnormal noise as per SMI 58. b. Vibration	Normal (0-20db) Green zone by SPM Normal i.e. 15 microns	
2.	**Stator** a. Baking of stator as per SMI 86. b. Insulation resistance by 500 volt megger. i. Before overhauling ii. After overhauling	Min. 10 MΩ Max. infinite	
3.	**Winding resistance** a. UV phase b. UW phase c. VW phase	Siemens- IRA-2-164/2 0.36 -10 % Ω	

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SN	TEST	STANDARD	ACTUAL
4.	**Winding resistance** a. UV phase b. UW phase c. VW phase	HBB-QP200M46 bi 0.225- 7 % Ω	
5.	**Winding resistance** a. UV phase b. UW phase c. VW phase	Crompton-NADL 0.39-10 % Ω	
6.	HV testing of stator at 2 kV for 1 minute to check leakage current.	Max. 10 mA	
7.	Check condition of terminal block and connection leads.	Good condition	
8.	**Rotor** a. Check rotor bar by growler test b. Dynamic balancing of rotor by Balancing machine. c. Fit the bearings with the help of puller/pusher. d. Mark the date of replacement on new bearing with itching ink. e. Check the bearing clearance as per SMI-23. f. Check bearing outer diameter for 6313 for 6312 g. Check the inner diameter of endshield Clearance for 6313 Clearance for 6312	 140.00-139.982 130.018-129.993 140.018-139.933 130.018-129.993	

SN	TEST	STANDARD	ACTUAL
	h. Apply lock tight no.648 on outer race of bearing (SMI-78). i. Following clearance to be checked during fitment of bearing on shaft in mm. i. Outer diameter of rotor shaft 6313 - 65mm 6312 - 60mm ii. Inner race diameter of bearing 6313 6312	 65.015-65.017 60.015-60.017 64.985 mm 59.985 mm	
9.	Sleeving of connection leads in case of damage.	As per SMI 32	
10.	**Run test after overhauling** Run the motor for half an hour on no load and check the following: a. DE side i. Noise of the bearing. ii. Temperature rise of the bearing. b. NDE side i. Noise of the bearing ii. Temperature rise of the bearing.	 Normal 5°C above ambient temperature Normal 5°C above ambient temperature	

SN	TEST	STANDARD	ACTUAL
	c. Current on no load (10 to 15 times of running current) UV phase, UW phase, VW phase: 146/2, 164/2, HBB, NGEF	 12 ≡ 10 % A 17 ≡ 12 % A 10 ≡ 10 % A 18 ≡ 12 % A	
11.	**Load run test** Run the motor for two hour no load and check the following: a. DE side i. Noise of the bearing. ii. Temperature rise of the bearing. b. Load current (6 to 8 times of running current) UV phase UW phase VW phase c. Running current UV phase — For Siemens UW phase — For HBB VW phase — For HBB	 Normal (9-20 db green zone) 10°C Maximum 220 A 38 ± 10 % A 41 ± 12 % A 42 ± 10 % A	

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SN	TEST	STANDARD	ACTUAL
12.	**Blower**		
	a. Check crackness of dome.	No crack	
	b. Check crackness of impeller blade by RDPT	No crack	
	c. Check alignment between impeller and cone and ensure that cone is not touching to the impeller.	Aligned properly	
	d. Check threads on lock nut of impeller.	No any threads damaged.	
	e. Check tightness of lock nut.	To be checked	
	f. Check for abnormal noise at the time of starting and running.	No abnormal noise	

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CHAPTER 3

COMMON DEFECTS CAUSES AND REMEDIES

3.1 DEFECTS AND THEIR REMEDIES

Winding failure	
• Insulation failure	• Use H class insulation.
• Stator winding interturn short circuit/ open circuit/ earthing by one phase, two phase or all phases.	• Ensure proper cleaning during periodic schedule. • Do baking for 8 hours and further blow with compressed air to remove fine dust. • Do meggering during each IC. • Conduct surge test during AOH.
• Due to over heating.	• Conduct run test for at least 2 hours. • Ensure proper cooling
• Out going leads damaged.	• Use proper size of lug and lead. • Apply epoxy coat at overhang portion once after rewinding • Check for loose lug, connections etc. • Use correct size of crimping tool.

• Overhang portion burnt • Due to aging effect.	• Conduct HV test at 2 kV during every AOH (leakage current 10 milli amp.) • Condemn the motors worked for 15 years and rewounded two times.
Single phasing	
• Due to loose terminals/stud breakage. • Due to breakage of lugs • Due to EMC failure	• Ensure tightness of terminals • Tighten cleats with rubber. • Change the terminal block on condition basis. • Use proper size and quality of lug as well as good crimping tool. • Check closing and crushing times of contactor/ switch. • Provide double wires for incoming supply on contactor.
Star point failure	
• Open circuit due to burning/ brazing failure	• Conduct HV test 2 kV for 1 minute.

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Rotor Failure	
• Due to bar lifting. • Due to end ring cracking/ bar cracking • Due to brazing failure	• Check RPM of the motor. • Housing of the bearing worn out in service and cause rubbing of rotor with stator resulting in cracking of end ring, bar cracking, high vibration, uneven gap between stator and rotor. Housing bore should be checked and rehabilitated if required. • Check brazing of end rings properly during overhauling.
Bearing Failure	
• Due to improper fitment • Due to less / excess grease • Due to bearing worn out/ cage broken • Due to bearing seizer.	• Maintain proper clearance of bearing and housing during changing of bearing. • Fill proper quantity of grease during IC/AOH. • Special attention to be paid for checking during IC/AOH/IOH/ POH. Use SPM for monitoring bearing condition. • Identify new or reconditioned bearings before fitment. • Protect from ingress of dust, dirt and foreign materials. • Change bearings in every IOH. • Do rehabilitation of bearing sheet at end shield during IOH. • Use heat tracer model IR 750 CL2 to check temperature rise.

Ducts crack
• Use high permanite sheet between duct and motor. • Ensure proper alignment of MVMT and VMT with chair and channel respectively. • Procure the material from approved sources only. • Weld the pedestal base properly. • L-clamps to be welded at critical areas for strengthening them. • Leveling to be done during fitment. • There should be no gap between motor base and foundation chair as well as between joints of housing and column. Use sim to fill the gap.
Impeller cracks
• Conduct dye penetrate test/ megnaflux test during repairing, AOH, IOH, POH. • Always use puller/ pusher for fitment of impeller. • Balancing is to be done by portable balancer after every repair/ overhaul. • Replace mild steel impeller with steel alloy impeller. • Follow the correct welding procedure. • Use correct grade of electrode and voltage etc.
Dome crack
• Strengthen dome from inner side near motor fitting hole area. • Strengthen corners of the dome base. • Strengthen curved portion by welding L-clamps.

3.2 MEASURE TO PREVENT FAILURES

To improve the inter-turn insulation in the overhang, the following measures are suggested.

3.2.1 Strengthening of Overhang Portion

The coil should be taped in the overhang portion with a layer of ½ lap, impregnated glass tape 0.3 mm x 20 mm as shown in figure 3.1(a).

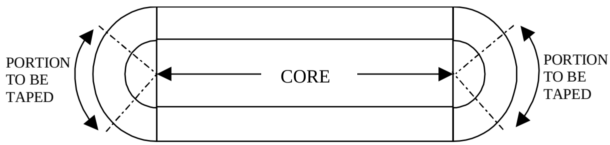

Fig. 3.1(a) Coil

This taping should be done before inserting the coils in the slots.

Alternatively coil separators similar to the phase separators may be provided between adjacent coils emerging from the slots as shown in figure 3.1(b)

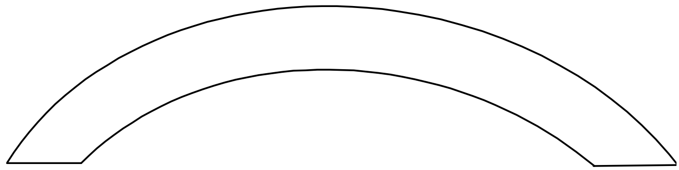

Fig. 3.1(b) COIL SEPARATOR

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3.2.2 **Sleeving**

Since another weak point observed on some motors is the Sleeving, it is necessary to take special care in this regard. As per SMI No.RDSO/ELRS/SMI/185 - 2000 Rev.-I dated 30.10.2000, flexible insulated fibre glass sleeve with coating of fire retardant silicon elastomer applied by extrusion or multi dip process having temperature index of 180° C as per BS 2848 type 1/180 Tb having wall thickness of 0.9 mm and capable to withstand minimum BDV of 5 kV for one minute is to be used. The sleeve should be from the point where the wires emerge from the slot up to the brazed joint. The brazed joint should also have a similar sleeve.

3.2.3 **Strengthening of Inter Turn Insulation**

At present the coil for insertion in slots is wound in wooden former which has a square section not only in the slot portion but also in the overhang portion. The space available in the slot is also square in shape and hence the coil as wound in the former can fit in without any distortion but in the overhang portion the coil is flattened and curved as it is formed into the round cross-section of the overhang. In this process the wires are stretched, buckled and bent. As the coil is formed of relatively thin, ductile and flexible copper wires there is no practical difficulty in forming the overhang but it is unlikely that the enamel insulation passes unscathed in this process. While the enamel coating is indeed capable of withstanding some distortion of the copper wire, it is considered that the inter-turn insulation in overhangs

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would improve if this distortion can be minimized by adjusting the cross-section of the former in the overhang portion as shown in figure 3.2.

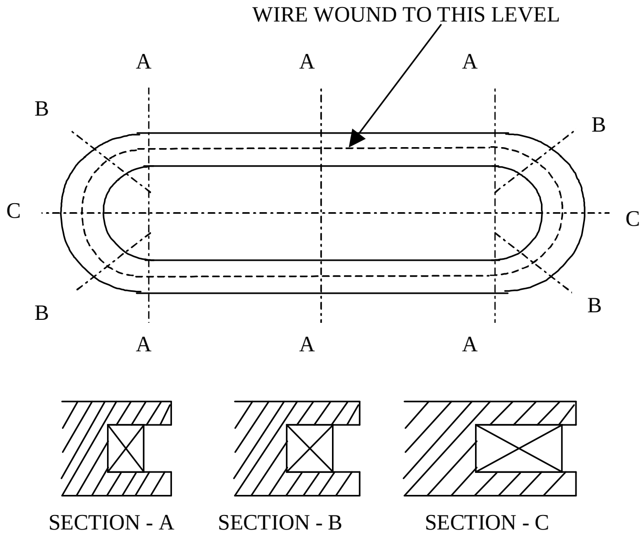

Fig. 3.2 Sectional details of Coil

The change of section from A to C will be smooth and continuous through the intermediate stage B. the actual dimensions can be determined by cutting the overhang of a burnt motor.

With such a former which could be easily shaped in the wooden construction, the wires will have to be distorted much less in the overhangs and this will help to obtain a higher inter-turn insulation strength and consequently lower failure rates.

3.2.4 Reporting of Failure

In order to facilitate future investigations the following details should be recorded in each case of failure.

a) Loco No., date, and place of failure.

b) Serial No, make and year of manufacture of MVMT.

c) If rewound, name of shop and year of winding.

d) Exact location of fault centre as clock position looking down from top & taking terminal box centre as 12.00 clock.

For example

Inter-turn short centered at 11.00 clock position (seen from above, terminal box centre at 12.00)

- Globules of copper seen.
- Fault mainly in W phase.
- Fault in top overhang
- No other defect in rotor, terminal box, or starting gear.
- Bottom overhang in sound condition
- Slot insulation sound.

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3.3 SUGGESTIONS TO AVOID FAILURES

- Store section receives the impellers in packing from firms fully balanced. Therefore this packing should be removed in auxiliary section at the time of fitment only. However it is observed that in some of the sheds packing is removed in store section and the impeller is taken to the auxiliary section either by putting on trolley or some times by rolling on the floor which may cause damage to the impeller and disturbs the balancing. Hence impeller should be carried from store to section on trolley in duly packed condition.
- Lug size should be proper.
- Lead size should be minimum 15 mm^2.
- Thickness of dome sheet at driving end should be increased from 2.2 mm to 3.15 mm.
- Rubber packing should be used in between terminal cleat cables.
- Balancing should be done after overhauling/ repairing of impeller.
- Measures to be taken to avoid slackening of bearing in the housing. Otherwise it will result in temperature rise and increase vibrations.
- Portable balacer may be used for ensuring balancing on position.
- Puller and pusher should be used for extraction and fitment of bearing and impeller.
- Cracks of dome should be welded from both inside and outside.

3.4 DO's

- Do replace bearings of MVMT after 3 years.
- Do balancing of impeller during overhauling as well as after repairs.
- Do procure impeller only from approved sources.
- Do ensure 100 % replacement of bearings during IOH/ POH.
- Do ensure availability of special tools in section required for repairing/ overhauling.
- Do use puller and pusher for removing and fitment of impeller.

Fig. 3.3 Puller / Pusher

- Do ensure winding diagram and winding procedure for rewinding work being done through trades.
- Do change the impeller if it is unbalanced due to vibration etc.

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- Do ensure use of approved winding wire and procurement from approved sources only as per rewinding specifications.
- Do use approved make of varnishes, leads and sleeves.
- Do analyses failures as per RDSO format.
- Do pretest the locomotive before taking into schedule.
- Do change the cracked motor end shield.
- Do depute two persons for removing and assembling of MVMT rotor to avoid damages at overhang portion due to falling by weight.
- Do ensure proper identification mark on the rotors fitted with bearing numbers 6312 & 6313 to avoid interchanging during assembling.
- Do ensure perfect fitment of unit on motor foundation and MVMT duct. These are shown in figure 3.4

Figure 3.4 Motor foundation and MVMT Duct in loco

- Do use sprit level for leveling the base.
- Do vacuum pressure impregnation of stators.
- Do surge test on stator after every overhaul.

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- Do dye penetrate test/ megnaflux test for crack detection.
- Do measure shaft dimensions at bearing seating as per norms.
- Do prevent stretching of supply leads.
- Do use 3-mm thick high permanite sheet in place of asbestos rope for sealing to avoid deformation of joint.

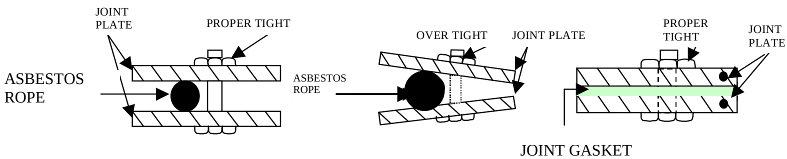

Fig. 3.3 Jointing with high permanite sheet & asbestos rope

3.5 DON'Ts

- Don't allow the impeller blade if it is cracked more than one inch.
- Don't try to match the fixing holes by means of screwing the bolts of improper size or tapered bolt. This will develop stress in the unit and cases of cracks will increase.
- Don't interchange stator and rotor.
- Don't mix the grease of having same grade but different make.
- Don't run the blower without impeller guard/ jallie.
- Don't do any repair work while the unit is running.
- Don't modify without approval of competent authority.
- Don't permit smoking in the vicinity of blower.

- Don't use flammable solvent for cleaning purpose.
- Don't wear loose clothing and confine long hair.
- Don't ignore small cuts and burns as they may lead to infection.
- Don't leave the MVMT un attended with open electrical enclosures.
- Don't attempt to lift in high winds.
- Don't lift the MVMT higher than necessary.
- Don't fit impeller striking through hammer or iron rod etc.

Figure 3.6 Wrong fitment of Impeller

APPENDIX - A

LIST OF SMIs FOR IMPROVING RELIABILITY OF VMT/ MVMT UNIT

SN	TITLE	MI/ SMI No.
1.	Fits and limits on bearing of auxiliary motors	RDSO/ELRS/SMI/ 16
2.	Procedure for measurement of bearing clearances	RDSO/ELRS/SMI/ 23
3.	Condition monitoring of auxiliary motor bearing	RDSO/ELRS/SMI/ 58
4.	Provision of Epoxy moulded terminal block	RDSO/WAM4/ MS-61
5.	Fitment of outer race bearing in bearing housing.	RDSO/ELRS/SMI/ 78
6.	Vacuum impregnation of stator	RDSO/ELRS/SMI/ 86
7.	Puller for extracting traction motor cooling blower impeller	RDSO/ELRS/SMI/ 87
8.	Use of button type grease nipple on auxiliary motors	RDSO/ELRS/SMI/ 147

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SN	TITLE	MI/ SMI No.
9.	Guide lines to identify genuine/ spurious bearing	RDSO/ELRS/SMI/ 148
10.	Surge testing of 3 phase auxiliary motor	RDSO/ELRS/SMI/ 149
11.	Balancing of rotor and impeller of MVMT	RDSO/ELRS/SMI/ 152
12.	Dynamic balancing of impeller & rotor in position	RDSO/ELRS/SMI/ 162 & 199
13.	Rewinding materials for Auxiliary motors and Arno Converters.	RDSO/ELRS/SMI/ 185-2000 Rev.1
14.	Rewinding of stator winding of MVMT and MVRH.	ELRS/MS-0295-2000 Rev-0

Note: Always refer latest/ revised No. of MI/ SMI issued by RDSO.

APPENDIX - B

TEST FACILITIES AS PER RDSO GUIDE NO. ELRS/ PR/ 0103 JUNE 2001

The following minimum essential testing facilities are required for blowers:

1. Testing rig as per IS:3588
2. Manometers
3. 3-Phase voltage regulator (0-500V)
4. Facility for creating unbalance up to 5%
5. Control panel comprising wattmeter, ammeters, voltmeters, frequency meter etc.
6. Multimeter
7. Tong Tester
8. Tachometer
9. Vibration meter
10. Shock pulse meter
11. On-Off timer arrangement for starting duty test.
12. Stop watch
13. Thermometers
14. Dynamic balancing machine suitable for balancing grade G2.5
15. Portable balancer
16. Weighing machine
17. Air velocity meter
18. Vernier calipers, screw gauge, scale, etc.
19. Megger

Note: All above instruments should be duly calibrated.

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APPENDIX - C

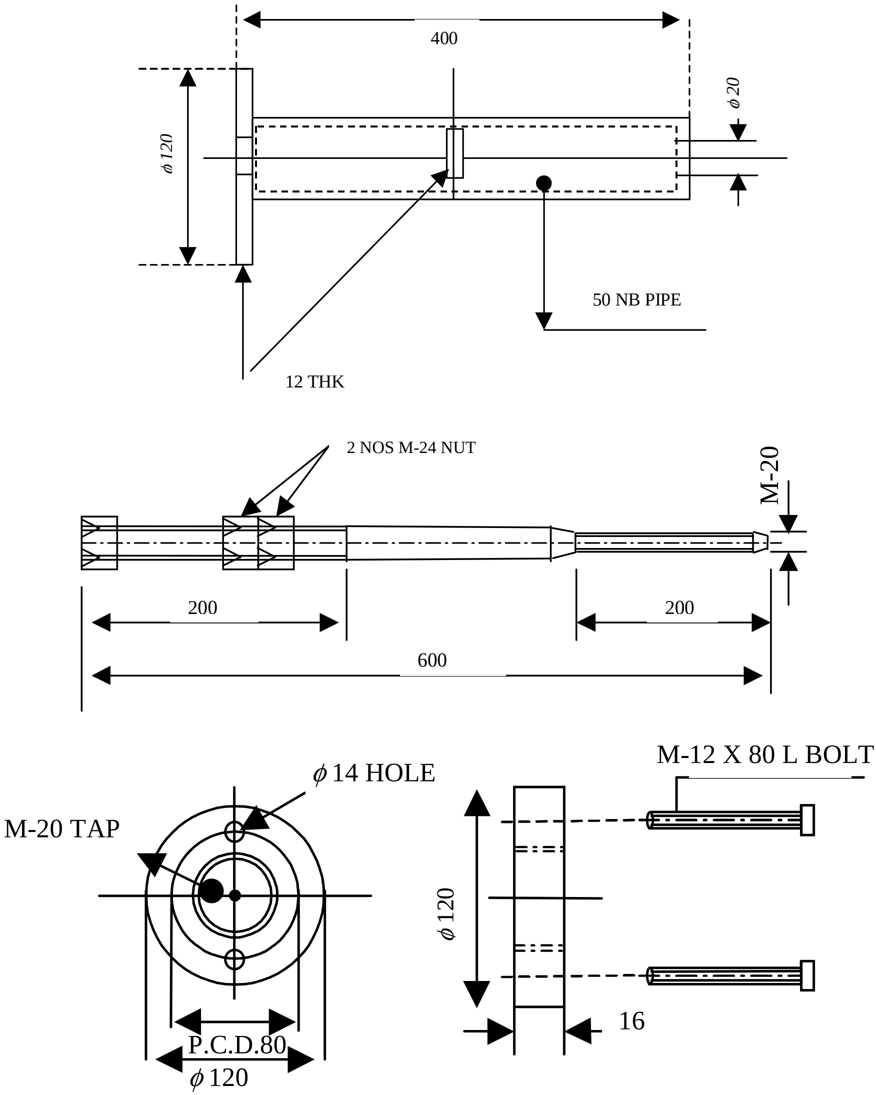
SPARE PART LIST FOR MVMT (BBL MAKE)

SN	DESCRIPTION	MATERIAL	QTY.
1.	Body	C.I.	1
2.	Flange/Endshield DE	C.I.	1
3.	Endshield NDE	C.I.	1
4.	Bearing Cover DE outer	C.I.	1
5.	Bearing cover NDE outer	C.I.	1
6.	Bearing cover DE inner	C.I.	1
7.	Bearing cover NDE inner	C.I.	1
8.	Terminal box	AL	1
9.	Terminal box cover	C.I.	1
10.	Conduit Flange	AL	1
11.	Terminal Plate	DMC	1
12.	Rubber Grommet	Rubber	3
13.	Fan with insert	AL/ MS	1
14.	Bush	C.I.	1
15.	Rotor packet	Al/steel	1
16.	Shaft	EN8	1
17.	Shaft extension key	EN8	1
18.	Rotor packet key	EN8	1
19.	Terminal box adapter plate	MS	1
20.	Stator packet with winding	Cu/Steel	1

SN	DESCRIPTION	MATERIAL	QTY.
21.	M.S.Jallie for flange/endshield	M.S.	1
22.	M.S.Jallie for NDE endshield	M.S.	1
23.	Bearing DE		1
24.	Bearing NDE		1
25.	Cable gland	Brass	1
26.	Cable clamp	M.S.	1
27.	Grease nipple with pipe	M.S.	1
28.	Circlip	M.S.	1
29.	Drain pipe for grease outlet	M.S.	1
30.	Crimping Lug	Cu	3
31.	Hex head screw terminal box fixing	M.S.	4
32.	Hex head screw bearing cover fixing	M.S.	4
33.	Hex head screw conduct flange fixing	M.S.	4
34.	Hex screw for earthing	M.S.	1
35.	Hex head screw for B/ cover fixing	M.S.	4
36.	Hex head screw T/ box cover fixing	M.S.	4
37.	Hex head screw earthing (body)	M.S.	1
38.	Hex head screw flange/ES fixing	M.S.	4
39.	Hex head screw NDE endshield fixing	M.S.	4
40.	Eye bolt	M.S.	1
41.	Stator locking grub screw	M.S.	1
42.	Plug for speed measurement	Plastic	1

APPENDIX - D

DETAILS OF PUSHER / PULLER



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