



GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

MAINTENANCE OF ELECTROPNEUMATIC CONTACTOR of ELECTRIC LOCOMOTIVE

CAMTECH/2000/E/EPC/1.0
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Centre
for
Advanced
Maintenance
TECHnology



Excellence in Maintenance

**MAINTENANCE
OF
ELECTROPNEUMETIC CONTACTOR
OF
ELECTRIC LOCOMOTIVE**

FOREWORD

The proper maintenance of Electropneumatic Contactor is vital for trouble free operation of Electric Locomotive and avoid failures enroute. CAMTECH has prepared this handbook to cover all essential aspects of maintenance of these contactors to ensure their reliability.

The handbook describes various maintenance schedules alongwith 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

1st Aug' 2000

M.L.GUPTA

DIRECTOR

PREFACE

The Electropneumatic Contactors are used in all WAM4, WAG5, WAG7, WAP1, WAP4 electric locomotives and where DC series motors are provided. It is vital equipment and its proper upkeep and maintenance is necessary to ensure reliability and availability of electric locomotives. This handbook on maintenance of Electro Pneumatic Contactor on Locomotive 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 and CETI/THK 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 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
31ST JULY' 2000

KHUSHI RAM
JT. DIRECTOR

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REFERENCE

CHAPTER 1

INTRODUCTION

1.1 DESCRIPTION OF CONTACTOR

The closing of the electrical circuit is obtained by the movement of the movable contact which closes on to the fixed contact under a pressure of more than 11 kg for line and excitation contactors and more than 6.4 kg for shunting contactor. The servomotor drives the moving contact through two levers, a spring and an insulator.

In these contactors, compressed air enters through the opening A; passes through the connecting sleeve B into the magnet valve. Then passes through connecting sleeve C and comes to servo motor piston as shown in figure 1.4 page 8. The servomotor has synthetic rubber gaskets, which make them air tight. All contactors should correctly close at a minimum pressure of 5 kg/cm². For a working pressure of 8 kg/cm², there should be no leak perceptible to the ear. Opening of the electrical circuit is done by the action of return spring, as the magnet valve allows compressed air to escape through the sleeve D as shown in figure 1.5 page 9. L1, L2, L3, L4, L5, L6 & C145 contactors are provided with auxiliary contacts.

1.3 ELECTRO PNEUMATIC CONTACTORS

An electric locomotive has following Electro pneumatic contactors:

CONTACTOR	TYPE	UTILIZATION
S-141, S-142, S-143, S-144, S-361, S-362, S-363, S-364, S-21, S-22, S-23, S-24, S-51, S-52, S-53, S-54	TCP 718- M16-4	Field weakening Contactors (Shunting Contactors)
C-145	TCP 3469-24-3	Excitation contactor for rheostat breaking.
L1, L2, L3, L4, L5 and L6	TCP-3421-25-2	Motor Contactor

1.4 MAIN PARTS OF A CONTACTOR

The main parts of contactor are following, which are shown in figure 1.1

	Part No.
1. Moving contact lever assembly	1
2. Magnetic circuit assembly	2
3. Anchoring hook assembly	3
4. Fixed contact	4
5. Allen bolt M 8 x 30 mm	5b
6. Spring washer M8 mm	6
7. Insulated distance piece	7
8. Insulated distance piece	8
9 Blow out coil assembly	9
10. Servomotor assembly	10
11. Magnet valve assembly NC-4 type	19
12. Gasket	18

Fig 1.1 EP Contactor

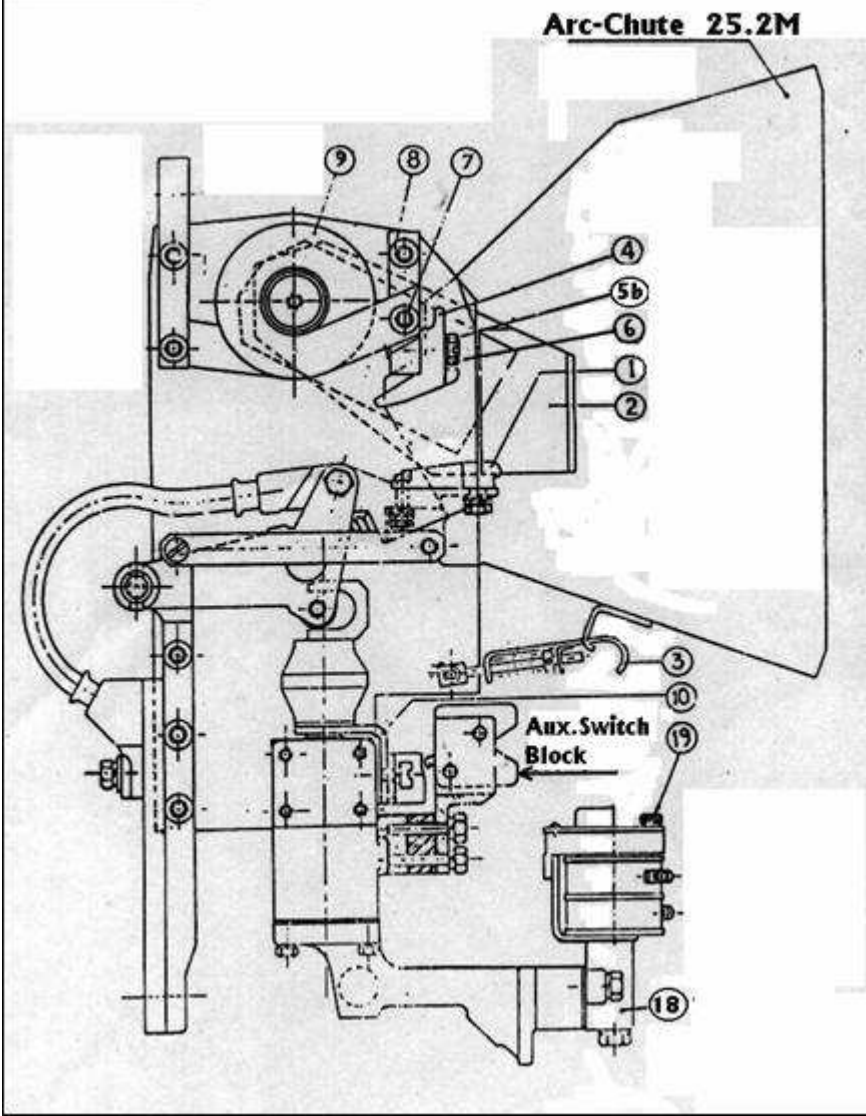
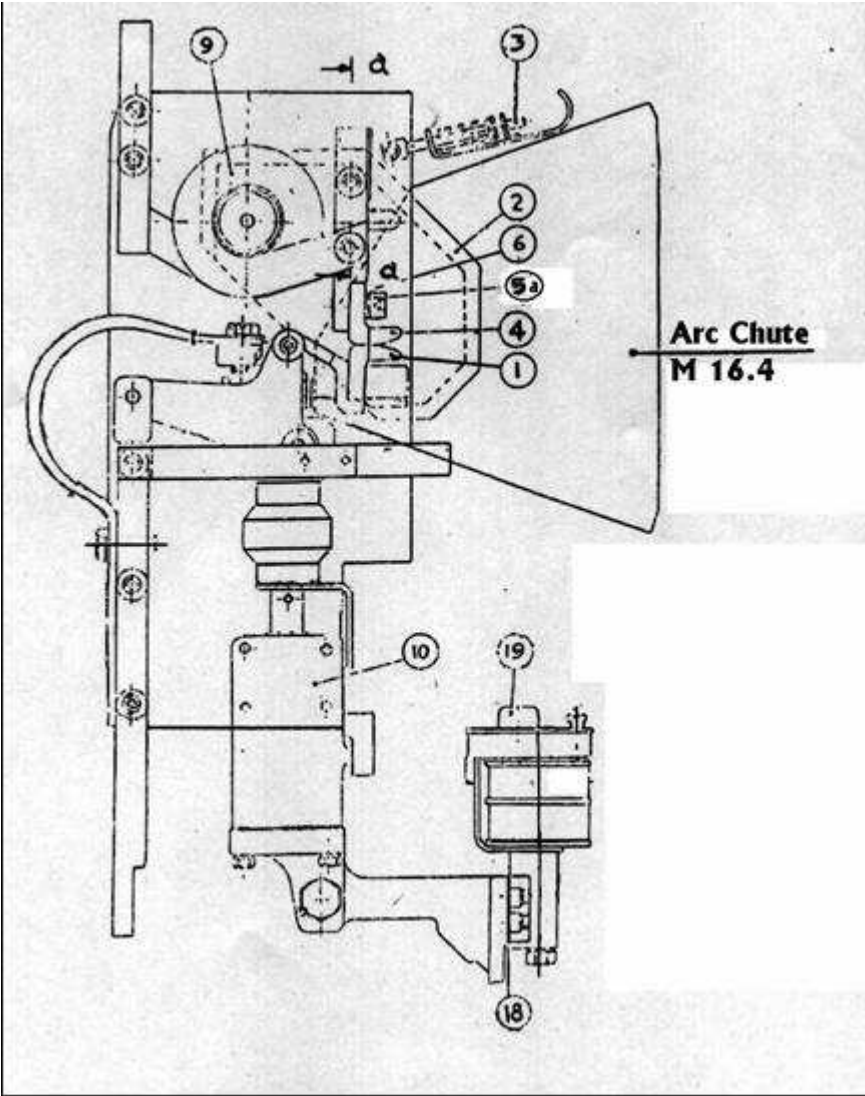
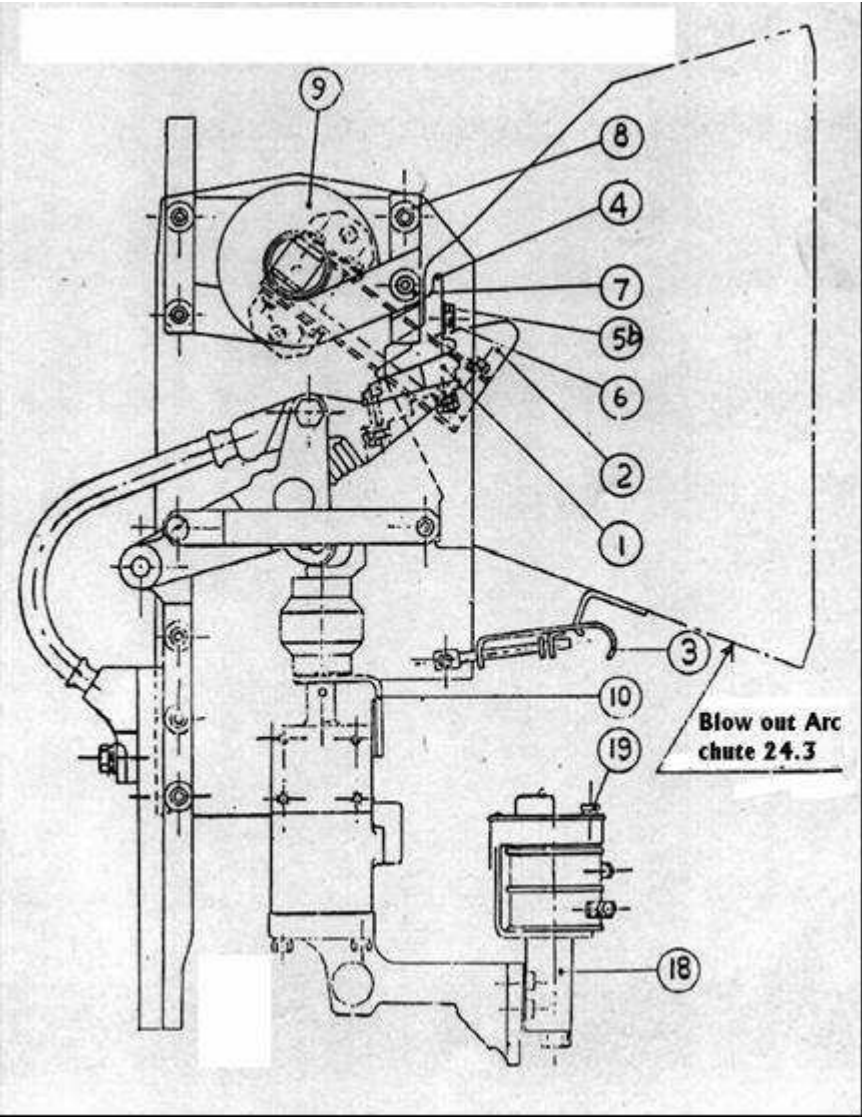


Fig 1.2 EP Contactor (s)





1.3.1 Main parts of Servomotor

The main parts of servomotor are shown in figure 1.4

	Part No.
1. Insulator with 'U' clamp	11
2. Spring	12
3. Lubricating felt ring	13
4. Piston cup	14
5. Gasket	15
6. Inlet tube	16
7. Outlet tube	17

1.3.2 Main parts of Magnet valve

The main parts of Magnet valve are shown in figure 1.5

	Part No.
1. Coil	20
2. Top valve	21
3. Bottom Valve	22
4. Spring	23
5. Gasket	24
6. Plug	25

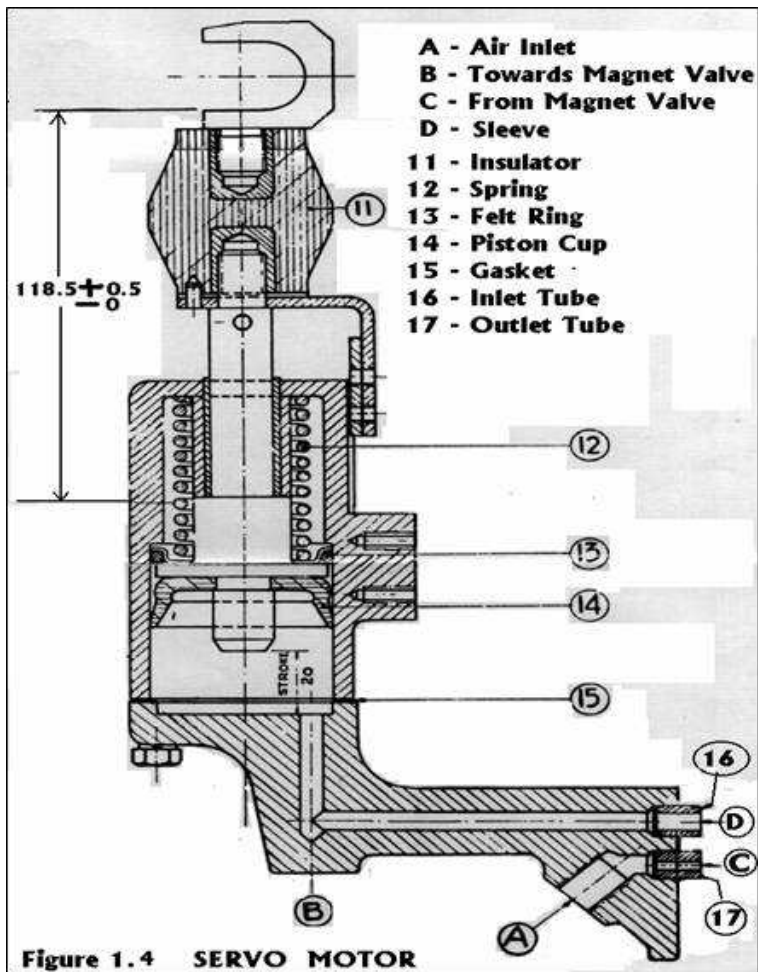
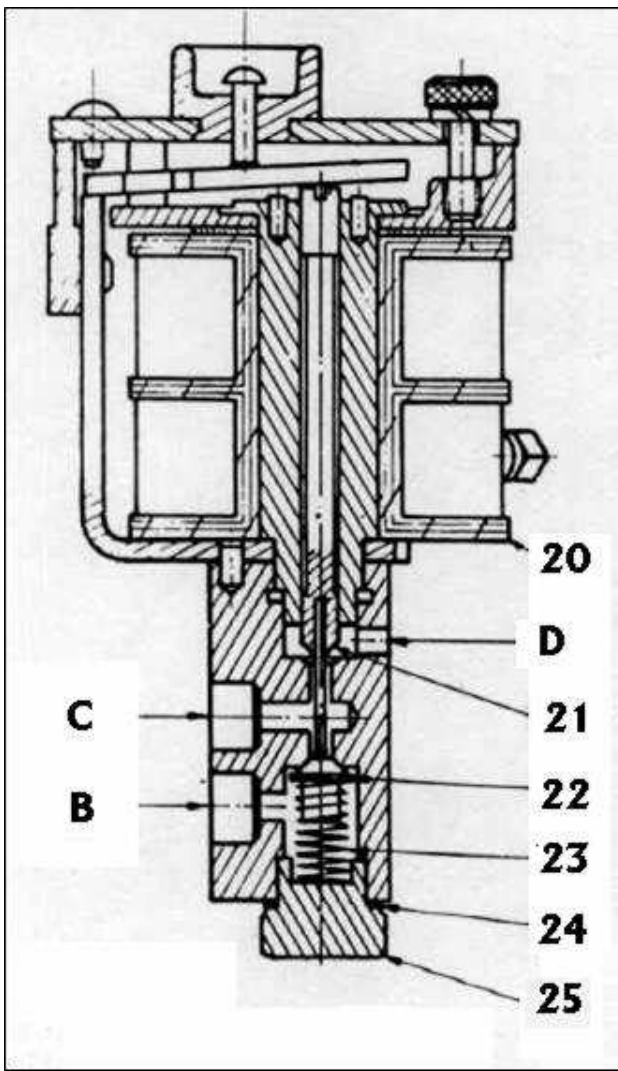
Fig 1.4 servomotor

Fig 1.5 magnet valve

1.4 MAGNET VALVE

These magnet valves are three way cocks, function through an electromagnet, in a compressed air circuit. These are connected to servomotors of Electro pneumatic contactors, through sleeves and chokes.

When current passes through the coil, the armature of the Electro magnet valve is attracted. The armature acts on two valves i.e. top valve and bottom valve.

At rest, that is as long as the Electro magnetic coil is not excited, the valve allows communication between servomotor and the atmosphere.

When coil is energized

- The top valve closes the opening to atmosphere.
- The bottom valve lets compressed air into the servomotor.

When the coil is de-energized, the valve regains its initial position. The servomotor opens to atmosphere and its piston moves down wards under the action of the restraining spring.

1.5 TECHNICAL PARTICULARS OF CONTACTORS

CONTACTOR	FOR MOTOR	FOR BRAKING	FOR SHUNTING
Type	TCP- 3421-25-2	TCP- 3469-24-3	TCP- 718M16-4
Rated Voltage	1270 V, DC.	75 V AC. (Maximum)	1270 V, DC.
Rated Current	1000A, DC.	850 A, AC.	325 A, DC.
Contract Pressure	11.6 to 16 Kg.	11.6 to 16 Kg.	6.4 to 8.8 Kg.
Voltage of Electro Valve Coil	68-136 V DC	68-136 V DC	68-136 V DC
Resistance of Electro Valve Coil	1100± 7%, Ohms.	1100 ± 7%, Ohms	1100 ± 7%, Ohms.
Minimum operating air pressure	4.5 Kg/Cm ²	4.5 Kg/Cm ²	4.5 Kg/Cm ²

1.6 WORKING PRINCIPLE

As shown in figure 1.1 an Electro magnetic valve is connected to the servomotor. The piston of servomotor is engaged with movable contact assembly through 'U' clamp of insulator.

Compressed air supply is fed to nipple 'A' of Electro valve supply. This air enters to incoming chamber 'B' of Electro valve. When it is required to close the contactor, the Electro valve is energized by 110 V DC as shown in figure 1.5. This magnet presses down the top valve, part number 21 and bottom valve, part number 22. Due to pressing of top valve, exhaust port 'D' closes and compressed air coming from Electro valve get diverted towards port 'C' and then enters into servomotor. This air raised the piston of servomotor upwards against the spring part number 23. Movable contact connected to this piston is also raised up and contacted to fixed contact and remain close till the Electro valve energized.

For opening the contactor, the supply to Electro valve is switched off. This causes Electro valve coil to get de-energised. The compressed spring fitted in Electro valve pushes both top and bottom valve upwards. Thus rising up of bottom valve closes the incoming compressed air supply passage from 'B' to 'C' and then to servomotor. Rising up of top valve connects exhaust port 'D' through port 'C' of servomotor and remaining compressed air of servomotor is exhausted to atmosphere. The springs part number 12, fitted in servomotor figure 1.4 presses the movable contact down wards and open the contactor.

The minimum pressure of compressed air should not be less than from 3 kg/cm^2 and should not be more than 5 kg/cm^2 . The Electro valve requires 36 to 136 V DC to operate.

We can close/ open the contactor having high current and high voltage by closing/opening the switch as per our requirement. Then by means of Electro valve using compressed air, the contactors fitted in HT compartment of an electric locomotive may be operated by operating the switches provided in both the cabs.

* * * * *

CHAPTER 2

MAINTENANCE

2.1 MINOR SCHEDULE

IA (MONTHLY)

- Check the condition of arc chute and fixing of pole plate.
- Check condition of movable and fixed contactors
- Check tightness of movable and fixed contactors
- Ensure proper lubrication of servomotor.
- Ensure no air leakage during testing from Electro valve etc.

IB (BI MONTHLY)

In addition to IA following work to be carried out.

- Open line contactors for overhauling.
- Check condition of electro valve. Attend, if found defective.
- Check condition of pole plate and contactors.

IC (QUARTLY)

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

- Check connections of all bus bars and cables.
- Check connections of SBBA 1 and SBBA2.
- Check tightness of nuts and bolts.
- Check shunting resistances for over heating marks cracks and flashes.
- Check all connections of bus bars and power cables.
- Check for no missing of negative link stickers.
- Check proper working of contactors.

2.2 MAJOR SCHEDULE

AOH/IOH (ANNUALLY)

- Examine the contactor removed from locomotive for any abnormality
- Remove insulating sleeves and distance pieces.
- Remove the movable assembly and blow out coil.
- Check condition of blow out coil, arc chutes and contactors.
- Clean the contactors. Check insulating parts connections of cables and foundation.
- Check rubber bucket of servomotor and clean servomotor.

- If the support plate is found cracked or damaged, then it should be changed. Carbon should be removed in case of minor carbonization by rubbing with polish paper. Clean support plate with clothes.
- Lubricate articulations.

2.2.1 Description of Nuts and Bolts used in an Electro pneumatic Contactor

1. Hexagonal head bolt M 6 x 90 mm 5nos. Magnetic.
2. Hexagonal head bolt M 6 x 90 mm 2 nos. Non magnetic
3. Hexagonal head bolt M 6 x 25 mm 12 nos. Steel
4. Square head bolt M 6 x 30 mm 2 nos. Steel
5. Chisel head Screw M 6 x 90 mm 1 no. Non magnetic
6. Chisel head Screw M 6 x 15 mm 2 nos. Steel
7. Chisel head Screw M 8 x 20 mm 2 nos. Non magnetic
8. Allen Screw M 8 x 30 mm 2 nos. Steel
9. Allen Screw M 8 x 45 mm 2 nos. Steel
10. Allen Screw M 8 x 75 mm 2 nos. Steel
11. Allen Screw M 6 x 35 mm 2 nos. Steel
12. Helical lockout M 6mm 2 nos. Steel

2.2.2 Description of Tools used for Overhauling

1.	'D' spanner/ring spanner	8 x 9 mm	1 no.
2.	'D' spanner/ring spanner	10 x 11 mm	1 no.
3.	'D' spanner/ring spanner	12 x 13 mm	1 no.
4.	'D' spanner/ring spanner	14 x 15 mm	1 no.
5.	'D' spanner/ring spanner	16 x 17 mm	1 no.
6.	'D' spanner/ring spanner	18 x 19 mm	1 no.
7.	'D' spanner/ring spanner	20 x 22 mm	1 no.
8.	'D' spanner/ring spanner	21 x 23 mm	1 no.
9.	Tube spanner	10 x 11 mm	1 no.
10.	Screw Driver	12"	1 no.
11.	Hammer	1 pond	1 no.
12.	Allen key	6mm	1 no.
13.	Allen key	5mm	1 no.
14.	Rough file	12"	1 no.
15.	Smooth file	12"	1 no.

2.2.3 Material used for Overhauling

1. Petrol/Acetone
2. Polish paper
3. Mobil oil servo system No. 9
4. Grease servogem 2 or 3
5. Grinding paste
6. Duster
7. Red varnish
8. Asbestos thread etc.

2.2.4 Overhauling of Servomotor

- Remove the Electro valve support by unscrewing bolts of size 6 x 25 mm fitted on servomotor.
- Clean the grease of piston cup using duster (khadi cloth).
- If it is found normal then pour some petrol into servomotor. Push the piston repeatedly to clean it from inside without dismantling.
- Leave it ideal for some time so that remaining petrol came out. Now pour some Mobil oil.
- Again leave it for some time to ingress the oil inside the servomotor.
- If 'U' insulator of piston of the servomotor have any abnormality then dismantle the piston thoroughly.
- Clean its spring and 'U' insulator.

- Ensure that these are neither broken nor cracked
- Replace the lubrication felt.
- Drop Mobil oil and leave for some time.
- Apply grease on 'U'insulator and fit new piston cup.
- Clean the Electro valve support.
- Blow out its hole by compressed air and ensure that it is not jammed.
- Provide new gasket on servomotor and tighten with Electro valve support by means of bolts size 6 x 25mm.
- Check the piston stroke by pressing the piston. It should be 20mm.
- Tighten the valve support along with servomotor.

2.2.5 Overhauling of Blow out coil

- Check the condition of asbestos thread provided to avoid inters turn short circuit. Change on condition basis.
- Clean the contact portion of contactor by polish paper.
- Check for any overheating mark, then clean with petrol.
- Varnish the coil with red insulating varnish. It is to be kept in mind that this varnish should not be pasted on contact portion and other connection of the coil.
- Check the condition of threads and tighten the fixed contact with blow out coil. Repair if required.

2.2.6 Overhauling of Contact assembly

- Remove the spring.
- Check the roller, roller bush, roller pin, axle pin etc. for any defect. Change if required.
- Clean roller arm, brass plate and movable contact lever.
- Check condition of brazing at all shunts. All shunts should be brazed with rupton silver 14.
- Clean brazed portion by acid then water. Now clean complete movable assembly with petrol and polish paper.
- Lubricate the roller and bushes.
- Open the movable contacts and polish the contact holder. Change if required.
- Open the fixed contact and inspect thoroughly. If found normal and its thickness is more than 50% then clean with polish paper and reassemble, otherwise replace with new. Also provide new screws of size M 8 x 30 mm and new 'U' spring.
- Fit the contactor by means of square head bolt M 6 x 30 mm, spring washer, flat washer and heli lock nut. Air gap between contact and contact holder is not permissible.
- Measure length of spring and distance piece of movable contact. These should be 78mm and 7mm respectively.
- Fit spring and distance piece assembly to axle pin.
- The axle pin play for movable assembly should not exceed 0.5mm

2.2.7 Overhauling of Insulating sleeve and Distance piece

- Before changing, it is to be ensured that the sleeves and distance pieces are not broken.

2.2.8 Overhauling of Electro valve (NC-4)

- Dismantle the electrovalve.
- Check resistance of both top & bottom coils.
- Megger their insulation with 500V megger. This should be at least $1\text{M } \Omega$
- Replace the spring and gasket.
- Re-assemble the valve.

2.2.9 Assembling of Electropneumatic Contactor

- Provide distance piece at both ends of servomotor and assemble with the body plate.
- Provide new distance piece and new sleeve at both ends by mounting blow out coil in between core and pole plate. Tighten with non-magnetic bolts M 6 x 90 mm.
- Maintain $65 \pm 0.5\text{mm}$ gap between both pole plates.
- Insert roller of movable assembly into 'U' clamp insulator of servomotor. Tighten insulating sleeves with bolts M 6 x 90 mm.
- Connect two numbers of brass distance pieces fitted with screw M 6 x 15 mm to contact strip coming from arcing resistance.

- Maintain contact to contact (Movable to fixed) gap between 20-25 mm. Ensure the center for movable contact and fixed contact.
- Provide new gasket on electrovalve. Fit the electrovalve with this ready assembly.

2.2.10 Testing of Contactor after Overhauling

- Mount on test bench.
- Connect compressed air supply through nipple. Air pressure should be maintained up to 5 kg/cm^2 .
- Adjust pickup and dropout voltage of electrovalve by adjusting length of top and bottom valve. It should be 65 ± 5 and 20 ± 5 volt respectively.
- Operate electrovalve for many times to check satisfactory working. There should not be any air leakage and sluggish operation during both pickup and dropout position.
- Check the bedding of fixed and movable contact with blow out coil. This bedding should be more than 80%.
- Operate the contactor again and again to ensure its satisfactory working. Especially check its wiping operation during closing of contact.
- Check the spring tension of the contactor with the help of spring balance for movable contact. Normally this should be 13 to 16 kg.
- Check the piston lift. This should be 20 to 25 mm.
- Now the contactors are ready for service.

2.3 GENERAL MAINTENANCE

The normal maintenance operations and testing, that have to be carried out regularly to maintain equipment in perfect working condition, are indicated hereunder:

2.3.1 Dusting

Dust from the equipment should be removed after completion of each inspection. For this purpose, brushes, dusters or compressed air can be used.

The brushes should be soft and it should not have loose bristle. Care should be taken to remove all bristles, which might have stuck in between parts. The dusters should be clean, dry and without fluff. Care should be taken not to hook the duster on to the auxiliary contact fingers or any small parts.

Utilization of compressed air is the best method for cleaning the contact, but air should be dry.

2.3.2 Cleaning

2.3.2.1 Insulating parts

The insulating parts should be carefully cleaned with a clean dry duster. Scratching of varnished surfaces should be avoided. All traces of grease or oil, which might retain dust, should be removed.

The insulating plates of blow out arc chutes, made of the carbon should be removed with sandpaper.

2.3.2.2 Contacts and segments

The contact surfaces should be cleaned and de-oxidized. Verification should be carried out to ensure that fingers could bear the pressure, if the contacts are strongly pitted. Roughness should be removed and leveled with a soft file. For contacts, which are slightly damaged, abrasive paper should be used.

Copper contacts should be lightly smeared with Vaseline on a cloth to protect them from oxidation. Special precautions should be taken to clean silver contacts. Fine paper smeared with a little chalk should be used. This should then be wiped with a clean dry cloth. The burrs of strongly pitted contacts should be removed with very fine abrasive paper. These silver contacts should never be filed. Vaseline should never be used on contacts, which do not slide one over the other.

2.3.3 Mechanical Verification

All moving components should be checked to ensure that they move, slide and turn freely neither with difficulty nor with excess play and that they are not extremely worn out. Screws, nuts and bolts should be tightened properly. It should be ensured that cotters and pins are in position and in good condition, particularly the conical pins are in the holes.

The tightness of the cable sockets should be verified. The proper crimping in the cable sockets are also to be checked by gently pulling the cables. The correct working of the position indicators should be checked.

2.3.4 Replacement

All parts that are worn out or broken should be immediately replaced with new parts. A spring should never be deformed. If it is not suitable, it should be changed.

2.3.5 Lubrication

It is advised to lubricate all equipment lightly, with care and regularity. The lubrication of the contacts with Vaseline prevents oxidation. Clogging and bad contacts of contactor may result, if excess Vaseline is used.

The articulations should be lubricated in order to reduce friction. But the quantity of oil or grease used should be limited as, too large quantity could lead to a discharge of oil and grease which would cause clogging of adjacent contacts and insulating parts. All segments, fingers, contacts etc. which make electrical contacts should be carefully cleaned and de-oxidized before applying vaseline. Care should be taken not to file the silver contacts.

2.4 MAINTENANCE OF MAGNET VALVE

No lubrication or special maintenance is necessary. If there is a leak or bad operation, the valve rod as well as the valve seating must be removed and cleaned with petrol. The whole unit must be carefully wiped and refitted without any lubricant. In case of contactor not in use the magnet valve ports should be kept closed by means of adhesive tape to prevent dust getting in.

2.5 DEFECTS AND REMEDIAL ACTION

S.No	DEFECT	REMEDIAL ACTION
01.	a. Breakage of servomotor roller of nylon made. b. Servomotor leakage.	a. Rollers should be replaced with epoxy material during over hauling. b. Piston cup to be replaced during over hauling.
02.	Fixed and movable bits flashed due to loosening of movable bit fixing nuts.	Change with new design as per “CLW” drawing for 1500 Amps motor contactor.
03.	Insulator getting slackened.	Provide lock tight during overhauling.
04.	Sluggish operation of servo motor, due to dust entry from the pipe line.	During overhauling pipe lines should be blown before providing.
05.	Coil open/ short circuited.	a. Surge test to be carried out during AOH/IOH. b. Burn-in test to be carried out at 110 V, DC for 100 hours.

S.No	DEFECT	REMEDIAL ACTION
06.	Shunt Broken.	Shunt end crimping should be well mouth and it should not be brazed.
07.	Failure of auxiliary interlock.	Parallel interlocking to be done during AOH/IOH.
08.	Centre fixing bolt of movable assembly loosen/ over tightened.	Simple bolt to be replaced with an special bolt having castle nut and split pin as shown below in figure 3.1

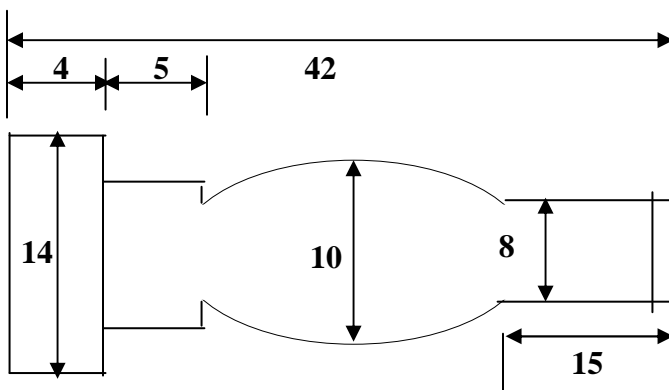


Figure 2.1: Centre fixing bolt with castle nut and split pin.

2.6 TESTING OF CONTACTORS

After an overhaul or thorough repairs, the adjustments have to be carried out again. Therefore to verify these adjustments following tests to be carried out.

2.6.1 DI-electric test

The dielectric tests to be carried out are as follows:

HV circuits	:	4000 volts, 50 c/s, 1 minute.
Circuits of auxiliaries	:	1500 volts, 50 c/s, 1 minute.
LV circuit	:	1000 volts, 50 c/s, 1 minute.

2.6.2 Mechanical Test

2.6.2.1 Pressure measurement

The pressure for main contacts of contactors TCP 3469-24-3 and 3421-25-2 should be 11.5 kg/cm^2 and for TCP 718-16-4 should be 6.4 kg/cm^2 . The minimum air pressure necessary for operation should be 5 kg/cm^2 .

2.6.2.2 Air tightness tests

The cylinder should be connected to a reservoir of 1, liter capacity. The loss of pressure in the whole circuit, initially at a pressure of 9 kg/cm^2 should not exceed 5% of the initial pressure after a test of 10 minute.

2.6.2.3 Verification of mechanical working

The correct operation of each contactor, fitted with its servomotor and magnet valve should be checked at ambient temperature, 20 times in succession. Maintain air pressure range of 5 to 9 kg per cm² and voltage of 68 to 136 volts.

2.6.3 Endurance Test

Duration of 2 hours, at the rate of 20 closings per minute after proper lubrication.

- Air pressure of 5 kg/cm².
- Voltage at magnet valve terminals of about 87 volts.
- After the test, the main contact surfaces should be checked for any abnormality.
- During testing, no part should have got damaged.

2.6.4 Milli volt drop Test for Auxiliary Contacts

S.No	CONTACT	VALUE	
		Between Contacts	Between opposite Terminals
1.	Line contactor 1500A at 1500A.	0-6mV	100 mV max.
2.	C-145 at 850A DC.	0-10mV	100 mV max.
3.	Shunting contactor at 500A	0-10mV	150 mV max.

2.6.5 Procedure for Testing of Electro pneumatic Contactor

- Hold the overhauled Electro pneumatic contactor on test bench. Connect its nipple with pneumatic supply.
- Check and adjust pick up and drop out voltage of electrovalve at pneumatic pressure of 5 kg /cm^2 and 3 kg /cm^2 . These should be 65 ± 5 volts and 20 ± 5 volts respectively.
- Ensure that there is no leakage or sluggish operation.
- Ensure that there is no gap between movable and fixed contact.
- Ensure that bedding between fixed and movable contact is more than 80%.
- Check the contact pressure by means of spring balance.

Thus after passing above said testing stage the Electro pneumatic contactor is ready for service.

2.6.6 Testing of Magnet Valve

2.6.6.1 Measurement of coil resistance

The resistance of coil should be $1100 \pm 7\%$ ohms at 20°C.

2.6.6.2 Air tightness tests

At ambient temperature, the air inlet should be connected to a reservoir of one liter capacity at a pressure of 9 kg/cm².

The loss of pressure should not exceed 10% of the initial pressure after a test of 10 minutes.

2.6.6.3 Minimum working voltage

The magnet valve should close for a voltage equal to at least 57 volts.

2.6.6.4 Dielectric strength tests of new valves

It should be 1500 volts, 50 c/s, one minute between coil and earth.

2.7 CHECK SHEET FOR TESTING OF LINE CONTACTOR AND SHUNTING CONTACTOR

S.No.	Checks	Standard
1	Check all components for crack and damage.	No crack.
2	Replace piston cup and felt.	Replace 100%.
3	Check inlet port diameter.	1.5 to 2 mm.
4	Check exhaust port diameter.	4 mm.
5	Check magnet valve coils resistance.	$1100 \pm 7\%$.
6	Check main contact gap: For Line contactor For Shunting contactor	24 ± 1 mm 23 to 27 mm
7	Check main contact pressure: For Line contactor For Shunting contactor	11.6 to 16 kg/cm ² 6.4 to 8.2 kg/cm ²
8	Check the distance from wheel to pivot point.	47 mm
9	Check minimum operating air pressure.	5 kg/cm ²
10	Check minimum operating voltage at 9 kg/cm ² .	68 V

S.No.	Checks	Standard
11	Lubrication to be done.	Servo lubricant 25
12	Check air leakage a) Coil in energizes condition. b) Coil in de-energize condition.	No leakage No leakage
13	Check condition of shunt maximum broken strands permitted.	10%
14	Check the continuity and discontinuity of auxiliary interlock.	Perfect
15	Check insulation resistance with 2.5 KV megger. a) Between bus bar & earth, arc chute fitted. b) Between contact to contact with arc chute fitted and contact in open condition. c) Between coil and earth with 500 V megger.	10 M Ω 10 M Ω 10 M Ω
16	Check the locking condition of arc chute.	Perfect

2.8 CHECK SHEET FOR AUXILIARY CONTACTS OF LINE CONTACTOR AND C-145 CONTACTOR

S.No.	Checks	Standard
1.	Total length	98 ± 1 mm
2.	Fixation hole center and hole diameter.	16 ± 0.1 mm and 6.2 mm
3.	Fixed and mobile contact matching	Perfect
4.	Contact pressure	150 – 200 gms.
5.	High voltage test 1.5 kV between earth and terminals	Perfect
6.	Insulation resistance checked by megger	Minimum 10 M Ω

2.9 LUBRICATION CHART FOR ELECTRO PNEUMATIC CONTACTORS

S.No	Parts to be lubricated	Lubricant
1.	Joint of roller arm, fixing bracket and hinge pin.	Servoprime 46 or Castrol 46T
2.	Axle pin of main contact lever and roller arm joint	
3.	Roller and pin of roller arm for Servomotor special hook.	
4.	Piston of Servomotor and cylinder oilite bush (1-2 drop)	
5.	Finger contact lever and roller arm joint with hinge pin of shunting contactor.	

2.10 PARTS OF ELECTRO PNEUMATIC CONTACTOR REQUIRE FREQUENT REPLACEMENT

- a. Tips of both fixed contacts and movable contacts.
- b. Main contact lever assembly with rope shunt and axle pin since possibility of damage of rope shunt is high.
- c. Connection strip.
- d. Side plate.
- e. Finger contact holding pin for shunting contact.
- f. Piston cup.
- g. Rubber gaskets, felts.

ANNEXURE-A**LIST OF SPARE PARTS OF SHUNTING CONTACTOR**

S.NO	DESCRIPTION	DRAWING NO.
1.	Blow out Coil assembly	3TWD.111.101
2.	Blow out coil	3TWD.111.101
3.	Pole plate (Set)	SL/SC/0005A(RH) SL/SC/0005A(LH)
4.	Pole plate screen	3TWD.111.067
5.	Connection strip	SL/SC/00/03
6.	Arching horn	4TWD.111.063
7.	Anchoring clamp	4TWD.111.054
8.	Fixed/Mobile Contact	3TWD.111.051
9.	Screen angle(PG)	4TWD.111.082
10.	32x16x2 Bakelite shim	3TWD.111.067A Ref 11
11.	Fixing Bracket	SL/SC/00/08
12.	Roller arm	3TWD.111.084
13.	Dia. 8x47 Spindle	4TWD.111.040
14.	Dia. 8x42 Spindle	4TWD.111.041
15.	Dia. 8x32 Spindle	4TWD.111.042

S.NO	DESCRIPTION	DRAWING NO.
16.	Spring	4TWD.111.047
17.	Spring seat	DQ/A5/018
18.	Bend pin	4TWD.111.044
19.	Lock plate	4TWD.111.045
20.	Bronze roller	4TWD.111.079
21.	Shunt	3TWD.111.062
22.	Finger contact lever	3TWD.111.060
23.	56x44x2 Bakelite distance piece	3TWD.111.067
24.	Steel rivet	
25.	M8x25 Hx.Hd. F.T.	IS:1364
26.	M6 Nyloc nut	3DD.000.020
27.	M8x 15 Hex. Head F.T.	IS:1364
28.	M6X15 Hex F.T.	IS:1364 Part I
29.	M5X12 CSK Screw	IS:1365-1978
30.	M6 Spring washer	IS:3063-1972
31.	M6 X Dia. 16 Special washer	4TWD.112.101
32.	M8 Spring washer	IS:3063-1972

S.NO	DESCRIPTION	DRAWING NO.
33.	M8 Plain washer	IS:2016
34.	2.5 X 20 pin	4TWD.111.043
35.	Split pin	
36.	M8 X 25 Allen bolt	IS: 2269
37.	M8 X 30 Allen bolt	IS: 2269
38.	M8 X 76 CSK(MS)	IS: 1365
39.	M6 X 73 Hx.Head (MS)	4TWD.111.037
40.	M6 X 76 CSK(MS)	IS: 1365
41.	Name plate (SL)	
42.	Name plate (Equipment)	
43.	Arc chute	1TWD.111.110
44.	Anchoring hook assembly	2TWD.111.083
45.	Side plate (Set)	2TWD.111.076 Ref 1/2
46.	59.5 X 8 X 6.2 Tube	
47.	59.5 X32 X 30 FG.Distance piece	4TWD.111.064
48.	13.5 X 16 X 8 F.G. Distance piece	4TWD.111.064
49.	(4+12) X 32 X 30 F.G. Distance piece	4TWD.111.064

S.NO	DESCRIPTION	DRAWING NO.
50.	(4+10) X 32 X 30 F.G. Distance piece	4TWD.111.064
51.	(4+8) X 32 X 30 F.G. Distance piece	4TWD.111.064
52.	(4+3) X 32 X 30 F.G. Distance piece	4TWD.111.064
53.	Paper washer	
54.	Servo motor assembly	2TWD.111.025
55.	Electro valve	3TWD.111.080
56.	Lead washer (Big)	
57.	Brass nozzle (Small)	DQ/A4/000/C145
58.	Half round gasket	3TWD.102.034 Rev.

ANNEXURE-B**LIST OF SPARE PARTS OF C-145 CONTACTOR**

S.NO	DESCRIPTION	DRAWING NO.
1.	Side plate (RH)	2TWD.113.020A Ref 1
2.	Distance piece	2TWD.113.020A Ref 2
3.	Distance piece 15 X 16 X 18	4TWD.113.008 Ref 3
4.	Distance piece 14 X 16 X 18	4TWD.113.008 Ref 2
5.	Distance piece 7 X 16 X 8	4TWD.113.008 Ref 1
6.	Insulating tube 67 X 8 X 6	4TWD.113.037
7.	Insulating tube 67.5 X 32 X 30	4TWD.113.002
8.	Insulating tube 55 X 32 X 34	4TWD.113.004
9.	Synthetic resin bond paper OD.15.5, ID 5.5 TH-1M	4TWD.113.003
10.	Magnetic core screen 0.5	4TWD.112.035
11.	Blow out coil assembly	3TWD.113.017
12.	Fixing bracket roller arm assembly	F/B=2TWD.112.007, R/A Assy = 4TWD.112.0022 Roller arm (Machined) = 4TWD.112.0023

S.NO	DESCRIPTION	DRAWING NO.
13.	Mobile contact lever	3TWD.113.023A
14.	Cable socket	3TWD.112.086A
15.	Rope shunt	3TWD.112.087B
16.	Clamping ring	4TWD.112.085
17.	Connection stip	4TWD.112.008
18.	Magnetic core	2TWD.113.041
19.	Spring (Small)	4TWD.111.046A
20.	Mobile contact	4TWD.112.116
21.	Fixed contact	3TWD.112.010
22.	Anchoring hook assembly	2TWD.113.022
23.	Self lubricating bush	4TWD.112.079
24.	Brass distance tube 56 X 16 X 8.2	SL/C145/A4/001
25.	Roller arm spindle (9.5 X 50)	4TWD.112.026
26.	Roller arm spindle 8.42	4TWD.112.089
27.	Brass nozzle	DQ/A4/000
28.	Electro valve	3TWD.111.080

S.NO	DESCRIPTION	DRAWING NO.
29.	M6 X 82 SS Hex. Hd. Bolt	SL/A4/113/001
30.	M6 X 82 MS Hex. Hd. Bolt	4TWD.113.009
31.	M6 SS Hex. Hd. nut	IS: 1364
32.	M6 X 20 SS CSK Screw	IS: 1365
33.	M6 Nyloc Self locking nut	3TDD.000.020
34.	M6 X 16 Special washer	3TWD.112.110
35.	M6 spring washer	IS:3063
36.	Industrial pin Dia. 2.5 X 20	IS: 5988
37.	Industrial pin Dia 3X 25	IS: 5988
38.	M5 X 36 Hex. Hd. F.T. Bolt	IS: 1364
39.	M5 Nyloc self locking nut	
40.	M8 spring washer	IS: 3063-1972
41.	M8 plain washer	
42.	M6 X 24 Sq. Hd. Bolt	4TWD.112.119

S.NO	DESCRIPTION	DRAWING NO.
43.	M6 X 30 Sq. Hd. Bolt	4TWD.112.118
44.	M8 X 50 Allen bolt	IS: 2269
45.	Plain washer 6mm	4TWD.112.010
46.	M8 half nut	
47.	Lead washer (Big)	
48.	Servo motor assembly	2TWD.112.025
49.	Arc chute assembly	1TWD.113.042
50.	Name plate (Equipment)	
51.	Name plate (SL)	
52.	M5 Spring washer	IS:3063
53.	56 X 44 X 6 distance block	4TWD.113.015
54.	85 X 32 X 2.2 F.G. round washer	4TWD.113.015
55.	M8 X 30 HEX. Hd.F.T. Bolt SS	IS: 1364 REF 2
56.	M8 X 30 HEX. Hd. F.T. Bolt MS	IS: 1364
57.	M6 X 35 HEX. Hd. H.T. Bolt	IS: 1364

S.NO	DESCRIPTION	DRAWING NO.
58.	MS Roller 5mm	
59.	Plain washer 5mm	
60.	M6 X 25 HEX. Head Bolt	IS: 1364 part I – 1983
61.	Aluminum extended piece (S/M)	4TWD.112.061
62.	Half round gasket	4TWD.111.020
63.	M6 X 35 HEX.Head HT Bolt	
64.	M6 X 10 pan head screw	IS: 1364
65.	Wood screw	
66.	6 Block switch assembly	3TWD.112.090
67.	Nylon cam assembly	SL/DQ/A3/076
68.	16 X 20 X32 Block	3TWD.112.076
69.	Spring seat	DQ/A5/019
70.	Axle pin	DQ/SL/10/15/005
71.	32 X 16 X 1 Shim	3TWD.111.076A
72.	M6 X 12 CSK Screw	IS: 1365

ANNEXURE-C**LIST OF SPARE PARTS OF LINE CONTACTOR 1500 AMPS**

S.NO	DESCRIPTION	DRAWING NO.
1.	Blow out coil assembly	3SAB/15A/020
2.	Blow out coil core	SL/DQ/A4/088
3.	Fixed contact	DQ/A4/005
4.	Poll plate (Set)	3TWD.112.016 RA 3TWD.112.016 LA
5.	Poll plate screen	3TWD.112.041A
6.	Backing plate (Set)	3TWD.112.017
7.	Connection stip	4TWD.112.008
8.	Copper distance PC	SL/DQ/A4/091
9.	Brass distance tube	SL/LC/A4/001
10.	Fixing bracket	A1/SL/15/LC/052 Part G
11.	Roller arm	A1/SL/15/LC/052 Part H
12.	Self lubricating bush	A1/SL/15/LC/052 Part L

S.NO	DESCRIPTION	DRAWING NO.
13.	Roller arm spindle	A1/SL/15/LC/052 Part N
14.	Roller spindle	A1/SL/15/LC/052 Item O
15.	Bronze roller	A1/SL/15/LC/052 Item M
16.	Mobile contact lever	A1/SL/15/LC/051 Item B
17.	Rope shunt	A1/SL/15/LC/051
18.	Cable socket	A1/SL/15/LC/051 Ref D
19.	Clamping ring	A1/SL/15/LC/051 Item F
20.	MS distance tube 5.2 Dia.	
21.	Hx.Hd. Screw M5 X 55	
22.	Spring seat (MS)	DQ/A5/019
23.	Axle pin with nut	DQ/SL/10/15/005
24.	Small spring	SL/DQ/A4/029A
25.	Connection terminal	A1/SL/15/LC/051 Item E
26.	Mobile contact	A1/SL/15/LC/051 Ref A
27.	Aluminum cylender	2TWD.111.055

S.NO	DESCRIPTION	DRAWING NO.
28.	Piston rod	4TWD.111.048
29.	Insulating washer	4TWD.111.038
30.	Insulator	3TWD.111.100
31.	Special hook	4TWD.111.050
32.	Auxiliary contact support (‘L’ Bracket)	4TWD.111.097
33.	Servo motor spring	4TWD.111.046A
34.	Brass felt ring	4TWD.111.056
35.	Woolen felt	4TWD.111.074
36.	Piston cup	4TWD.101.035
37.	Square gasket (Small)	4TWD.111.019
38.	Electro valve support	2TWD.111.018
39.	Inlet/Outlet tube (Set)	4TWD.111.058 A Ref ½
40.	Lead washer (Big)	
41.	Air nozzle	DQ/A4/000
42.	Half round gasket	3TWD.102.034 Rev
43.	Aluminum extended piece	4TWD.112.061

S.NO	DESCRIPTION	DRAWING NO.
44.	Electro valve	3TWD.111.080
45.	Adjusting washer 0.5/1.0	4TWD.112.101
46.	Nylon cam assembly	SL/DQ/A3/076
47.	6 Block switch assembly	3TWD.112.090
48.	Bakelite distance piece 56 X 44 X 11	3TWD.112.041 A
49.	Bakelite distance block 16 X 20 X 32	3TWD.112.041 A
50.	Bakelite shim 1 mm /0.5 mm	3TWD.112.041 A
51.	Allen bolt M8 X 50	IS: 2269 – 1981
52.	Hex. Hd. F.T. bolt M8 X 45	IS: 1364 Part I
53.	Allen bolt M8 X 30	IS: 2269 – 1981
54.	CSK Screw M8 X 20	IS: 1365 – 1978
55.	Hex. Hd. H.T. bolt M8 X 92	4TWD.112.099
56.	Hex. Hd. H.T. bolt M8 X 92	4TWD.112.080
57.	CSK Screw M6 X 92	IS: 1365
58.	Hex. Hd. H.T. bolt M6 X 3.5	IS: 1364

S.NO	DESCRIPTION	DRAWING NO.
59.	Hex. Hd. H.T. bolt M6 X 30	IS: 1364
60.	Square Hd. Bolt M6 X 30	4TWD.112.119
61.	Square Hd. Bolt M6 X 24	4TWD.112.118
62.	CSK Screw M6 X 10	IS: 1365 – 1978
63.	Pan head screw M6 X 10	
64.	Wood screw	
65.	Half nut M8	IS: 1364
66.	Nyloc nut M6	3TDD.000.026
67.	Helilock nut M6	IS: 1364 part 3
68.	Plain washer M8	4TWD.101.072
69.	Spring washer M8	IS: 3063
70.	Spring washer M6	IS: 3063
71.	Special washer M6 X 16	
72.	Industrial pin 3 X 20	
73.	Industrial pin 2.5 X 20	
74.	Anchoring hook assembly	2TWD.112.013

S.NO	DESCRIPTION	DRAWING NO.
75.	Name plate (SL)	
76.	Name plate 1500/1000 AMP.	
77.	Arc chute assembly	1TWD.112.005
78.	Steel rivet	
79.	Side plate (FG) Set	2TWD.112.006
80.	Tube 78 X 22 X 30	
81.	Tube 78 X 8 X 62	
82.	Distance piece 15 X 16 X 18	
83.	Distance piece 10 X 16 X 8	
84.	Distance piece 3 X 16 X 8	
85.	Distance piece 16 X 16 X 8	

REFERENCE

1. Maintenance Manual of CLW for WAM4, WAG5, WAP1 Locomotives.
2. Maintenance Manual of BHEL for WAG5 Locomotives.
3. AC Traction Manual.
4. Comments/Suggestions given by RDSO.
5. IRIEEN Journals.
6. Comments/Suggestions given by CETI/THK.
7. Comments/Suggestions given by various sheds during visit as well as during seminar.
8. Electric Locomotive POH check sheet.

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