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अनुसंधान अभिकल्प और मानक संगठन
लखनऊ – 226011

Government of India - Ministry of Railways
Research, Designs & Standards
Organization, LUCKNOW - 226011

No. EL/11.5.5/5

Date: 23.12.2010

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3. Central Railway, HQs Office, 2nd floor, Parcel Office Bldg., Mumbai-400 001
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6. South East Central Railway, Bilaspur-495 004.
7. South Eastern Railway, Garden Reach Kolkata-700043

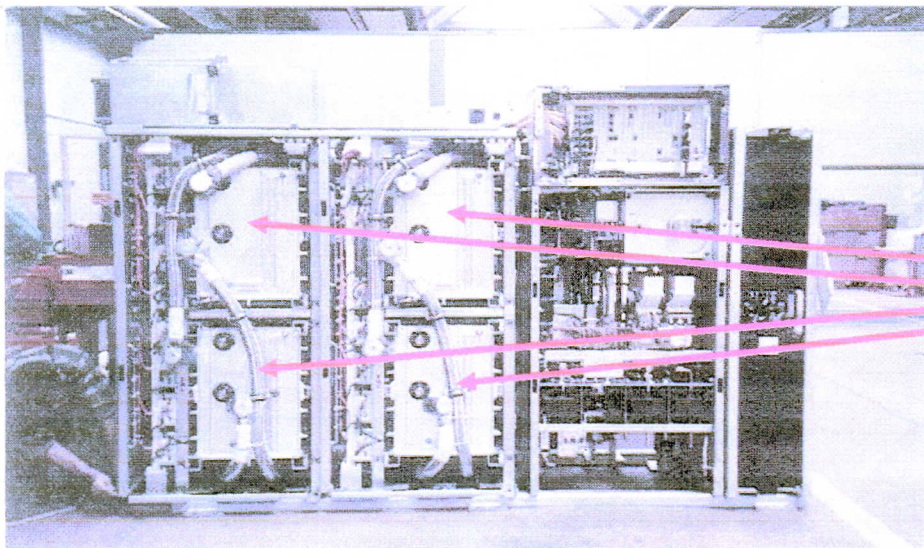
**SPECIAL MAINTENANCE INSTRUCTION No. RDSO/2010/EL/SMI/ 0265 (Rev. '0'),
Dated. 08.12.10**

1.0 Objective:

Procedure for repairing of valve sets of traction converter of three phase electric locomotives.

2.0 Introduction:

Each locomotive is equipped with 02 (two) traction converters (SR-1 & SR-2). Valve set is a vital part of traction converter (SR) which houses GTOs, Diodes and snubber circuit components. One traction converter consists of 04 (four) valve sets. Each locomotive consists of 08 (eight) valve sets. In each traction converter, 03 (three) ZV- ZV and 01 (one) ZV- MV type valve sets are fitted. ZV- ZV type valve set consists of one bridge circuit of GTO which is either used as rectifier or inverter depending upon the firing command given by processor (NSC or ASC). ZV- MV type valve set has one inverter unit & one crow bar protection scheme (MUB protection). Crow bar protection scheme is used for DC link protection. Typical photograph of valve sets used in traction converter is shown in figure-1 below.

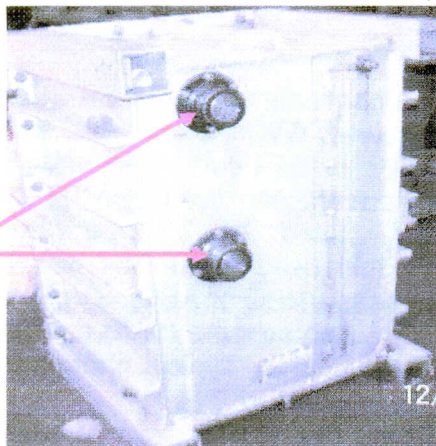


Valve sets in a
traction
converter

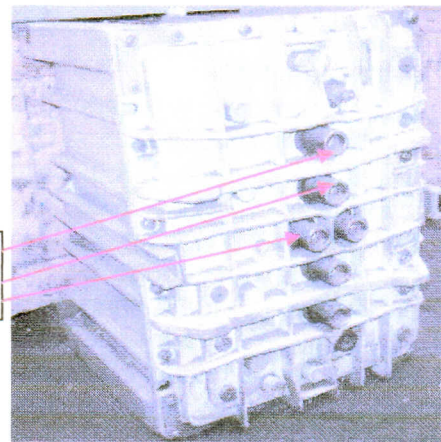
Fig.1: Traction converter

2.1 Due to defect in GTOs or due to defect in other components of valve set, sometimes the complete valve set is required to be opened and maintenance task is required to be done. Presently valve sets are being repaired from the TOT partners. ELS/Gomoh has started the repairing of valve sets at shed level. This SMI has been prepared so that other sheds can also take up the work of repairing of valve sets of traction converters of three phase locomotives on similar lines.

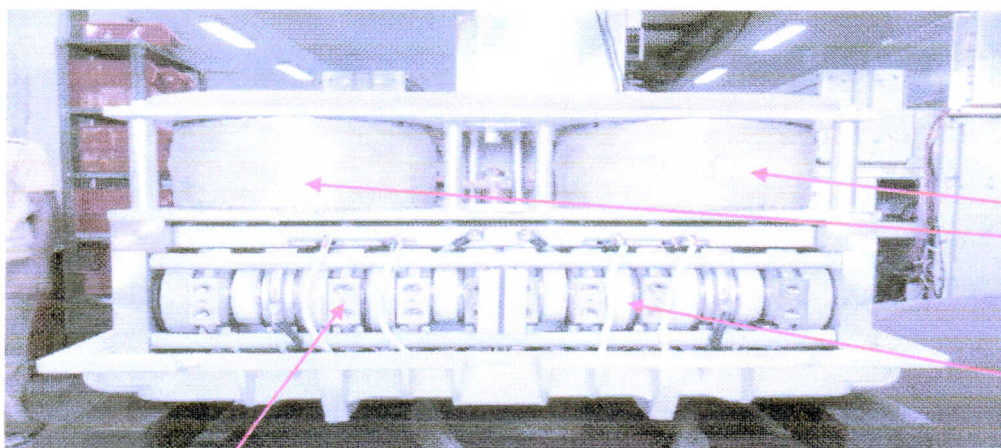
3.0 **Constructional details-** Outside construction of valve set is shown in following figure-2. Inside the valve set, there is a complete stack of GTO's & Diodes along with cooler unit. This stack is called main stack which is pressed by 38 KN force. Main stack is mounted on the base plate of valve set. All bus bars of main stack are connected to the base plate. Gate cathode cable is connected to gate cathode point of base plate. On main stack, pressure chamber is mounted in longitudinal pattern. All oil circulating pipe of pressure chamber is connected to the cooler unit of small stack assembly (snubber diode assembly). Capacitor bank, fitted on the base plate, is electrically connected with the bus bar of main stack. On the capacitor bank M1 and M2 (snubber diode) assembly is fitted. RC network is fitted on the outer side of capacitor bank. After fitment of RC network one layer of valve set assembly is completed. On the top of first layer L1 and L2 (inductors) assembly is fitted. Two resistors are fitted on the L1 and L2 assemblies. Nomex paper is fitted around the whole assembly and the top cover is fitted on the base plate.



Valve set- front side



Valve set- back side



Spiral cooler

(Valve set in open condition)

Inductor assembly

GTO stack

Fig-2

3.1 Components of Valve Set- A Valve set contains mainly following components.

S.No.	Component	ABB/Adtranz Id No.
1.	GTO	3EHN425024R4240
2.	Freewheeling diode	3EHT435029P9645)
3.	Spiral cooler unit	HIET210005R0001
4.	Snubber diodes	3EHN424290P9645
5.	Pressure chamber (ZV-ZV)	3EHN100020R0001
6.	Pressure chamber (ZV-MV	3EHN100020R0002
7.	Snubber Capacitor	HEIS307793P0001
8.	Inductor (L1, L2)	3EHN424023R0002
9.	Grid Resistor	HIET428126P0001
10.	Copper COVER PLATE I (FOR VALVESET - POWER CONVERTER)	3EHN400086P0001
11.	Nomex paper	3EHN400118P0001
12.	INPUT A11 AND A21 (BUSROD A11-A21- VALVE SET-POWER CONVERTER)	3EHN400082P0268
13.	Precision 'O' Ring. (Dia.D=642, Self dia.d=4)	3EHN424200P0001
14.	GTO SNUBBER CAPACITOR 300 0V,9.0 uF (S.POS .C1,C3)(TYP:B25556- J7905-A003)	HIET428134P0090
15.	GTO SNUBBER CAPACITOR 300 0V-3.5uF (S.POS.C 11,C13)(TYP:B25856- J7355-J013)	3EHN424241P0035
16.	FLEXIBLE CONNECTION L1-V1 (BUS BAR L1/V1- VALVE SET - POWER CONVERTER)	3EHN300018R0001

3.2 Some of the above components are illustrated in following figures 3-7.

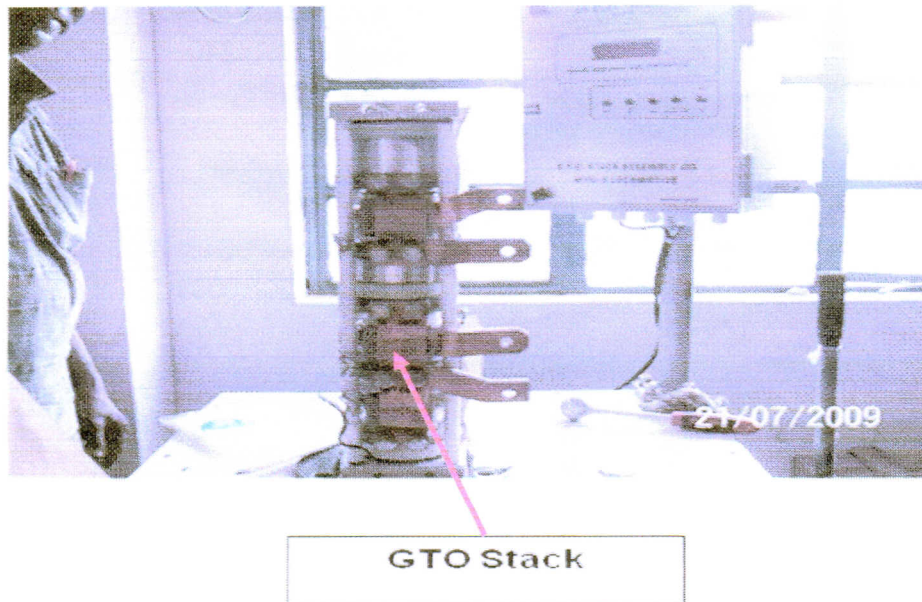


Figure-3

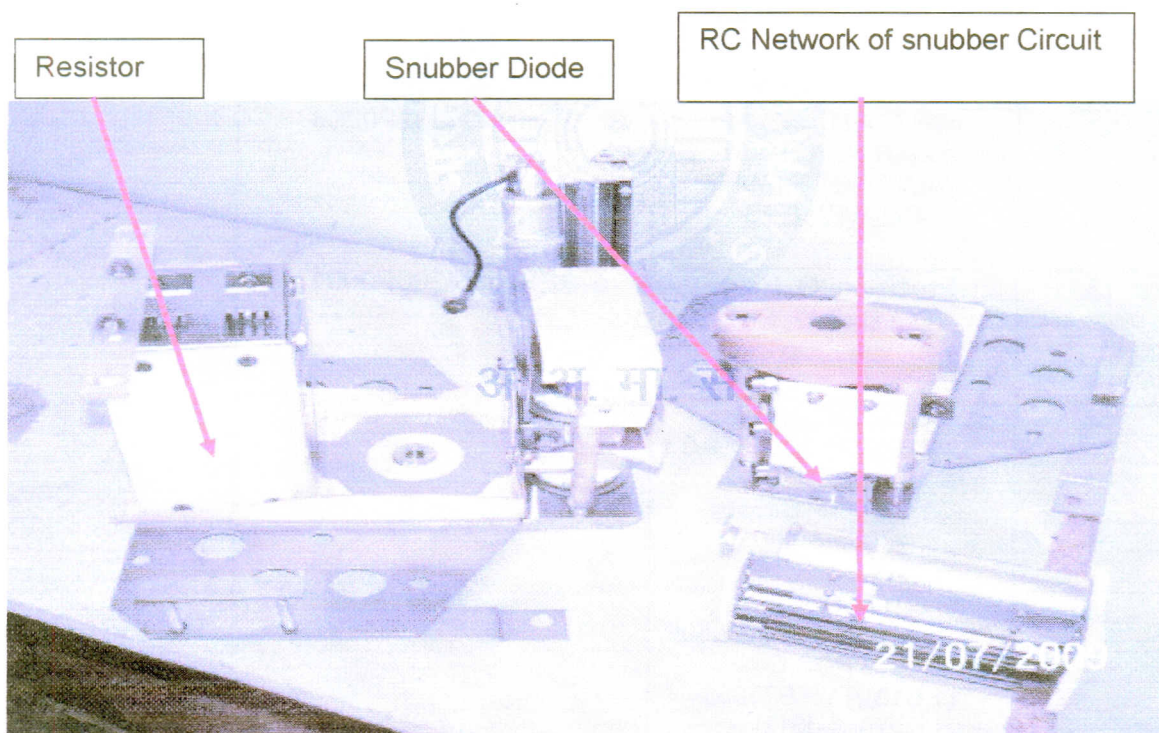
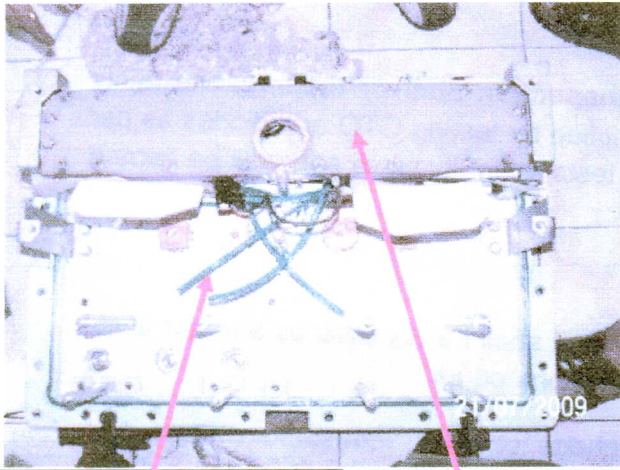


Figure-4



Back plane & GTO
pressure Chamber oil pipe

Pressure
chamber

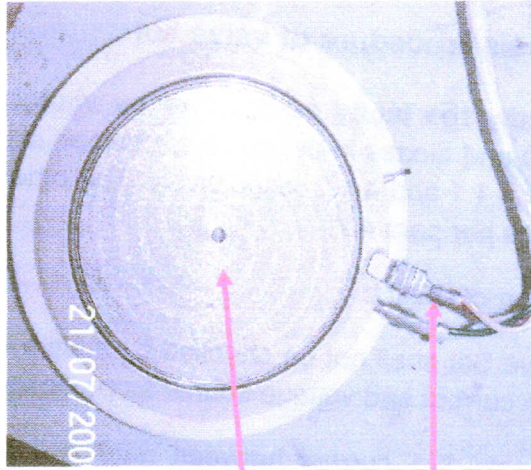


Figure-5

GTO

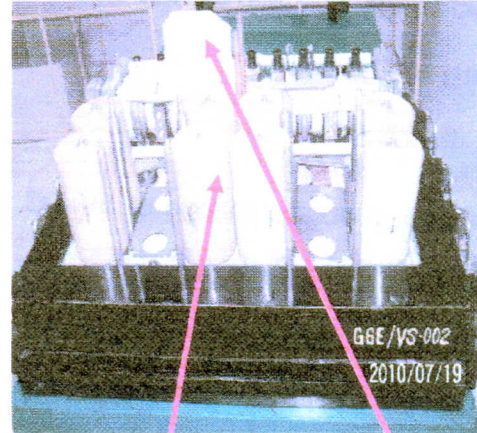
Gate cathode cable



Freewheeling Diode

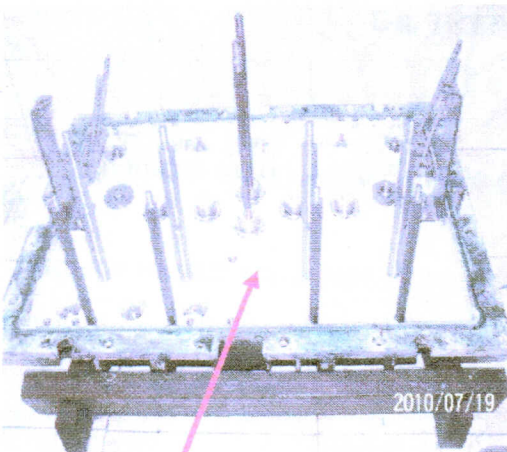
Cooler unit

Figure-6



Capacitor assembly

Nomex paper



Base plate with studs

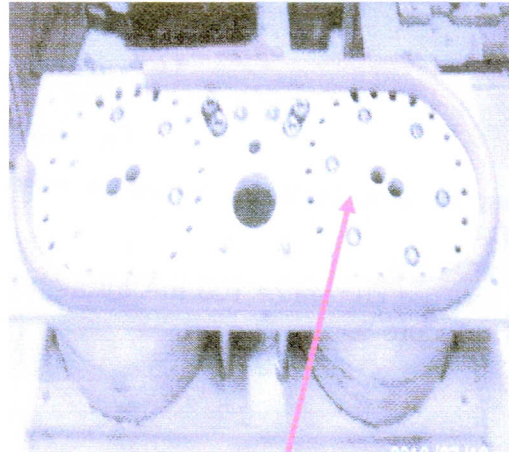


Figure-7

Inductor assembly

4.0 Repair Procedure of valve set:

- 4.1 **Identify the faulty component by visual inspection and/ or testing:** The faulty GTO and diodes in the valve set can be identified by testing GTO and diodes as per para 4.1.1 and 4.1.2 respectively. The other tests on faulty valve set shall be carried out as per para 4.7.

4.1.1 Testing of GTOs:

Valve Set shall not be checked by multi meter. It shall be checked by a meter along with current and voltage source as per following procedure:

- (a) Apply 1 A current between gate and cathode of GTO, measured voltage drop between gate and cathode. For healthy Valve set it should be 0.5 to 0.7 V.
- (b) Apply 10 V in reverse polarity between gate and cathode. For healthy Valve set leakage current should be less than 50 mA.

4.1.2 Testing of Diodes:

a) Blocking direction

Apply cathode to anode voltage of 5V DC to the diode under test using power supply source as shown in Figure- 8 below.:

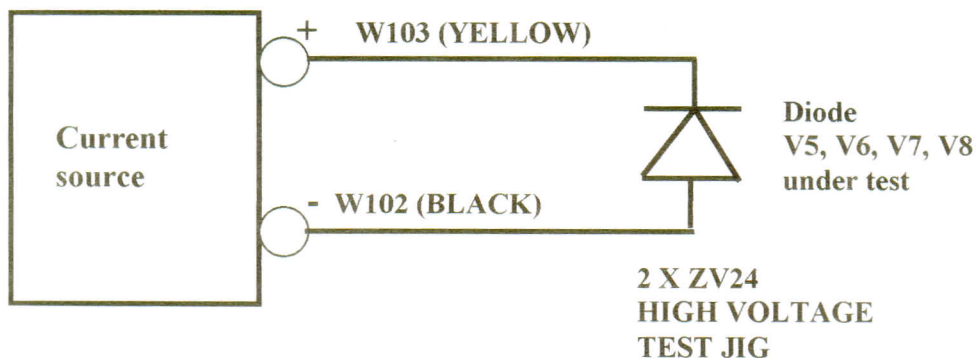


Figure-8

Resulting blocking current i_R should be in the range of 0 to 5.0 mA (pass criterion)

b) Forward direction

Impose a forward current of 100 mA through the diode under test using current source as shown in Figure-9.

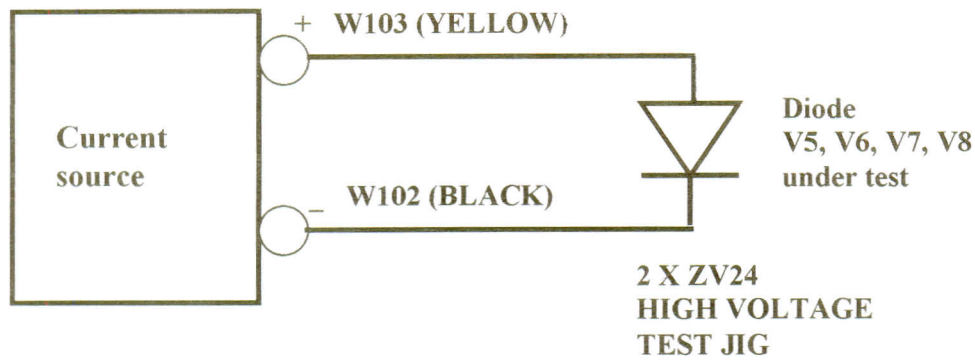


Figure-9

Resulting forward voltage V_F should be in the range of 0.5 to 1.0 Volt (pass criterion)

4.2 Opening of Valve set assembly: The following should be done in sequence given below:

- A. Open the cover of valve set.
- B. Open capacitor connected with M1& M2 assembly.
- C. Open pressure chamber.
- D. Disconnect snubber circuit (RC network).
- E. Open big capacitors (4 nos. each).
- F. Disconnect gate cathode connection.
- G. Disconnect input and output power connection.
- H. Open GTO assembly from base plate.
- I. Clean all open items with oil (Shell Diala DX)
- J. Check all Electrical components.

4.3 Replacement of faulty diode /GTO in the stack. : Following steps should be taken to replace the faulty diode or GTO in a stack.

- A. After identifying faulty GTO or diode, place GTO assembly on GTO stack machine and connect it with machine. GTO stack machine is shown in Figure 10.
- B. Set pressure to 38KN-m in GTO stack machine.
- C. Disconnect all GTOs, Diodes and cooling units and remove all equipments.
- D. Clean all equipments.
- E. Replace the defective items.
- F. Refit all GTOs, Diodes and cooling units as per sequence.

G. Set pressure 38KN-m in stack machine.

H. Tighten top screw with 10 N-m

I. Release pressure slowly to 0 N-m

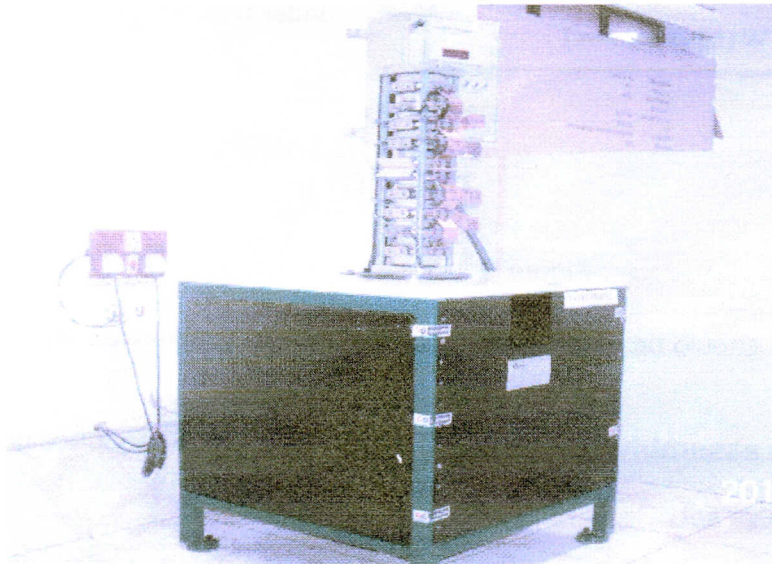


Figure- 10

4.4 Must change items of valve set: Following items must be changed invariable whether defective or not when ever valve set assembly is opened for repair.

S.No.	Component	IDENTIFICATION DOC.
1.	Precision 'O' Ring. (Dia.D=642 ,Self dia.d=4)	3EHN424200P0001
2.	Polyimide tube for small cooler (240mm),	3EHN 400187P0240
3.	Polyimide tube for small cooler (340mm),	3EHN 400187P0340
4.	HT Spring Washer M6 SST	NB 335805P0509
5.	HT Spring Washer M8 SST	NB 335805P0511
6.	HT Spring Washer M10 SST	NB 335805P0512
7.	Conical Spring washer 4.3/9 ST-NR	GZN490084P0505
8.	Conical Spring washer 5.3/11 ST-NR	GZN490084P0506
9.	Conical Spring washer 6.4/14 ST-NR	GZN490084P0507
10.	Conical Spring washer 8.4/18 ST-NR	GZN490084P0508
11.	LEMO female connector for gate cable (Double pole and single pole for oil pressure chamber)	HIET428081R0002

4.5 Procurement of Items: All the items to be replaced during repairing of valve set shall be procured from TOT partners only.

4.6 Assembly of Valve Set: Following steps are taken to assemble the valve set.

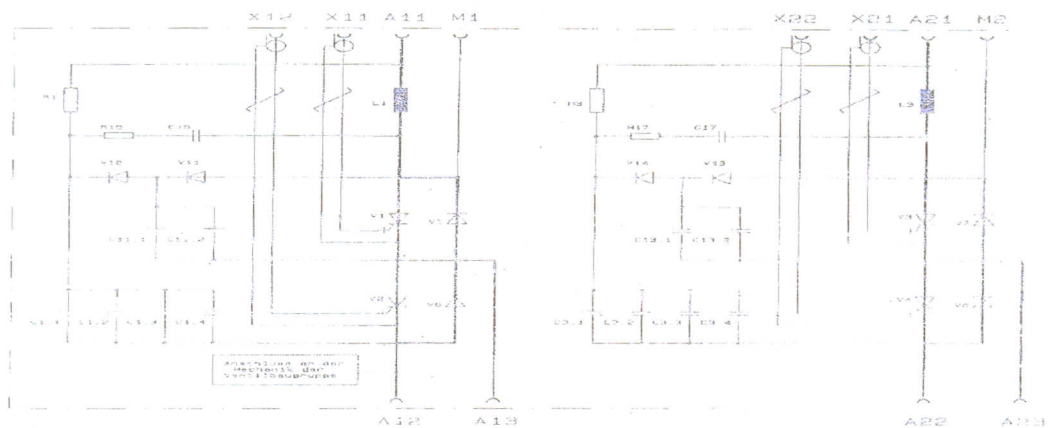
- A. Re-assemble all items in the reverse sequence of opening.
- B. Use torque wrench during tightness. Following torque is recommended for tightness:

Position	Recommended torque
Cu bar with GTO stack	30N-m
all capacitor with plate	13N-m
Inductor coil plate with stud	25N-m
Inductive coil with I/O	30N-m
I/O point	50 N-m
Allen/Hex Screw thread M3	0.7 N-m
Allen/Hex Screw thread M4	1.6 N-m
Allen/Hex Screw thread M5	3.0 N-m
Allen/Hex Screw thread M6	5.3 N-m
Allen/Hex Screw thread M8	12.5 N-m
Allen/Hex Screw thread M10	25.0 N-m
Allen/Hex Screw thread M12	43.0 N-m
Allen/Hex Screw thread M16	104.0 N-m

- C. After final assembling check all electrical equipments.
- D. Ensure insertion of NOMEX paper in proper place.
- E. Ensure tightness during refitting with proper hardware.
- F. Refit tank.
- G. Fix the 'O' ring in the groove of cover plate with rubber based glue 'Universal sealing compound PU-200'. Remove excess glue.
- H. Fill up oil (Shell diala DX) & check oil leakage as per para 4.7.
- I. Check electrical connection from back side access point of valve set as per para 4.6.

- J. Check IR value in between tank and all electrical components as per procedure given in para 4.8.

4.7 Measurement of various test values between various components of valve set (ZV-ZV) & (ZV-MV) from outside terminals after assembly: The continuity and test values between various component of valve set are required to be taken to ascertain the correct assembly of components. Various test values are given in following tables. Please refer figure 11 for various terminals. Use diode mode of multi meter to test diodes, resistance and capacitance meter to measure capacitance and resistance.



Circuit diagram of ZV-ZV Valve set

Circ

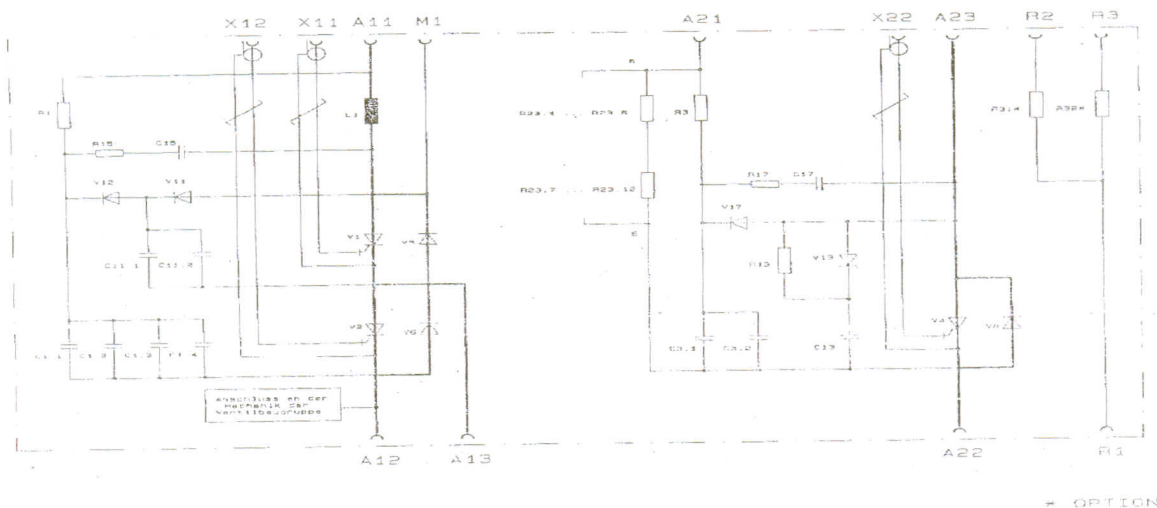


Figure-11 (Circuit diagram of ZV-MV Valve set)

GBC-1 Configuration:

Terminal Name	Test Value	Description of Components
A13-M1	0.23 to .26 V	V5 (freewheeling diode)

A12 - M1	0.46 to .52 V	V6 + V5 (freewheeling diode)
A12 - X12 (Cathode)	00 V	Continuity between V2 cathode and A12
A12 – X22 (Cathode)	OL	Continuity between V4 cathode and A12
A12 - X11 (Cathode)	0.23 to 0.26 V	V6 (freewheeling diode)
A13 - X11 (Cathode)	0 V	Continuity between V1 cathode and A13
A12 - X21 (Cathode)	OL	Continuity between V3 cathode and A12
A11 - A12	38 to 42 μ F	Capacitor (C1.1+C1.2+ C1.3 + C1.4)
M1 - A13	7 to 8 μ F	Capacitor (C11.1 + 11.2)

GBC-2 Configuration:

Terminal Name	Value	Description of Components
A23 - M2	0.23 to .26 V	V7 (freewheeling diode)
A22 - M2	0.46 to .52 V	V7 + V8 (freewheeling diode)
A22 - X22 (Cathode)	0 V	Continuity between V4 cathode and A22
A22 - X12 (Cathode)	OL	Continuity between V2 cathode and A22
A22 - X21 (Cathode)	0.23 to 0.26 V	V8 (freewheeling diode)
A23 - X21 (Cathode)	0 V	Continuity between V3 cathode and A23
Terminal Name	Value	Description of Components
A22 -- X11 (Cathode)	OL	Continuity between V1 cathode and A22
A21 - A22	38 to 42 μ F	Capacitor (C3.1+C3.2+C3.3+C3.4)
M2 – A23	7 to 8 μ F	Capacitor (C13.1+C13.2)

GBC-3 Configuration:

Terminal Name	Value	Description of Components
A13--M1	0.23 to .26 V	V5 (freewheeling diode)
A12 - M1	0.46 to .52 V	V6 + V5 (freewheeling diode)
A12 - X12 (Cathode)	00 V	Continuity between V2 cathode and A12
A12 – X22 (Cathode)	OL	Continuity between V4 cathode and A12
A12 - X11 (Cathode)	0.23 to 0.26 V	V6 (freewheeling diode)
A13 - X11 (Cathode)	0 V	Continuity between V1 cathode and A13
Terminal Name	Value	Description of Components
A12 - X21 (Cathode)	OL	Continuity between V3 cathode and A12
A11 - A12	38 to 42 μ F	Capacitor (C1.1+C1.2+ C1.3 + C1.4)
M1 - A13	7 to 8 μ F	Capacitor (C11.1 + 11.2)

MUB Configuration:

Terminal Name	Value	Description of Components
A22 - A23	0 V	V8
A21 - A22	7 to 8 μ F	Capacitor (C3.1+C3.2)
A21 - A22	7 to 7.5 K Ω	R23 + R32
A21 - A23	0.23 to 0.26 V	V17

A21 - A23	0.6 to 0.7 μF	C17
A23 - A22	0.23 to 0.26 V	V13

4.8 Oil pressure and leakage test: Oil (Shell Diala DX) at 60 degree C is passed through valve set at 1.0 ± 0.1 bar and Circulated for 30 minutes. The oil flow shall be ≤ 258 lpm. After the above test, check the valve set for oil leakage and oil leakage should be checked in locomotive also. The internal oil pressure should not exceed 1.1 bar otherwise it may damage the internal parts of the valve set.

4.9 Insulation test of Valve Set body and internal components:

4.9.1 Short the following terminals as per table below for ZV-ZV and ZV-MV valve set:

Valve set	Terminals to be shorted
ZV-ZV	M1, X11, X12, X22, X21, M2, A13, A12, A11, A21, A22 and A23
ZV-MV	M1, X11, X12, X22, M2, A13, A12, A11, A21, A22 and A23

4.9.2 **Megger Test:** Apply 1 kV DC across shorted terminals and Aluminium tank body. Insulation value should be more than 3 M ohm.

4.9.3 **HV Test:** Apply 9 kV across shorted terminals and Aluminium tank body for 60 sec. Leakage current should be less than 50 mA.

5.0 Tools and Plants required:

5.1 General purpose T&P: Following T&P can be purchased from open market.

- I. Pressure gauge
- II. 9 kV AC HV tester
- III. Meggar 1 kV DC.
- IV. 10 VDC, 1 amp power supply
- V. Multimeter
- VI. Shorting cables with banana terminals and spring loaded clips
- VII. Torque wrench range 5 Nm to 50 Nm
- VIII. Nose plier
- IX. Mallet
- X. Spanners, ring spanners
- XI. Philip and chisel head screw driver set
- XII. Valve set assembly fixture.

5.2 Special type T&P:

- I. **Oil Circulating pump and Oil tank:** In order to test oil leakage as per para 4.8, an oil circulating pump and oil tank shall be required. The capacity of pump required to be procured shall be at least 300 l/min at the variable pressure of 1.1 bar or more. The oil tank of suitable size to store 500 litre of oil may be procured. The oil tank can be connected to existing filtration plant to filter the oil.

II. **Stack clamping machine:**

The stack clamping machine for clamping and unclamping valve set assembly up to 45 kN variable force is required. The operator shall be able to vary force manually. There shall be facility to display the value of force through suitable 7 segment LED display. The stack clamping machine shall have the facility to set the upper limit of the force. If the force exceeds the upper limit, suitable alarm shall be generated. The stack clamping machine can be procured from any TOT partner or from following source:

M/s GG Electronics

6, Akash Complex Laxminagar, Amrutdham Mumbai-Agra Road,
Near Hotel Kunal, Panchvati Nashik-422003 Maharashtra (India).

Tele fax: 0253-2304589

Email: ggelectronics@sancharnet.in, ggelectronics@rediffmail.com

6.0 Application to:

WAP5, WAP7, WAG9 and WAG9H based locomotives.

7.0 Agency of implementation:

All sheds holding & maintaining WAP5, WAP7, WAG9 and WAG9H locomotives.

8.0 Reference:

The following documents of three phase locomotives may please be referred in connection with the above details.

- (i) Supplier's Documentation Volume F4 (page 76-84).
- (ii) Spare part catalogue Volume E
- (iii) Maintenance and repair manual D2

40/23/12/10
(Sandeep Srivastava)
for Director General (Elect)

Encl: Nil

Copy to:

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