ELECTRIC LOCO TRAINING CENTRE
USLAPUR, S.E.C.RAILWAY

COURSE MATERIAL

for

Assistant Loco Pilot

Rng : 2.2

ELECTRICITY

Electricity is a form of energy produced by the flow of electrons in a closed circuit when a generator or battery maintains the potential difference.

It is not visible to us, but its effects are felt and realized.

Voltage: The pressure produced by a generator is known as 'voltage' (or) the potential difference between two points is called 'voltage'. It is measured in volts by voltmeter and indicated by the letter 'V'. The voltmeter should be connected to the generator in parallel.

Intensity: The flow of electrons in a circuit is known as "current". The rate of flow of current for second in a closed circuit is called "intensity". It is measured by ammeter, which is connected in series to the circuit. Intensity represented by the letter " I ".

Resistance: The opposition offered by a material to the flow of current is called "Resistance". It varies from metal to metal according to the cross sectional area, length of the conductor and temperature. Resistance is measured in "Ohms" by Ohmmeter (or) Megger, which should be connected across the receiver. It is represented by a letter" R "

Ohm's Law: Ohm's law states that in a closed electrical circuit, intensity is directly proportional to the voltage and inversely proportional to the resistance provided the temperature remains constant.

V = I X R ; I = V/R ; R = V/I

V = Voltage

I = Intensity.

R = Resistance.

Factors Affecting Ohm's Law:

If resistance decreases, current increases.

If resistance increases current decreases.

If length of the conductor increases, the resistance increases.

If cross sectional area of the conductor increases, the resistance reduces.

Rng : 2.3

SIMPLE ELECTRICAL CIRCUITS

An electrical circuit is a continuous path from source of energy (generator) to the receiver and back to the same source. It consists generator, fuse, switch, voltmeter, ammeter, receiver and its terminals etc.,

Generator : It produces electrical energy.

Fuse : It is a protective device to the circuit.

Switch : It is a switch for opening and closing of the circuit.

Voltmeter : Voltmeter indicates the amount of electrical pressure producedby the generator. It should be connected across the terminals of the generator.

Ammeter : Ammeter is used to measure the flow of current and gives the reading when the circuit is closed. It is connected to the circuit in series.

Receiver : It receives the current and produces the useful work.

Conductor : It is a metallic path from the generator to receiver and back to the same source

Electrical Circuits can be divided into four types.

Open Circuits.

Closed Circuit

Short Circuit

Earth (or) Leakage Circuit

Open Circuit: If anyone of the supply wires is disconnected or the fuse is melted, the current will not flow through the receiver. This type of circuit is called "Open Circuit".

Closed Circuit: The complete path for a flow of electrical current through the receiver is called "closed Circuit".

Short Circuit: An Electrical Circuit having two different levels known as Positive and negative levels. The positive terminal of the generator to the positive terminal of the receiver is known as "Positive Level" and from negative terminal of the receiver to the negative terminal of the generator is called "Negative Level". An accidental contact between the two different levels of a circuit is called "Short Circuit".

Reasons For Short Circuit:

a. Old or damage insulation.
b. Loose and hanging wires.
c. Contact due to leftover tools.
d. Contact of outside wires.
e. Contact of wires due to water leakage.
f. Placing Uninsulated wires very closely without giving safety gap.
g. Due to wrong connections.
h. Constant rubbing of two cables (or) naked conductors touching to the loco body.

Bad Effects of Short Circuits:

a. The receivers are by passed.
b. The intensity in the circuit increases suddenly.
c. Sudden increasing of intensity produces abnormal heat in the Circuit.
d. Due to high temperature the insulations are damaged.
e. Due to high temperature electrical fire can be caused.
f. The life of the generator and receiver are reduced.
g. The increasing of intensity will cause further short circuits and resulting more damages of the equipments.

Earth (or) Leakage Circuit:

If any wire of the supply touches the body of an appliance, then it is called "Earth Circuit (or) Leakage Circuit."

Preventive measures to be taken to avoid short circuits.

Conductors are to be covered with insulating material such as rubber, cotton, silk according to the value of current passing in the conductor.

Un insulated wires are to be kept with sufficient gap according to the voltage value.

The terminals are to be provided with lugs and fix them firmly.
High tension cables are to be insulated.

Heating elements are properly to be secured at safest distance.

Every circuit should be fixed with fixed value of intensity.

To avoid wrong connections, each terminal of the wire is to be numbered.

Fuses and miniature circuit breakers are to be provided in the low tension circuits.

High Voltage circuit breakers (or) minimum oil circuit breakers are to be provided as protective devices against over current.

0	to	250 V	-	Low Tension
250 V	to	650 V	-	Medium Tension (M.T
650 V	and	above	-	High Tension (H.T)

Electrical Connection :

Electrical Connections can be made in many ways and they are mainly classified as follows.

Series Connection: In this circuit the receivers are connected one after another in the form of chain and in turn finally connected to positive and negative terminals of the generator.

In this connection

The voltages is divided according to the resistance value.
Intensity remains constant in circuit.

Total resistance is equal to - the sum of all receivers.

A cut in the circuit causes "Total Failure" of circuit.

Parallel Connection : In this circuit the receivers are connected directly to the positive and negative terminals of the generator.
In this connection

The voltage remains constant in all receivers.

The intensity is divided among the receivers, according to their resistance value.
The total resistance of the circuit is calculated by the formula.

$I/R = I/R1 + I/R2 + I/R3 + - - - - - -$

A cut in the branch causes failure of that parallel branch only.

Series - Parallel Connection: In this connection the receivers are connected in the form of series and also in parallel in one circuit is known as "Series - Parallel" connection. This type of circuit will have behavior of both series and parallel connections.

Difference between series and parallel connections:

SERIES	PARLLEL
1. Receivers are connected in the form of chain one after another . 2. Total Resistance of the circuit is equal to the sum of the all receivers. i.e R=R1+R2+R3 - - - 3. Voltage is divided according to the resistance value. 4. Intensity is constant through out the circuit. 5. A cut in the circuit causes total failure of the circuit. 6. Power varies according to the number of receivers connected in the circuit.	1. Receivers are connected directly to the generator. 2. In this connection the formula is used to find total resistance. 1/R = 1/R1 + 1/R2 + 1/R3 + - 3. Voltage remains constant in all receivers. 4. Intensity is divided according to the resistance value on each branch. 5. A cut in the circuit causes failure of that parTICular branch only. 6. The power of receivers remains same as generator.

Rng : 2.4

M E T E R S

Various circuit parameters are required to be measured the parameters such as voltage, current, resistance, power, energy etc., need to be measured.

The current transformers and potential transforms are specially designed transformers which are used in the system where secondaries are connected to meters for measurement of current and voltage, resistance respectively.

Name of Meter Measuring Parameters in Units:

Ammeter	- Current	- Amperes
Voltmeter	- Potential Difference	- Volt
Watt meter	- Power	- watts
Ohm meter	- Resistance	- Ohms
Frequency Meter	- Frequency of Supply	- Hertz
Megger	- Insulation testing	
Energy meter	- Energy	- Kwh

Rng : 2.5

PROTECTIVE DEVICES

It is a device to protect the electrical circuits in the event of any short circuit in the electrical circuits.

Fuse: Fuse is a device connected in series to the circuit to protect the circuit from damage in the event of over current.

Limiting tension Battery: It is a device to protect the low tension circuit and the batteries in the event of any accidental contact between high tension, or medium tension with the low tension circuits.

In this device two terminals are placed with a gap of 3mm, One terminal is connected to the positive level of the battery and the other terminal is grounded through loco body. When ever there is an accidental contact between high tension or medium tension with low tension circuits, intensity increases suddenly. At this time an arc will be formed in the gap of limiting tension battery (LTBA) terminals in turn CCBA fuse melts which provided on the low tension circuit.

The high tension circuit is also earthed and trips main circuit breather (DJ). If the accidental contact remains permanent the terminals of LTBA get welded together and causes permanent short circuit in the low tension circuit. This condition leads repeated melting of fuse CCBA.

Miniature Circuit Breaker (M C B):

This is also a safety device provided in electrical circuits for the protection of the circuit equipments whenever current exceeds beyond the rated value in a electrical circuit the miniature circuit breaker will trip off, so that damages are avoided. The miniature circuit breaker has three positions.

ON

OFF

TRIP (middle).

In case of this circuit breaker trips off, keep in "ON" position.

High Voltage Circuit Breakers:

This type of circuit breakers are provided in A.C. Loco for breaking the high voltage circuit by opening automatically when there is over current or any abnormality in the circuit.

There are two types of high voltage circuit breakers used in the A.C. Loco.

1. Air Blast Circuit Breaker.
2. Vacuum Circuit Breaker.

Rng : 2.7

BONDING

Introduction: Bonding is an electrical contact between any part of the electric circuit to the body of loco;

Effects of bonding:

A single bonding has no effect since the circuit is not completing.

More than one bonding in same level also has no effects.

More than one bonding at different levels have bad consequences.

When there is one boding already in the positive side the man who comes into contact with negative level may be electrocuted.

When there is already one bonding in the positive (or) negative level and another bonding is created at different potential level is equivalent to a short circuit.

Accidental Bonding: When an electrical wire of a circuit comes in contact with the loco body is called "Accidental Bonding".

Intentional Bonding:

Making the electrical wires to come into contact with the loco body intentionally is called "Intensional Bonding". The negative wires of the circuit are connected to the ground through loco body, wheels & rails. This arrangement is known as "Intensional Bonding".

To have a simple construction all wires of the negative level belonging deferent, circuit are connected to a common grounding point, this arrangement does not cause any disturbance to any circuit since all are negative wires.

Whenever there is a positive bonding (or) [accidental bonding on positive side] the circuit is closed through the loco body and through the intensional bonding") there by sudden increase of current in the circuit, which in turn melts the fuse and save the circuit from damage. This arrangement also ensures the safety of the person.

H O B A [Battery Earthing Switch] :

The intensional bonding is arranged through a knife switch 'HOBA' and a by passing resistance RBOBA 210Ω is also produced 'H' stands for switch "O" stands earth, 'BA' stands for Battery.

This switch having 'ON' and 'OFF' position. Normally this switch should be in ON position that means the negative wires of the LT circuits are connected to the earth through this switch. Repeated melting of the fuses indicates that there is an accidental boding on the positive level when such things occur Loco pilot has to operate this switch HOBA from ON to OFF position. By doing this the resistance RHOBA of 210Ω will be added to the circuit there by over current will be reduced and fuse may hold.

Grounding

Earth is taken to be a good conductor of electricity and for all practical purpose. Its resistance is taken as zero and its potential value is also zero. These characteristic of earth are of great advantage to us. Generally in all the industrial circuits the return path of the current is ensured through the earth. The negative level of a generator (or) transformer and the negative level of the last receiver of the circuit are deeply buried in the earth, this is known as "Grounding".

Advantages of Grounding:

In case of short circuit on the positive side there will be increase of intensity in the circuit which will cause melting of fuse (or) tripping of circuit breaker by that the circuit is saved from the damage.

In case of leakage at any point in the circuit there is no danger of being electrocuted, since the leakage is drained to the earth.

Since the return path of the current is arranged through earth from the receiver to the generator. Hence a lot of copper conductor is saved.

This arrangement is adopted in A.C. Traction in which negative wire at the sub station is earthed and the receiver being loco its negative

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wires are connected to the earth through loco body, frame, wheel and rail.

Rng : 2.8
EARTH RETURN CIRCUIT

Earth is a good conductor of electricity, its potential value is considered as zero. so negative level of the generator and negative level of the last receiver terminals are deeply buried in the earth, the current passes through the conductor from the negative terminal of the last receiver the current passes through the earth, so that the circuit is completed.

The one terminal of A.C.transformer secondary in the sub station is connected to the over head equipment (OHE) through the feeding poles and the other terminal of the transformer is deeply buried in the earth the current from the transformer is taken through the catenery and contact wires for the use of locomotive.

When the pantograph of the locomotive is raised and the main circuit breaker D J is closed the current from the OHE passes to the main transformer. After completion of its work in the loco, it passes through the loco body, axle, wheel, rail, rail bond, traction mast and then to the earth. Hence the circuit is completed through the earth with the substation.

Rng : 2.9

B A T T E R Y

Battery is the source of electrical supply of electrical energy where the chemical energy is converted into electrical energy due to chemical reaction. It is a combination of two or more cells connected in series (or) in parallel in both series - parallel according to the necessity the cells are two types namely primary cell and secondary cell.

Primary Cell:

It is a cell capable of producing 22 V max. as a single unit and the electrical energy is stored in the form of chemical energy. In this type of cell once the electrical energy is used, the chemicals will loose their properties and cannot be used further. The primary cell is capable of converting chemical energy into electrical energy and it is not capable of converting electrical energy into chemical energy through charging. That means once this type of cell is discharged, it's life will be over. This type of cells are normally used in laboratories.

Secondary Cell:

The secondary cell also works as same principle of primary cell and produces maximum voltage of 22V. The main difference is chemical reaction which is in two ways in the secondary cell. First the electrical energy is converted into chemical energy while charging and the electrical energy is stored in the form of chemical energy. While discharging the chemical energy is converted into electrical energy. The life is more and it is about 4 to 5 years. In order to maintain the cell in good condition the cell should be in the process

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of charging and discharging. Due to this process distilled water in the electrolyte evaporates from the cells hence the cells require filling up with distilled water.

In our A C Loco lead acid cell batteries are used. The following are the main parts of the secondary cell.

Container: It is vessel made up of hard rubber in which the electrolyte is filled and electrodes are placed.

Electrode: This electrodes are made up with two different type of materials they are.
Anode or positive rod is made up with lead oxide (PbO2).
Cathode or negative rod is made up with pure lead (PB).
These two rods are placed in the container without touching each other and their contact is made through electrolyte.

Electrolyte: It is a combination of distilled water and sulphuric acid (H2SO4) in the ratio of 8 : 1 (aprox). It is called dilute H2SO4. It is filled in the container up to the active plate level and the electrodes are placed in the electrolyte when the cell is fully charged the density of liquid will be 1.25.

Terminals: These are the top ends of the anode and the cathode to which the circuit wires are connected. Anode end is positive and the cathode end is negative.

Connective Wire: This is the conductor connected to the positive and negative terminals of the cell through the receiver to complete the circuit. When the two electrodes i.e., anode and cathode are immersed in dilute H_2SO_4 (electrolyte) the oxide and lead present in the anode, hydrogen and sulphur present in the electrolyte will undergo chemical reaction. Due to this electrons present in the anode are displaced. When a wire is connected between the two terminals of anode and cathode to a receiver, the current starts flowing in the circuit. The potential difference is maintained between anode and cathode due to chemical action. The current flows from anode to cathode outside the cell and flows from cathode to anode inside the cells.

The maximum voltage that a cell can produce is 2.2 v. The cell should not be used if it's voltage is dropped below 1.8 v, because if the voltage drops below 1.8 v the cell cannot be recharged.

Charging is the process adopted to recap the chemical properties of the cell which are lost due to discharging. The positive terminal is connected to the positive level of the generator and the negative terminal of the battery is connected to the negative terminal of the generator.

Usage of Battery on A.C. Loco/EMU/MEMU: There are 10 batteries in the loco. In each battery 5 cells are connected in series. Battery boxes are provided on both sides of the loco frame. 5 batteries each side between two trucks in two container boxes. Total voltage of the batteries is 110 V and having amperage of 60 to 70. The battery voltage is used on the loco for the following purposes.

For working of baby compressor (MCPA) to build up pneumatic pressure.

For raising of pantograph.

For closing of DJ (de jointer).

For maintaining all control circuits when battery charger fails.

The Loco pilot should check the battery voltage before energising the loco while taking over charge. For this purpose voltmeter (UBA) is provided which will indicate battery tension when the switch ZUBA and HBA are kept in one position. The UBA should indicate more than 85 V and the Loco pilot should also check the charging rate of the batteries by the battery charger when the loco is energised. For this purpose an ammeter is provided on the battery charger which should normally indicate 2 to 3 amps and in no case it should indicate more than 7 amps.

We have to observe smoke or smell from the battery leakage of electrolyte any crack of the container and also condition of the battery boxes. All these things should be checked by the Loco pilot and the Asst.Loco pilot at the regular intervals.

Checking methods of the battery:

There should not be any leakage of electrolyte from the battery.

The connecting wires of the batteries should not be slack and to be secured properly.

Battery boxes, covers should be secured properly.

Battery charging rate and battery voltage should be noted at every neutral section or at certain intervals.

Ensure the terminals of the battery i.e they should be free from any foreign body in order to avoid short circuit.

Rng : 2.10

MAGNETISM

The specific quality of the material which attracts the ferrous materials like iron, nickel, cobalt etc., is called "magnetism". The material which posses this quality is called "magnet".

The ordinary iron rod is not capable of attracting any iron fillings. By some process or other if the small molecules are arranged in a systematic manner, the same iron rod becomes a magnet.

The magnet will have the following properties.

The magnet attracts the iron filling of magnetic materials towards it.

Any magnet will have two poles.

A) North Pole B) South Pole.

Two like poles will repel and unlike poles will attract.

Every magnet will have its own magnetic field or Flux.

Lines of forces will start from north and join in south pole.

Within the magnetic field it will attract the magnetic materials.

If the magnet is suspended freely its north pole will always point towards north side of the earth and its south pole will be pointed towards south side of the earth.

If the magnet is hammered or heated, it loses its own properties.

When the magnet is broken into pieces each individual piece acts as a magnet.

Magnets are two types.

Natural magnets.

Artificial magnets.

Natural Magnets: Some specific type of stones which are found on earth have the property of attracting magnetic materials by their nature, hence they are called "Natural Magnets".

Ex: Bar Magnet, Horse Shoe Magnet.

Artificial Magnets: The magnets are prepared by some process or fabricated through some process are known as " Artificial Magnets".

These are two types. 1. Permanent Magnet

2. Temporary Magnet.

Difference between permanent and temporary magnets.

Permanent Temporary: It is fabricated by influence of other magnet.

The power of magnet fixed.

The polarity is fixed.

Magnetic properties effected by heat.
This power is permanent.

The permanent magnet looses its quality due to old age.

It is prepared by passing current through an insulated wire.

The power can be increase (or) decreased.

Polarity can be changed.

Properties not effected by heat.
We can convert in to a magnet (or) ordinary iron piece.

Magnetic Induction: If an ordinary iron piece is kept within the field of magnet, we observe that the iron piece attract the iron filling but as soon as the iron piece is moved away beyond the field this iron piece will not have the quality of magnetism. The ordinary iron piece becomes a magnet by keeping in the field of another magnet is due to magnetic induction. The iron piece posses the quality of magnet is called "Induced magnets"

Electro Magnet: It is an artificial temporary magnet which is made with the help of electricity, if an insulated wire wounded round a soft iron core and the terminal are connected to the battery (or) through a generator. We can observe that on closing of the switch the soft iron piece becomes a magnet due to the current passing through the coil around. When the switch opened, the core will become an ordinary iron piece.

Residual Magnetism: when an iron core is magnetized by allowing the current to flow in the coil, normally the iron core should become an ordinary iron piece, when the flow of current is stopped. But in practice the iron core retains some magnetism even after the flow of current is stopped. This quality is called "Residual Magnetism" and the iron piece which retains this magnetism is called "Residual Magnet".

It will be low in power and that power varies from material to material according to their quality. In our A C Loco we are using special type of soft iron which will be obtaining residual magnetism.

Protection During Coasting: When the loco is on coasting with MP (Master Controller) on zero there is no supply of the current to the traction motors, either to the armature or to the field. Since the armature is connected to the axle through a pinion and gear, the armature continue to rotate, the inductor which worked as electro magnets are having some Residual magnetism. Since the above conditions are fulfilled the motor starts producing current, and the current passes through the cables and to the high tension

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compartment. So it is dangerous to enter into high tension compartment even when the loco is in coasting.

Rng : 2.11

D. C. MOTORS

The D.C. Motor is a machine which converts electrical energy into mechanical energy fed by D.C. This motor will works on the principle of attraction and repulsion. When the inductors and armature are energised the magnetic line of forces are created between armature and inductors. Due mutual action of poles the armature starts rotating since the polarities of the armature is changing at regular intervals through the commutator, whenever the armature comes in front of the conductors there by the armature rotates continuously. The rotation of armature is transmitted through the shaft to the machine which is attached to it.

Advantages of D. C. Series Motors:

It's starting torque is more,
Reversal of direction of armature rotation is easy.
Variable voltage can be applied and also variable speeds are possible.
Due to thse reasons this type of motor is used in our AC locomotives

Reversing The Direction Of The Motor:

The reverse direction of motor is achieved by changing the direction of flow of current either in inductors or in the armature.

In our A.C. Loco the direction of flow of current is changed in the inductors through the "Reversor". For this purpose in our loco the Reversors will be operated with remote control operations through M.P.J. It is having three positions. They are O, F and R.

For reversing the direction of motor first loco should be stopped. Then only M.P.J should be operated for required direction.

If sudden changing of rotation of armature to opposite direction, it results slipped pinion or danger to the machine parts.

Rng : 2.12

D. C. GENERATORS

Generator is a device which converts mechanical energy into electrical energy. Generator works on the principle of field and displacement. When a conductor is moved in a magnetic field, an induced E.M.F. (Electro Motive Force) is produced in the coils. When the terminals of the coils are connected to the external circuit there by the current starts flowing in the circuit.

Working Principle of D.C. Generator:

When the switch is closed the flow of D.C. Current will pass into the inductors and both inductors are becoming as electro magnets, there by it will produce magnetic field. By rotating the armature with in the magnetic field, the magnetic lines of forces is cut by moving armature. By this action the field and displacement is occurred, hence an E.M.F. is produced in armature coil. The armature coils are connected by the commutator segments, and this commutator collects the current from the armature and sends to external circuit through "carbon" brushes. In the form of D.C. The output of generator depends upon the flow of current through the inductors and also speeds of the armature.

Differences between D.C motor and Generator

D. C. Motor	D. C. Generator
1. Electrical energy is converted into mechanical energy. 2. Both inductors and armature are energised and armature is rotated by mutual attraction of poles. 3. Commutator energises the armature coils and changes it's polarities at regular intervals. 4. Motor works on the principle of attraction and repulsion.	1. Armature rotated by means of attraction and repulsion. 2. Mechanical energy is converted into electrical energy. 3. Only inductors are energised and armature is rotated by the external force. 4. Commutator collects the current from the armature and fed to the outside circuit. 5. Generator works on the principle of field and displacement. 6. Armature rotated by means of external force.

Rng : 2.13

ALTERNATING CURRENT

The current which flows in one direction and constant in it's valve is called "Direct Current".

The current which flows in either directions and changes it's direction at regular intervals is known as "Alternating Current". The positive and negative of this current will change alternatively.

A dynamo or generator without a commutator is called "Alternator", which produces alternating current. The tension produced by alternator is known as "Alternating Tension or Voltage" and it varies from Zero to maximum and vice versa on either sides. The flow of current in this form is sinusoidal wave.

Poles: Every generator or an alternator will have minimum two stationary electromagnets which are called poles. In the case of generator they are called as inductors and in the case of an alternator they are called as stators. If more number of stationary electromagnets are provided, .that alternator will be called as "Multipolar Alternator".

Pole Pitch: The distance from the center of one pole to the center of adjacent pole is called "pole pitch".

Alternation: The time taken by the rotor to travel one pitch distance is called "Alternation".

Cycle : One complete set of positive and negative valves of alternating quantity is known as "Cycle".

Period : The time taken by the rotor to travel two pole pitches is called "Period". There is only one cycle per revolution if there are two poles in the alternator. There will be two cycles for revolution. It there are four poles in the alternator. Cycle consists of two alternations.

Frequency: Number of cycles per second is called "Frequency". This depends upon the No. of poles of the alternator and R.P.M. of the rotor.

In India the standard frequency is 50 cycles. In our A.C. Traction 25 K V, single phase, 50 cycles/sec A.C. is used. Formula for frequency is

$$F = P / 2 \times N / 60$$

Where P = No. of poles.

N = r. p. m made by the rotor.

Amplitude: The maximum value of A.C. in either positive or negative is known as " Amplitude ".

Phase: One of the circuits of a poly phase system or one of the lines of terminals.

Phase Angle: The angle made by two vectors representing two simple periodic quantities which varying sinusoidal and having the same frequency but difference in phase.

Advantages of A. C. Over D.C.

A.C	D.C
1. Production and transmission costs of A.C. are low. 2. A.C. varies both in magnitude and direction. 3. A.C. produces a varied magnetic field. 4. A.C. energy can be converted from one voltage to another one. 5. A.C. machines are robust (powerful w/o trouble). 6. A.C. machines occupy less space for the given capacity. 7. A.C. can be transmitted to distant places by high voltage transmission lines there by the loss is minimum. 8. A.C. substations can be far away from 50 to 80 kms.	1. Production and transmission costs are high. 2. D.C. is constant in both magnitude and direction. 3. D.C. produces constant magnetic field. 4. D.C. energy cannot converted from one voltage to another one. 5. D.C. machines are not robot. 6. D.C. machines occupy more space for the same given capacity. 7. D.C. cannot be transmitted to distant places due to low generating voltage and losses are maximum. 8. D.C. substations are to be constructed at 10 to 15 kms distance only.

Due to these advantages substantial saving in the cost of OHE substations reductions in the size of copper cross section of OHE conductors and lesser in the voltage drop.

Note: The only disadvantage in A.C. is induction effects on the near wise structures.

A.C. Circuits: In A.C. Circuits, voltage applied to the circuit and current flowing through it changes from instant to instant. The variation of current reference to the line set up magnetic effects while variations of e.m.f set up electrostatic effects both these effects must be taken into account while dealing with A.C. Circuits. Magnetic effects will be appreciably with low voltage and heavy current circuits. Electrostatic effects are usually appreciable with proportional to voltage. Phase angles are used to distribute the time relation ships between A.C.voltages and currents. They are also specify the position or point in time of one voltage or current.

D.C. Circuits: In D.C. Circuit voltage applied and current flow are constant with respect to time as such solution of the circuits could be attempted simply by applying the Ohm's law stated in the form of equations.

$$I = \frac{\text{Applied voltage}}{\text{Resistance offered by the circuit}} = \frac{V}{R}$$

However when circuits is completed it is not possible to analyze it simply by application Ohm's law and net works theorems are to be applied to solve such type of circuits.

Rng : 2.14

SINGLE PHASE A.C. MOTOR (1Ø)

The stator coils are connected in series and ended with two terminals when these type of stator coils are used for motor, the motor is known as "Single phase (1Ø) A.C.Motor" When rotors are short circuited, it can be fed by induction it is known as "Single Phase A.C. Induction Motor."

Principal parts of an A.C. Induction motor:

1. Stator coils
2. Rotor coils
3. Auxiliary Stator coils
4. Contactor (C 118).
5. Resistance (R 118)
6. Main shaft
7. Switch.

Stator Coils: The stator coils are attached to the motor body and are energised by single phase A.C. and having minimum two stator coils.

Rotor Coils: The rotor coils are placed between the stator coils and mounted on the main shaft which is connected to some device for some useful work. The rotor coils are short circuited so as to form a separate circuit. The rotor coils are energised by induction. In the single phase motor the rotor is not having self starting. It requires rotor to rotate initially either by mechanical or magnetic impulsion.

Auxiliary stator coil: There are additional windings placed by the side of main windings at a certain phase angles and connected to single phase supply by closing of contactor (C 118) through the resistance (R 118) and switch. When the starting winding is energised it gives diphase current , so that the field strength can be increased in one direction. This arrangement help to rotate the rotor initially. The starting winding should be cut off after the rotor reaches required speed.

Resistance: It is a device connected in series with a starting phase winding and helps to disphase the current at the time of starting single phase AC motor.

The rotor is connected at one end of the shaft and the other end is connected with some device which produces useful work.

Main shaft: The rotor is connected at one end of the shaft and the other end is connected with some device which produces useful work.

Works on the principle of magnetic impulsion: In this type of motor the stator coil fed by single phase A.C. supply and rotor coils are fed by induction when the stator fed by A.C. current a rotating magnetic field changes it's direction at regular intervals. Due to this rotating magnetic field the e.m.f is induced by the rotor coils. The terminals of the rotor coils are short circuited there by the induced current closes the circuit.

Since the flow of current in the stator coils changes it's direction in every alternation and produces the rotating magnetic fields which is equal in strength with opposite direction. This can be done by the magnetic impulsion or mechanical impulsion. The strengthening is done by mounting another set of stator coil which initially arranged, so that the diphase current strength in the rotor field to become more powerful. When the rotor gets sufficient speed it suppresses the starting phase automatically (by the action of relay QCVAR).

ARNO: In our A.C.Loco ARNO is single phase induction Motor while starting and after picks up rated speed it works as three phase alternator. Single phase motor requires starting phase. To give starting phase current is sent through the Resistance (R 118) there by the rotor starts rotating when the rotor gets sufficient speed the relay QCVAR is energised which in turn the indication lamp LSCHBA will be extinguished on the Loco pilot's desk. So that Loco pilot release the BLRDJ switch. After picking up rated speed ARNO will work as three phase alternator.

The purpose of ARNO in our A.C.Locomotive is to convert single phase A.C. into three phase A.C. supply and it feeds all the three phase auxiliary motors.

1. MPH : Transformer oil pump motor.
2. MVRH : Transformer oil cooling blower motor.
3. MVSI1 : Silicon rectifier blower motor No.1.
4. MVSI2 : Silicon rectifier blower motor No.2.
5. MVSL1 : Smoothing reactor blower No.1.
6. MVSL2 : Smoothening reactor blower motor No.2.
7. MCP1 : Main compressor motor No.1.
8. MCP2 : Main compressor motor No.2.
9. MCP3 : Main compressor motor No.3.
10. MPV1 : Vacuum exhauster motor No.1.
11. MPV2 : Vacuum exhauster motor No.2.
12. MVMT1 : Traction motors 1,2&3 blower motor No.1.
13. MVMT2 : Traction motors 4,5&6 blower motor No.2.

In WAG-5 & WAG-7 we are having additional MVSL MCPs 3 Nos.

Its construction is same as that of 3Ø induction motor but with a difference of (a) Its stator is provided with a single phase winding

(b) A switch used in order to cutout starting winding used only for starting purpose.

When fed from a 1Ø supply, its stator winding produces a flux which is only alternating i.e., which one alternates along space axis only. This alternating or pulsating flux acting on a stationary rotor cannot produce rotation. But a revolving flux can rotate the rotor. So 1Ø motor is not self starting.

Rng : 2.15

THREE PHASE A.C. MOTOR(3Ø)

Three sets of stator coils are provided with the six terminals are connected.. Three terminals of one end are connected to 3-phase alternator, the other three terminals are short circuited with the motor with the help of star connection. The rotor coils are energised by the induced current from the rotaring magnetic field of stator coils. Since rotor coils are short circuited the induced current flows in the rotor coils and produces polarity according to the direction of induced current flow because of 120^0 phase difference. Two phases join together at a particular level and produce stronger magnetic field in on side than the other side. There by rotor is forced to rotate towards the direction of the stronger magnetic field so the motor starts automatically. Hence 3Ø induction motor is a self starting motor.

Starting the 3-Phase (3Ø) Induction Motor:

To start the 3-phase induction motor all the 3-phases of supply should be connected simultaneously. For this purpose Tripolar contactors are provided which will close simultaneously by closing a single switch. The motor should not be kept in working order, if any one of the 3-phase of supply is not available.

Advantages Of 3-Phase Induction Motor:

1. This motor is a self starting one.
2. Its costs is low and maintenance is easy when compared to single phase motor.
3. Its efficiency is high.

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4. These motors will occupy less space.

Inter Connection

These are two types:

a. Star connection
b. Delta connection.

a. Star connection:

It consists of star point 'N' (Neutral point). In this type of inter connection the similar ends say star ends of the 3 coils are joined together at a point 'N'. The point is known as "Star point" or "Neutral point". The three conductors meeting at a point "N" are replaced by a single conductor known as "Neutral conductor" such as interconnecting system is known as "4 wire 3Ø system, if this 3 O voltage is supplied across a balanced symmetrical load then a neutral wire will be carrying three current which are exactly equal in magnitude but with phase angle of 120^0 between each other.

The potential difference between any terminal or line and neutral point is called "phase voltage" and the potential difference between any two lines is known as "wire voltage".

Here I_L = I phase

V_L = Root 3 V phase.

Delta Connection (Or) Mesh Connection:

In this inter connection the dissimilar ends of 3Ø windings are joined together i.e., the starting end of one phase is joined to the finishing ends of the other phase and so on. In other words the 3 windings are joined in series to form as closed mesh the e.m.f. in one phase is equal and opposite to the resultant of the other two phase.

V_L = V Phase.

I_L = Root 3 I phase.

Rng : 2.16
TRANSFORMER

Transformer: The transformer is a static device which transforms A.C. supply from one voltage to another voltage, from one circuit to another circuit without changing the frequency.

Mutual Induction: It may be defined as the ability of one coil to produce on e.m.f.in a near by coil by induction when the current in the first coil changes. The action being mutual to each other, the second coil can also induce an e.m.f. in the first coil and current in the second coil changes.

This ability of reciprocal induction in terms of the co efficient of the mutual induction.

$$M = \frac{N_2 O_1}{I_1}$$

Uses Of Transformers:

1. To obtain higher or lower voltages.
2. To get variable voltages.
3. To get less or more current.
4. To transfer the voltage to another circuit.
5. For measuring instruments like ammeter, voltmeter.

Working System:

The moment of electricity occupied by the magnetic field either in the current A.C. or D.C. The wire carrying a. D.C. will have steady magnetic field. The strength of the magnetic field around the

current carrying wire depends upon the amount of current flowing. Greater the current, higher the magnetic field.

In A.C. when its cycle drops to zero, the magnetic field will also drop to zero. But the characteristic of A.C. is such that it starts at zero and varies to maximum value and drops to zero again. The magnetic field around it expands and contract when a coil is energised by A.C. It produces induced tension in turns of coil placed nearer to it and also in turns of its own.

A transformer works on the principle of mutual induction. It consists of iron core carrying two separate windings with different no. of turns. If any one of the two coils is connected to A.C. supply, it produces magnetic field around the core over the windings of the secondary coil. The value of the tension induced in the secondary coil depends upon the no. of turns of the secondary coil. The coil connected to A.C. supply is called "primary coil" and the coil in which tension is induced is called "Secondary coil". For a transformer a core, primary winding, secondary winding and a cooling agent are required.

If the transformation ratio is greater than 1, then it is a step-up transformer, if it is less than 1, then it is a step-down transformer.

There are 3 types of transformers

They are :

1. Step-down transformer.
2. Step-up transformer.
3. Auto transformer.

1. Step-Down Transformer: A transformer in which primary winding has more No. of turns than secondary is called "Step-down" transformer. In this transformer the output voltage 'V_2' is less than the input voltage 'V_1'.

2. Step-Up Transformer: A transformer in which primary turns are less than the secondary turns is called "Step-up transformer". In this transformer the output voltage 'V_2' is greater than the input voltage 'V_1'.

3. Auto Transformer: A transformer without secondary winding and with several taps on the turns of a single coil is called an "Auto Transformer". Auto Transformer is provided in A.C. Loco to increase or decrease the voltage to terminals of the traction motor.

Advantages Of Auto Transformer:

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1. One coil acts as primary as well as secondary. Hence copper conductor will be saved.
2. Variable voltage can be obtained as required by connecting the taps.

In this transformer the induction takes place on its own turns. Each turn of the coil acquires partial tension and full tension will be available at the outer terminals.

Each turn forms a source and we can obtain different voltages by tapping from different turns. The main transformer in A.C. Loco is auto transformer.

Current Transformer (Instrument):

It is a step-up transformer. In this primary coil, one or more turns are thick which may be connected in series with the line whose current to be measured. The secondary consists of more No. of turns of fine wire or thin wire and connected with an ammeter terminals.

Potential Transformer (Instrument):

This is a step-down transformer to reduce the primary voltage to a safe value for operation of voltmeters and instruments. Primary winding is connected to a high tension to be measured and secondary to a voltmeter. Normally a winding will be 10 : 1 , 100 : 1, 1000: 1 ratings.

On Load Working of Transformer: When the primary is under tension and secondary coil is closed with a load, then it is called on load working of transformer.

No Load Working Of Transformer:

It means the primary is under tension and secondary circuit is open. No load working transformer is generally to be avoided as it causes disturbances in supply line. In our A.C. Locos to avoid No-Load working, the main circuit breaker DJ is closed Auxiliary transformer connected to ARNO.

When DJ is closed the main transformer (T/F.W.R.) energises and the auxiliary transformer (T/F.W.A.) becomes the load on the main transformer and "ARNO" becomes load on T.F.W.A. and five direct motors which start along with the ARNO become load on T.F.W.A. Thus no load working of transformer is avoided.

Usage Of Transformer On Locomotive:

The different equipments on loco requires different voltages. By the use of transformer it is possible to obtain desired voltages for different purposes. By Auto transformer we can vary the voltage at the terminals of the traction motors according to the requirements.

On the locomotive the main transformer is an auto transformer with two secondaries. The transformer secondary feeds to the TMs, the auxiliary secondary feeds to the auxiliary motor through ARNO.

RNG3.1: ABBREVIATIONS OF LOCATIONS

BA -1, 2,3 & 4	POWER EQUIPMENT CUBICLE
CAB-1	LOCO PILOT'S CAB NO.1
CAB-2	LOCO PILOT'S CAB NO.2
PC-1	LOCO PILOT'S DESK NO.1
PC-2	LOCO PILOT'S DESK NO.2
RSI	SILICON RECTIFIER CUBICLE
TPN	PNEUMATIC CUBICLE
TB	PROGRAMME SWITCH BOARD IN CAB-2
TK-1	CONTACTOR CUBICLE IN CAB-2
TK-2	RESISTOR FRAME ON THE REAR OF CAB-2
TR	RELAY PANEL IN CAB-2
M	MACHINE ROOM
T	TRANSFORMER(HT COMPARTMENT

GENERAL LIST OF ABBREVIATIONS FOR LOCOMOTIVE

ABBREVIATION	DESCRIPTION	LOCATION
A3	AMMETER FOR CAB1	PC-1
A4	AMMETER FOR CAB2	PC-2
ARNO	ARNO CONVERTER	M
ASMGR	AUXILIARY INTERLOCKS OF TAP CHANGER	T
ATFEX	TRANSFORMER FOR BRAKING EXCITATION	HT1
BA	BATTERY	BOTH SIDES OF THE UNDER FRAMES
BL1-2	AUXILIARY CONTACTS ON THE SWITCH BOXES CAB1 & 2	PC1 & 2
BLCP1-2	COMPRESSOR SWITCH (AUTOMATIC)	PC1 & 2
BLCPD1-2	COMPRESSOR SWITCH (DIRECT)	PC1 & 2
BLDJ1-2	HIGH VOLTAGE CKT. BREAKER SWITCH	PC1 & 2
BLPRR1-2	REAR HEAD LIGHT SWITCH	PC1 & 2
BLLF1-2	MARKER & DESK'S LAMP'S SWITCH	PC1 & 2

BLLM1-2	COMPARTMENT LAMP SWITCH	PC1 & 2
BLPRD1-2	HEAD LIGHT DIM SWITCH	PC1 & 2
BLPRF1-2	FRONT HEAD LIGHT SWITCH	PC1 & 2
BLPV 1-2	VACUUM PUMP SWITCH	PC1 & 2
BLRA1-2	CAB HEATER SWITCH	PC1 & 2
BLRDJ1-2	HIGH VOLTAGE CKT. BREAKER RESETTING SWITCH	PC1 & 2
BLSN1-2	NEUTRAL SECTION SWITCH	PC1 & 2
BLVMT1-2	TRACTION MOTOR'S BLOWERS SWITCH	PC1 & 2
BLZLF1-2	MARKER (RED) LAMPS SWITCH	PC1 & 2
BP1DJ	PUSH BUTTON FOR TESTING DJ OPENING	TR
BP2DJ	PUSH BUTTON FOR TESTING DJ CLOSING	TR
BPP1 & 2	PUSH BUTTON FOR OPERATING GR PROGRESSION	PC1 & 2
BPR1 & 2	PUSH BUTTON FOR OPERATING GR REGRESSION	PC1 & 2
BV	AUXILIARY CONTACTS OF HOM SWITCH	M
BPT	PUSH BUTTON FOR SELF CHECK OF SIGNALLING LAMPS	TR
C101	3-POLE CONTACTOR FOR COMPRESSOR NO.1	TK1
C102	3-POLE CONTACTOR FOR COMPRESSOR NO.2	TK1
C103	3-POLE CONTACTOR FOR COMPRESSOR NO.3	TK1
C105	3-POLE CONTACTOR FOR TRACTION MOTOR BLOWER NO1	TK1
C106	3-POLE CONTACTOR FOR TRACTION MOTOR BLOWER NO. 2	TK1
C107	3-POLE CONTACTOR FOR TRANSFORMER OIL COOLER BLOWER	TK1
C111	3-POLE CONTACTOR FOR EXHAUSTER NO.2	TK1
C121	3-POLE CONTACTOR FOR EXHAUSTER NO.1	TK1
C118	ARNO STARTING PHASE CONTACTOR	M
C145	BREAKING EXCITATION CONTACTOR	BA-3
FL	FLASHER LIGHT UNIT	ROOF
GR	TAP CHANGER	T (HT-2)

HBA	BATTERY ISOLATING SWITCH	TB
HCP	SELECTOR SWITCH FOR COMPRESSOR	TB
HOBA	CHANGE OVER SWITCH FOR BATTERY NEGATIVE EARTHING	TB
HOM	LOCO EARTHING SWITCH	ROOF
HPH	DISCONNECTING SWITCH FOR OIL PUMP	TB
HPT-1	ISOLATING & EARTHING ROOF BAR FOR PANTOGRAPH1	ROOF
HPT-2	ISOLATING & EARTHING ROOF BAR FOR PANTOGRAPH2	ROOF
HQOA	ISOLATION SWITCH FOR QOA	TB
HMCS1, 2	MOTOR CUT OUT SWITCH	TB
HQCVAR	ISOLATING SWITCH FOR QCVAR	TB
HQOP1, 2	CHANGE OVER SWITCH FOR TRACTION POWER CIRCUIT EARTH FAULT RELAYS	BA-2
HVMT1 & 2	DISCONNECTING SWITCH FOR TRACTION MOTOR BLOWER	TB
HVRH	DISCONNECTING SWITCH FOR OIL COOLER BLOWER MOTOR	TB
HVSI1-1 & 2	DISCONNECTING SWITCH FOR RECTIFIER BLOWER-1 & 2	RSI-1 & 2
HVSL- 1 & 2	DISCONNECTING SWITCH FOR SMOOTHING REACTOR BLOWER MOTOR-1 & 2	TB
J1	REVERSER FOR TRACTION MOTORS 1, 2 & 3	BA-1
J2	REVERSER FOR TRACTION MOTORS 4, 5 & 6	BA-2
L1 TO 6	LINE CONTRACTOR FOR TRACTION MOTORS 1 TO 6	BA3
LA1-1/1-2	LAMPS FOR THE AMMETERS OF CAB-1	PC1
LA2-1/2-2	LAMPS FOR THE AMMETERS OF CAB-2	PC2
LBL1-1/1-2	LAMPS FOR SWITCHES BOX BL-1	PC1
LBL2-1/2-2	LAMPS FOR SWITCHES BOX BL-2	PC2
LC1-1/1-2	CEILING LAMP FOR CAB-1	CAB1

CCA	FUSE FOR AUX. CONTROL CIRCUIT	TB
CAPTFWA	CONDENSER FOR TFWA TERMINALS A0-A1 (AUX. WINDING)	T
CAPTFP	CONDENSER FOR TFP TERMINALS A3-A4 & A5-A6	T
CCBA	FUSE FOR BATTERIES	TB
CCDJ	FUSE FOR Q45, C118, EFDJ & MTDJ BRANCHES	TB
CCLC	FUSE FOR CAB, CORRIDOR, HT COMPARTMENT LIGHTING & WALL SOCKETS	TB
CCLF1-2	FUSE FOR MARKER & PC LAMPS	TB
CCRA1-2	FUSE FOR CAB HEATERS	TB
CCLS	FUSE FOR SIGNALLING CIRCUIT	TB
CCVT	FUSE FOR CAB FAN MOTORS	TB
CGR1, 2,3	TAP CHANGER CONTACTORS	T
CHBA	STATIC BATTERY CHARGER	M
CP	MAIN COMPRESSOR	M
CPA	AUXILIARY COMPRESSOR	CAB-1
CTF1, 2,3	TRACTION BRAKING CHANGE OVER CONTACTORS	BA1, 2,3
DJ	HIGH VOLTAGE CIRCUIT BREAKER	ROOF
ECC	FUSE TESTER	TB
EFDJ	ELECTRO VALVE FOR CLOSING OF THE HIGH VOLTAGE CIRCUIT BREAKER	DJ ASSEMBLY IN HT2
ELM	CURRENT TRANSFORMER FOR BREAKING EXCITATION TRANSFORMER	BA2
ET-1	ROOF SURGE ARRESTER	ROOF
ET-2	ROOF BUSHINGS SURGE ARRESTER	ROOF
EVPHGR	ELECTRO VALVE FOR GR OIL PUMP	T
FLCU	FLASHER LIGHT FOR CONTROL UNIT	IN BOTH CABS
LC2-1/2-2	CEILING LAMP FOR	CAB-2
LECC	FUSE TESTER LAMP	TB
LF1/D-1/G	MARKER LIGHTS CAB-1 (RIGHT & LEFT)	CAB-1
LF2/D-2/G	MARKER LIGHTS CAB-2 (RIGHT & LEFT)	CAB-2
LM1-6 & 8	CORRIDOR LIGHTS	SIDE WALLS
LSCHBA1-2	SIGNALLING LAMP FOR STATIC BATTERY CHARGER	PC1 & 2
LSDJ1-2	HIGH VOLTAGE CIRCUIT BREAKER	PC1 & 2

	SIGNALLING LAMP (RED)	
LSGR1-2	TAP CHANGER SIGNALLING LAMP (GREEN)	PC1 & 2
LSGROUP1&2	DEFECTIVE LOCO INDICATION LAMP IN MU (RED)	CAB1&2
LSOL1-2	HEALTHY LOCO INDICATION LAMP IN MU (YELLOW)	PC1 & 2
LSP1-2	SLIPPING SIGNALLING LAMP (RED)	PC1 & 2
LSB1-2	TRACTION BRAKING CONTROL CIRCUIT READINESS SIGNALLING LAMP	PC1 & 2
LSRSI1-2	RECTIFIER SIGNALLING LAMP (YELLOW)	PC1 & 2
LTBA	BATTERY SURGE ARRESTER	TK2
M1-6	TRACTION MOTOR 1-6	BOGIE
MCP1, 2,3	MAIN COMPRESSOR MOTOR	M
MCPA	AUXILIARY COMPRESSOR MOTOR	PC1
MF1-6	MAIN FIELD FOR TRACTION MOTOR	U N D E R TRUCK
MP1-2	MASTER CONTROLLER CAB1-2	PC1, 2
MPF1-2	BRAKING CONTROLLER	PC1, 2
MPH	OIL PUMP MOTOR	T
MPJ1-2	REVERSER HANDLE	PC1 & 2
MPS1-2	FIELD WEAKENING CONTROLLER	PC1 & 2
MPV1-2	EXHAUSTERS 1 & 2	M
MTDJ	DJ HOLDING ELECTRO VALVE	ROOF
MVMT1-2	MOTOR FOR TRACTION MOTOR BLOWER	M
MVRF1-2	MOTOR FOR BRAKING RESISTER BLOWER	M
MVRH	BLOWER MOTOR FOR OIL COOLER BLOWER	T
MVSI1-2	SILICON RECTIFIER BLOWER MOTOR	RSI
MVSL1-2	BLOWER MOTOR FOR SMOOTHING REACTOR	M
MVT1-1/1-2	CAB FAN MOTOR CAB-1	CAB-1
MVT2-1/2-2	CAB FAN MOTOR CAB-2	CAB-2
MUC	ELECTRICAL MU COUPLERS BETWEEN LOCOS	BOTH SIDE OF LOCO
PCLX1-3	WALL SOCKET	TB, BA1&BA2
PH	OIL PUMP	T
PR1-2	HEAD LIGHT CAB-1, CAB-2	ROOF
PSA1, 2	SANDING ELECTRO VALVE PEDAL SWITCH	PC1, 2
PT1, 2	PANTOGRAPH 1&2	ROOF
PV1, 2	EXHAUSTER1 & 2	M

PVEF1, 2	PEDAL SWITCH FOR LOCO BRAKE ELIMINATION	PC1, 2
Q20	OVER VOLTAGE RELAY	BA3
Q30	NO VOLTAGE RELAY OR LOW VOLTAGE RELAY	TR
Q44	HIGH VOLTAGE CIRCUIT BREAKER TRIPPING RELAY	TR
Q45	DJ RESETTING RELAY	TR
Q46	TAP CHANGER PROTECTION RELAY	TR
Q48	SLIPPING DEVICE TIME-LAG AND SIGNALLING RELAY	TR
Q49	SYNCHRONIZING RELAY	TR
Q50	RELAY FOR REVERSER, CTF & C145	TR
Q51	AUTO REGRESSION RELAY	TR
Q52	NOTCH TO NOTCH RELAY FOR GR	TR
Q100	INTERLOCKING RELAY OF REMOTE AUXILIARIES	TR
Q118	TIME-LAG RELAY FOR MONITORING AIR FLOW RELAY	TR
QCVAR	PROTECTION RELAY FOR ARNO	TR
QE	OVER LOAD RELAY FOR BRAKING EXCITATION	TR
QD1-2	SLIPPING DEVICE DIFFERENTIAL RELAY	BA1, 2
QLM	HIGH VOLTAGE OVER LOAD RELAY	TR
QOA	AUXILIARY CIRCUIT EARTH FAULT RELAY	TR
QOP1-2	MAIN CIRCUIT EARTHING RELAY	TR
QPDJ	PRESSURE SWITCH FOR DJ	T
QPH	OIL FLOW INDICATION RELAY	T
QF1, 2	OVER LOAD RELAY FOR BRAKING CURRENT	BA-2
QRSI1-2	OVER LOAD FOR SILICON RECTIFIER	TR
QTD105	TIME DELAY RELAY FOR C105	TK2
QTD106	TIME DELAY RELAY FOR C106	TK2
QV60	HIGH VOLTAGE CIRCUIT BREAKER SIGNALLING RELAY	TR
QV61	BATTERY CHARGER SIGNALLING RELAY	TR
QV62	TAP CHANGER SIGNALLING RELAY	TR
QV63	RECTIFIER GROUP SIGNALLING RELAY	TR
QV64	CONTROL CIRCUIT SIGNALLING RELAY	TR
QVLSOL	RELAY FOR DEFECTIVE LOCO FAULT INDICATION LAMP	TR

QVMT1-2	AIR FLOW INDICATION RELAY FOR TRACTION MOTOR BLOWERS 1 & 2	M
QVSL1-2	AIR FLOW INDICATION RELAY FOR SMOOTHING REACTOR BLOWERS	M
QVRH	AIR FLOW INDICATION RELAY FOR TRANSFORMER OIL COOLER BLOWER	T
QVSI1-2	AIR FLOW INDICATION RELAY FOR RECTIFIER BLOWER	RSI
QWC	WEIGHT COMPENSATION RELAY	TR
R118	STARTING RESISTANCE FOR ARNO CONVERTER	M
RA1/1-1/2	CAB HEATER FOR CAB1	CAB-1
RA2/1-2/2	CAB HEATER FOR CAB2	CAB-2
RCAPTFP1-2	RESISTANCE FOR CAPTFP	T
RF	BRAKING RESISTANCE	M
RGR	TAP CHANGER TRANSITION RESISTANCE	T
RPGR	TAP CHANGER PERMANENT RESISTANCE	T
RGCP	COMPRESSOR REGULATOR GOVERNOR	AC-1
RHOBA	BATTERY EARTHING DEVICE RESISTANCE	TK2
RPQOA	PERMANENT RESISTANCE FOR QOA	TK2
RPQOP	PERMANENT RESISTANCE FOR QOP	TK2
RPS1-6	PERMANENT FIELD WEAKENING RESISTANCE FOR TRACTION MOTORS 1-6	T
RQ20	LIMITING RESISTANCE FOR Q20	BA2
RQ30	LIMITING RESISTANCE FOR Q30	TK2
RQOA	EARTHING RESISTANCE FOR AUX. POWER CIRCUIT	TK2
RQOP1-2	PERMANENT EARTHING RESISTANCE FOR AUX. POWER CIRCUIT	BA2
RS	FIELD WEAKENING RESISTANCE	BA 3&4
RSI 1-2	SILICON RECTIFIER CUBICLE1-2	M
RSILM	RECTIFIER CURRENT TRANSFORMER	RSI1, 2
RU 1-2	RESISTANCE FOR VOLTMETER	BA2
SHAA 1-2	SHUNT FOR AMMETERS	BA1, 2
SHF 1 & 2	SHUNTS FOR RELAY QF 1 & 2	BA 3
SJ 1 & 2	INDUCTIVE SHUNT	M
SL 1 & 2	SMOOTHING REACTOR	FRAME
SMGR	TAP CHANGER AIR MOTOR	T
SMGR VE1	ELECTRO VALVE FOR PROGRESSION OF TAP CHANGER	T

SMGR VE2	ELECTRO VALVE FOR REGRESSION OF TAP CHANGER	T
TFVT	TRANSFORMER FOR CAB FAN	TK 2
TFWA	MAIN TRANSFORMER WINDING FOR THE AUXILIARY CIRCUITS	T
TFILM	CURRENT TRANSFORMER FOR QLM	M (CEILING)
TFP	MAIN TRANSFORMER, SECONDARY WINDING FOR POWER CIRCUITS	T
TFWR	MAIN TRANSFORMER WINDING FOR VOLTAGE REGULATION	T
TH	EARTH CONNECTION	LOCO FRONT & REAR SIDE
U 1, U2, U5, U6	VOLTMETER FOR TRACTION MOTOR	CAB1, 2
UA 1-2	AUXILIARY CIRCUIT VOLTMETER	CAB1, 2
UBA	BATTERY VOLT METER	TB
VEF	ELECTRO VALVE FOR BRAKING	TPN
VEPT-1	ELECTRO VALVE FOR PANTOGRAPH-1	TPN
VEPT-2	ELECTRO VALVE FOR PANTOGRAPH-2	TPN
VESA 1 & 2	ELECTRO VALVE FOR SANDERS	CAB-1
VESA 3 & 4	ELECTRO VALVE FOR SANDERS	TK2
VMT 1-2	BLOWER FOR TRACTION MOTOR	M
VRF 1-2	BLOWER FOR BREAKING RESISTANCE	M
VRH	BLOWER FOR OIL COOLER	T
VS	BLOCKING DIODES	TK-2
VSI 1-2	BLOWER FOR SILICON RECTIFIER	RSI
VSL	BLOWER FOR SMOOTHING REACTOR	M
ZCPA	SWITCH FOR AUXILIARY COMPRESSOR	CAB-1
ZLC 1-2	SWITCH FOR CAB LIGHT	CAB-1 & 2
ZLE 3	SWITCH FOR AC 2 PANEL LAMPS	CSAB-2
ZPT 1-2	SWITCH FOR SELECTION OF THE PANTOGRAPH	PC 1, 2
ZPV	SWITCH FOR SELECTION OF THE EXHAUSTER	TB
ZRT	SWITCH FOR RTPR	TB
ZSM-GR	SWITCH CUT OUT FOR SMGR ELECTRICAL AND PNEUMATIC	T
ZSMS	CHANGE OVER SWITCH FOR MP & EEC	T
ZUBA	SWITCH FOR BATTERY VOLTMETER	AC 2 (CAB-2)

GENERAL CHARACTERISTICS OF DIFFERENT LOCOS

S.No.	DESCRIPTION	WAG5	WAG7	WAP4
1.	Gauge	1676 mm	1676 mm	1676 mm
2.	Wheel Arrangement	Co-co	Co-co	Co-co
3.	Service	Freight	Freight	Passenger
4.	Length over Buffers	19974 mm	20394 mm	18794 mm
5.	Total Wheel Base	14898 mm	15690 mm	
6.	Bogie Wheel Base	3810 mm	3800 mm	3895 mm
7.	Diameter of Wheels- New : Half Worn : Condemned :	 1092 mm 1055 mm 1016 mm	 1092 mm 1055 mm 1016 mm	 1092 mm 1055 mm 1016 mm
8.	Distance between Bogie-Pivot Centers	12580 mm	11890 mm	10700 mm
9.	Height of Roof (in panto lock-down)	4165 mm	4205 mm	4232.5 mm
10.	Body Width without Fixtures	3055 mm	3179 mm	3055mm
11.	Minimum Radius of Curve	174 mm	174 mm	174 mm
12.	Maximum service speed with half worn wheels	80 kmph	100 kmph	140 kmph
13.	Continuous power of locomotive	3790 hp	5000 hp	5060 hp
14.	Speed at continuous Rating	56Km/h	50 kmph	72kmph
15.	Continuous Tractive effort at wheel rim	20.5 tonnes	27 tonnes	19tonnes
16.	Maximum starting effort	33.5 tonnes	42 tonnes	30.8 tonnes
17.	Weight of locomotive	123 ±1% Tonnes (with HS 15250A Motor) 118.8 ±1% Tones (with TAO 659	123 ± 1% Tonnes (with HS 15250A Motor)	11.8 ± 1% Tonnes (with HS 15250A Motor)

		Motor)		
18.	Maximum axle load	20.5 T	20.5 T	18.8 T
19.	Height of contact wire above Rail level Maximum Minimum Nominal	 6.10 meters 4.45m 5.50m	 6.10 meters 4.45m 5.50m	
20.	Catenary Voltage Nominal Maximum Average Minimum for Traction	 25.0 KV 27.5 KV 22.5 KV 19.0 KV	 25.0 KV 27.5 KV 22.5 KV 19.0 KV	
21.	Gear ratio of transmission between motors and wheels	18:64 for HS 15250A motor 15:62 for TA0659 motor	16:65 for HS 15250A motor	
22.	Traction motor Rating	630 KW for HS 15250A 585 KW for TAO659	630 KW for HS 15250A	
23.	Traction motor Insulation	'C' class for HS 15250A 'H' class for TAO 659	'C' class for HS 15250A	
24.	Type of Traction motor Cooling	Air Forced Ventilation 90-m^3/ min	Air Forced Ventilation 90-m^3/ min	
25.	Type of Braking system	Air & RB in loco & vacuum & air on train	Air & RB in loco & air on train	
26.	No. Of Traction motor	6	6	
27.	Current rating	TAO type Starting-1100A for 2 mins	Starting-1300A for 2 mins Acceleration-96	

		Acceleration-840A for 60 mins. Continous-750A,650V HITACHI type Starting-1200A for 2 mins Acceleration-840A for 60 mins. Continous-750A,650V	0A for 60 mins. Continous-900A ,750V	

Rng : 3.2
LOCATIONS

Cab1 - Loco Pilots Desk

A9 - AutomaTIC vacuum brake or Air brake valve with feed valve, SA9 - Independent air brake with feed valve, MP - Master Controller, MPJ - Reverses operating key, MPS - Shunting contactors operating handle, ZPT - Key for operating pantograph, BL - Box lever key, BL switches (8 on top row & 8 on bottom row), Pilot lamps (10 lamps), ZQWC -Weight compensation relay switch, BPP- Push button switch for progression, BPR - Push button switch for regression, BPT- Push button switch for testing, SON - Buzzer for over voltage, Horns (LT & HT), Cut Out COCs (COCs)(A9 inlet Cut Out COC (COC), A9 outlet COC,SA9 inlet COC, SA9 outlet COC, Horn (HT) COC, Horn (LT) COC, Wipers COC, A8 COC (Lead / Trail)), PSA- Pedal switch for operating sander valve, PVEF- Pedal switch for nullifying loco brakes, along with train brake, FLCU - Flasher light unit, Speedometer CAB1 (recorder), CAB2 (indicator), Gauges(Brake cylinder pressure gauge (Max of 3.5 kg/cm^2), Brake pipe pressure gauge (Max of 5 kg/cm^2), Feed Pipe pressure gauge (Max of 6 kg/cm^2), Main reservoir pressure gauge (Max of 9.5 kg/cm^2, , Vacuum gauge, Air flow indicator), Meters(U1 - Voltmeter for TM1, U2 - Voltmeter for TM2, A3 - Ammeter for TM3, UA - Line voltmeter, RS1 - Handle for operating brake by Assistant Loco Pilot)

Cab1 Left Side Locker

Limiting valve set at 2 kg/cm^2, Electrical VEF and Mechanical VEF, HS4 Pressure gauge with feed valve (Set to 1.4 to 1.7 kg/cm2), HB5 COC, SWC, RGEB-1, MU2B valve (Lead / Trail), F1 selector valve

Cab1 Centre Locker

VESA1 & VESA2 with COCs - Electro valves for sanders with COCs, VEPT1 - Electro valve for pantograph1, TV -Throttle valve, ZCPA -Switch for compressor auxiliary, MCPA-Motor for compressor auxiliary, CPA DC-CPA's drain COC, SS1 - Safety valve 1(Set to 8 kg/cm^2), RAL COC-RAL cut out COC, RS with gauge - Reservoir Secondary with pressure gauge, RS DC-RS drain COC, RGCP and it’s COC - Regulating governor for compressor and it’s COC.

Cab1 Right Side Locker

Normally this side locker is empty, but the following safety items will be provided in this locker. Loco Pilot’s Tool Box, Portable Telephone Box, Spare vacuum and air hose pipes (BP / FP), Fire extinguishers (4 numbers), Transition screw coupling , Ratchet type hand brake

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Safety clamp, Wooden wedges (4 numbers)

Motor Chest No.1

Motors: MCP1, MCP2, MCP3, MPV1, MPV2 MVMT1

Brake equipment: VA1B valve, Vacuum relief valves (2Nos), A1 differential valve, IP electrical valve with COC, VEUL1, 2 & 3 with COCs, capacitors bank for MCP1, 2 & 3, Vacuum train pipe COC(VTP COC), GD 8OD filter, Distributor Valve (DV or C3W) with passenger/ freight service COC, Quick release valve(QRV), PT1 COC, VEAD with COC.

HT1 Compartment

BA1 panel: CTF1, J1 for 1,2,3 Traction Motors, EP1 COC, QD1, ATFEX, SJ1 &2 (Inductive shunt), 9 shunting contactors with their resistances. RF resistances , MVRF (DC Series motor), QVRF.

HT2 Compartment

Tap changer (GR), CGR1, CGR 2 & CGR 3, MVSL1, QVSL1, MVSL2, QVSL1, roof bushing bar/ HT cable with TFILM, RGR,RPGR, PHGR, MPH, QPH, MVRH, QVRH, TFP oil conservator with gauge, cowl box with RPS resistances, radiator, DJ assembly, RDJ reservoir, RCC panel, A33 terminal, A34 terminal, a0, a1, a3, a4, a5 & a6 terminals, two GR safety valves on DR drum, TFP explosion door on TFP oil conservator

HT3 Compartment

BA-2 Panel: CTF2, J2, HQOP1, HQOP2, Q20, RQ20, QE, QF1, QF2, RU1, RU2, QD2

BA-3 panel: C145, L1 to L6, 9 shunting contactors with their resistances, SHAA, SJ3, SJ4, SJ5 &SJ6.

RSI-1 &RSI-2 , MVSI-1 & MVSI-2, QVSI-1 & QVSI-2, RCC panel.

Motor Chest No.2

ARNO, MVMT2, CHBA, RTPR, TFVT, C118 and R118

Cab2 Back Side Panel(TK-2)

Resistances for relays, VS diodes, QTD105, QTD106, LTBA, VESA3, VESA4, with COCs, VEPT2 with COC, Throttle valve and SPM equipment.

Cab2 Loco Pilots Desk

All the items are same as in cab 1, except the following changes Meters(A4 - Ammeter for TM4, U5 - Voltmeter for TM5, U6 - Voltmeter for YM6, UA - Line voltmeter)

Cab2 Right Side Locker (Relay Panel Or 'TR')

QOP1,	QE,	QRSI1,	QRSI2,	QLA
QOP2,	Q30,	QLM,	QOA	
QV60,	BP1DJ,	QV61,	BP2DJ,	QV62
QV63,	QV64,	Q51		
QVLSOL,	QCVAR			
Q45	Q46	QRS		
Q49	Q50	Q52		
Q100	Q120/121	QWC		
Q48	Q44	Q118		

Cab2 Centre Locker (Contactor Panel Or 'TK1')

C103	C102
C101	C105
C121	C106
C111	C107

Cab2 Left Side Locker (Switch Panel or TB)

LECC	ZUBA	ZRT	
HQOA	HBA	HPH	
HVRH	HCP	HVSL2	ECC
ZPV	HQCVAR	HVSL1	
HCHBA	UBA	HMCS1	
HVMT1	HVMT2	HMCS2	
	HOBA		
CCBA	CCA	CCLSA	CCLC
CCRA2	CCRA1	CCPT	CCLF1
CCDJ	CCLS	CCVT	CCLF2

Spare fuses rack (35amps-2, 16amps-2, 10amps – 2, 6amps-4nos)

'C' CONK 'B' CONK 'A' CONK

Corridor No.2

ZSMGR, ZSMS, Transformer oil gauge, RDJ drain COC, SMGR pressure gauge, SMGR shaft with digital indicator.

Corridor No.1

HOM, HVSI1, HVSI2, RSI1, RSI2 with 32 tell tail fuses.

Loco Right Side Towards Cab2 End

1. Feed valve 6 kg/cm^2 for Feed Pipe with COC
2. Duplex valve for MR equalizing pipe
3. SL1
4. NRV (Non Return Valve), MR3 with drain COC, BA box No.1
5. NRV, MR4 with drain COC, BA box No.2
10. Centrifugal dirt collector (CDC) with drain COC
11. MR4 COC
12. C2B relay valve, for loco brakes
13. Brake cylinder COC
14. Air flow measuring valve
15. Sander control valve with COC for wheel no 5 & 6
16. Centrifugal Dirt Accumulator drain COC above wheel No.4 (CDA)
17. R1 COC

Loco Left Side From Cab1 End

1. Three unloaded valves above wheel No.5
2. Three safety valves after un loader valves (Set at 11.5 kg/cm^2)
3. EP drain COC
4. Centrifugal dirt collector with drain COC
5. C2A relay valve for Brake Pipe
6. Control reservoir drain COC
7. DJ oil separator drain COC
8. MR1, with drain COC
10. Auto drain valve (ADV) with COC
11. Panto pipe line drain COC
12. MR2 with drain COC
13. Air intake COC with Non Return Valve (NRV)
14. SL2
15. Brake cylinder COC

Loco Front Side Cab1 End

1. MU Electrical jumper cables (3 cables with 3 sockets in wither side of cab1front side), MR equalising pipe and Brake Cylinder equalising pipes with angular COCs.
2. Feed Pipe with Angular COC
3. Brake pipe Angular COC

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4. Vacuum hose pipe with dummy
5. Marker lights (White and Red)
6. Cattle guard (4 inches away from rail)
7. Rail guard, attached to cattle guard (6 inches away from rail)
8. Two side Buffers
9. Center Buffer with Transition Screw Coupling
10. Head light
11. Flasher light

Loco Front Side Cab2 End

1. MU Electrical jumper cables (3 cables with 3 sockets in wither side of cab1front side), MR equalising pipe and Brake Cylinder equalising pipes with angular COCs.
2. Feed Pipe with Angular COC
3. Brake pipe Angular COC
4. Vacuum hose pipe with dummy
5. Marker lights (White and Red)
6. Cattle guard (4 inches away from rail)
7. Rail guard, attached to cattle guard (6 inches away from rail)
8. Two side Buffers
9. Center Buffer with Transition Screw Coupling
10 . Head light
11 . Flasher light

Locomotive Frame

1. Two Trucks
2. Main transformer oil tank between two trucks
3. SL Assembly
4. RheostaTIC Braking exhauster
5. Four Battery boxes (Two on each side)
6. Four Main Reservoirs (Two on each side)
7. One Control Reservoir(CR)
8. Sixteen sand boxes (Eight on each side)

On Truck

1. Tri-mount casting with center pivot and two side bearers
2. Equalising beams (long and short with friction rollers)
3. Helical springs (2 sets of primary and secondary with snubbers)
4. Tie rod and tie bolts (Safety Brackets)
5. Spring carrier brackets

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6. Brake rigging (clasp type)
7. Air brake cylinders (4 per truck)
8. Air bellows (3 each truck)
9. Sixteen sand pipes

Under Gearing From Cab1 Side

1. Cattle guard, Front truck, Traction Motors, brake rigging, oil points, gear cases, Suspension Bearings, wick pads, Suspension Bearing oil sumps lower and upper (lower is provided with gear driven pump), earthing bush one per axle, Resilient block Traction Motor inspection cover one per each TM.
2. Three after coolers (at the back of the truck) with three NRVs.
3. Control Reservoir
4. MVRF Motor on top of After Coolers
5. C2B relay valve for loco brake (towards corridor No.2)
6. C2A relay valve for Brake Pipe
7. Limiting valve 8 kg/cm^2, for control reservoir (on modification, it is removed)
8. Air Flow Measuring Valve(AMFV)
9. EP drain COC
10. Transformer oil tank with drain plug and seal
11. SL1 and SL2
12. Vacuum Reservoir

Loco Roof

1. MVRF exhaust,
2. Pantograph 1 & 2,
3. Roof Bars,
4. Earthling Bushes,
5. Insulators,
6. ET1 and ET2 (surge arrestors),
7. DJ primary and secondary.

Rng : 3.3
SWITCHES

Switch is a device, used for closing or opening LT circuit.

The different types of switches provided on the Loco are

a) Knife switch
b) Lever switch
c) Rotating switch
d) Push button switch
e) Pedal switch
f) Link switch

Knife Switch: - Knife switch will have two positions 'ON' and 'OFF'. In 'ON' position it will close the circuit and in 'OFF' position it will open circuit. In our loco, HOBA (located in Switch panel), HQOP1, and HQOP2 are (located in HT3 compartment) Knife switches.

Box-Lever Switch: - It will have two positions CLOSE and OPEN, and operated manually the by a lever

Eg. : - BLDJ, BLCP, BLPV, BLVMT.

Box-Lever Switch- Normally open (spring loaded): - This switch will have two positions CLOSE and OPEN. It is a spring loaded switch. Normal position of the switch is OPEN and keeps the circuit, open. On closing the switch, circuit will be closed. On releasing the hand, it will come to it's normal position.

Eg. : - BLRDJ

Rotating Switch: - It will have different positions. Each position of the switch closes individual circuit or circuits. We can operate different circuits by one single switch by rotating it to different positions. Hence this is also called as programming switch.

Eg.: HVMT1, HVMT2, HVRH, HPH, HVSI1, HVSI2, HVSL1, HVSL2

with 4 positions 0,1,2,3.

In 'O' Position, Motor and Relay both will be isolated.

In '1' Position, Motor and Relay both will be service.

In '2' Position, Relay will be in service, and Motor will be isolated.

In '3' Position, Motor will be in service but Relay will be isolated.

Eg. : - $HMCS_1$, $HMCS_2$, ZPV with 1,2,3,4, position

ZPV:-It is programming switch 1,2,3,4

ZPV in 1 position, PV2 will be in service.

ZPV in 2 position, PV1 will be in service.

ZPV in 3 position, PV2 will be isolated.

ZPV in 4 position, PV1will be isolated.

HMCS1 in 1 Position, Traction Motors 1, 2, 3 will be in service.

HMCS1 in 2 Position, Traction Motor 1 will be isolated.

HMCS1 in 3 Position, Traction Motor 2 will be isolated.

HMCS1 in 4 Position, Traction Motor 3 will be isolated.

HMCS2 in 1 Position, Traction Motors 4, 5, 6 will be in service.

HMCS2 in 2 Position, Traction Motor 4 will be isolated.

HMCS2 in 3 Position, Traction Motor 5 will be isolated.

HMCS2 in 4 Position, Traction Motor 6 will be isolated.

Eg. :HCP is having 8 positions They are 0-, 1, 2, 3, ½, 1/3, 2/3, 1/2/3.

HCP in 0 position, MCP1, MCP2, MCP3 will be isolated.

HCP in 1 position, MCP1 will be in service.

HCP in 2 position, MCP2 will be in service.

HCP in 3 position, MCP3 will be in service.

HCP in 1/3 position, MCP1 & MCP3 will be in service.

HCP in 2/3 position, MCP2 & MCP3 will be in service.

HCP in 1/2 position, MCP1 & MCP2 will be in service.

HCP in 1/2/3 position, MCP1, MCP2 & MCP2 will be in service.

Link Switch: - To put a circuit in working order, the link switch is provided in the circuit either side. The link will be fixed in the circuit. The link should be disconnected manually when there is no power in the circuit.

These type of switches are provided on the roof of the Loco, to isolate the Pantograph. They are HPT1 and HPT2.

These switches are to be isolated manually, only after taking the precautions.

Push Button Switch: -It is a spring loaded switch and used momentarily either to close a circuit or to opens a circuit. There are two types of push button switches.

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1. Normally Opened
2. Normally Closed

Normally Opened: On closing this switch, it closes the circuit and maintains the circuit in closed condition. When the switch is released the switch will return to normal position under the spring tension and the circuit is opened.

Eg. : - BP2 DJ provided in the relay panel for closing DJ.
BPP Push Button for Progression of GR notches.
BPR Push Button for Regression of GR notches.
BPT Push Button for test LSRSI, LSP.

Normally Closed: This switch also looks as in same way as above said switch. But normal position of this switch will keep the circuit close. When the switch is pressed, it will open the circuit.
Eg. : BP1DJ provided in Relay Panel (for opening DJ)

Pedal Switch: - These types of switches are operated by foot by the virtue of their location. Hence they are called as Pedal Switch.

Eg. : PVEF for isolating Loco Brakes, while applying formation brake.

PSA for operating sander valve, to effect sand under the wheels on rails.

CAM Contact: - It is a device, which opens or closes the HT circuit by the help of a cam. Number of cams will be provided on a single shaft and different circuits can be operated according to requirement.

Drum Contact: - It is also serves the purpose of opening or closing the HT circuit. But it is operated by means of a drum hence it is called as drum contact. The drum is attached to a handle and the handle will operated by an electro valve.

RNG : 3.4
INTERLOCKS

Interlocking means achieving of different operations one after the other in an automatic successive manner as desired. This is done with the help of different interlocks. The electrical interlocking is necessary to ensure correct sequence of operation and automatic energisation of circuit in a proper manner.

Types of Interlocks:

There are two types of interlocks used in electrical circuits.

1. Normally closed interlocks (upper interlocks)
2. Normally opened interlocks (under interlocks)

1. Normally closed interlocks: These interlocks by the virtue of its normal position, keeps the circuit in closed position. Such an interlock is called normally closed interlock. When concerned apparatus comes in to the service, this interlock will open the concerned circuit. They are shown on the left hand side in case of vertical line and on the upper side in case of horizontal line of the circuit diagram.

2. Normally opened interlocks: These interlocks by the virtue of its normal position, keeps the circuit in open position. Such an interlock is called normally open interlock. They are shown on the right hand side in case of vertical line and on the under side in case of horizontal line of the circuit diagram. When concerned apparatus comes in to the service, this interlock will close the concerned circuit.

Cascade Operation: Mounting of interlocks on different circuits will result in automatic successive closing or opening of different circuits in a proper sequence. When the contactor is closed, its normally open interlock will close the other branch, automatically. And its normally closed interlocks which opens the other circuit. This operation of different circuits by handling one switch is called "Cascade Operation".

Advantages of Interlocking and Cascade operation:

a. Number of switches can be reduced to a great extant.
b. Time can be minimised to operate different circuits.
c. Space can be minimised on loco, since switches are reduced.
d. Sequence of operations will be maintained automatically.

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e. Automatic closing and opening is possible.
f. The burden on the operator is reduced.

Chronometric interlock:

It is an interlock, which closes or opens the control circuits with some delay after opening of the contactor for which it is attached.

In WAG 5 loco, contactor C-118 is provided with Chronometric interlock. It's interlock is provided on the control circuit of remote control blower motors, compressors and exhausters. This interlock is attached to the contactor C-118. It is a contactor for giving starting phase to ARNO, when the contactor C118 is closed, the chronometric interlock opens the auxiliaries control circuits. When the contactor C118 is opened, it's Chronometric interlock will close after 5 seconds on the auxiliaries control circuit. Due to this arrangement, while closing DJ, though the control switch BLCP, BLPV, BLVMT are in closed condition, concerned contactors will not close. Hence the ARNO is protected from overload.

Rng : 3.5

MP (MASTER CONTROL)

MP is master controller. It is located on the Loco Pilot's desk in both cabs. It is a Cam operated switch, where a number of cams are mounted on a shaft. On the top end of the shaft, the wheel if fitted, which is called as MP. By rotating the MP, the shaft rotates and cam rotates, causing closing and opening of switch contacts.

Thus the MP operates control circuits of Tap Changer (GR) both for Traction as well as Braking operations. The MP will have two sides turning. Clockwise is Traction side and anti clockwise is Braking side. Both sides it will have stable and unstable positions. 'O' is the common position on either side in MP positions.

On Traction Side

O	Stable position
-	Unstable position
N	Stable position
+	Unstable position

On Braking Side

P	Stable position
-	Unstable position
N	Stable position
+	Unstable position

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1. In 'O' position, Traction Power Circuit is set to motoring side, that means CTFs will be in Traction side (Up direction) and Contactor 'C-145' remains opened.
2. In 'P' positions, Traction Power circuits is set for Braking by CTFs setting towards Braking side (Down direction) and C-145 Contactor closes.
3. When MP is moved to '0' position on traction side, the line Contactors will open.
4. When MP is moved to N position, line contactors will close.
5. When MP is moved to '+' position on either side, one notch Progression takes place.
6. When MP is moved to '-'position on either side, one notch Regression take place.
7. When GR on notches, if MP is moved to 'O', Quick Regression takes place (continuous Regression to 'O').
8. When GR on notches if MP is moved to 'P', Quick regression takes place to 'O'
9. If MP is moved from 'P' to 'O', Traction Power Circuit will set towards Motoring side (Up direction) and Contactor C-145 opens
10. During Braking, if MP is moved form 'N' to 'O', quick Regression of GR takes place.

RNG : 3.6

PANTOGRAPH

It is a collapsible framework mounted on loco roof. Pantograph is mounted on four base insulators. This frame is made of several metallic tubes and springs. Ball bearings are provided for easy movement of articulations and at each joint, flexible shunts are provided to give continuous flow of current. On the top frame of the pantograph, panto pan is provided to collect the current from OHE. Panto pan is made up of high carbon strips, which can be replaced when worn out. Normally the panto is in lowered position by the tension of lowering springs provided inside the servomotor. When compressed air is admitted inside the servomotor, piston is operated and compresses the lowering spring.

The piston rod is attached to the rocker arm and releases actuating rod, thereby the cam is released and operates the lower articulation drum. When the lower articulation drum is operated, the lower articulation is raised upwards by the action of rising springs. The upper articulation, which is connected to the lower articulation at free end, will also rise by the action of thrust rod. Thereby the upper articulation will rise. The tension of lower spring is more than the

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raising spring. So it is necessary to admit the compressed air inside the servomotor continuously. For lowering the panto, it is enough to exhaust the compressed air from the servomotor; thereby with the action of lowering spring panto lowers.

Which in turn operates the lower articulation rod against the tension of rising spring, due to this action the lower articulation is pulled down and upper articulation is also pulled down simultaneously by the action of thrust rod. The admission and exhausting of compressed air in the servomotor is controlled by electro valves (VEPT1 & VEPT2), which are remotely controlled by ZPT from Loco Pilot's desk. Each loco consists of two pantos. These are electrically connected by means of HPT1, HPT2 and Roof bars. The OHE supply collected by panto is taken to the main transformer through roof bars, DJ and roof-bushing bar. For isolating the panto PT1 & PT2 cot out COCs are provided. PT1 cot out COC is provided in Cab1 center locker and PT2 cot out COC is provided in Cab2 back panel.

THE PANTOGRAPH SELECTOR SWITCH (ZPT) HAS THE FOLLOWING POSITIONS.

POSITION 0: The Two Solenoid Valves Of VEPT-1 and VEPT-2 are Switched Off And The Pantographs 1 And 2 are lowered.

POSITION 1: Rear pantograph raises through the energisation of rear VEPT

POSITION 2: Front/ leading pantograph raises through the energisation of leading VEPT

PRINCIPLE

Basically, compressed air raises the pantograph and lowering springs of servomotor lower the pantograph. The sole function of air is to cancel the lowering effort of the springs (servomotor) and it has no direct effect on the pantograph. When the pantograph is working and the air pressure is maintained in the servomotor, the piston is kept forward and the articulated system is entirely free to keep panto in raised position only. Therefore, it absorbs freely all the oscillations of the contact wire. The equipment lowers by itself when pressure drops below 3 to 3.5 kg/cm². All parts of panto are alive and used as conductors. The current collection is made on the frame with shunts fitted at all moving points.

Minimum air pressure to raise panto	: 4.5Kg/cm^2
Nominal pressure	: 7Kg/cm^2
Raising time	: 6 - 10 sec
Lowering time	: 10 sec or below
Rated current	: 400 Amps

Principle Parts of the Panto:

1. Base Insulator And Frame: The frame is made of light metal and mounted on four insulators on the loco roof. The panto frame also mounted on the loco roof.
2. Raising Springs: Two springs are provided for raising the panto. One end is connected to the bottom frame and the other end is connected to the horizontal frame. When panto is in lowered condition, the springs will remain in expanded condition, and when the panto is raised the springs will be in compressed condition.
3. Horizontal Spindle: It is solid metallic spindle capable of turning the ball bearing. The cam is provided at the end of the spindle which connecting neutralizing rod.
4. Lower Articulation Rod: It is a metallic tube connected with horizontal spindle and the other end is connected with the upper articulation through ball bearings.
5. Upper Articulation Rod: This assembly is made with two steel tubes on either side of the balancing rods. The upper articulation rod is connected to panto pan and bearing.
6. Thrust Rod: It is a metallic tube connected to the bottom frame and the other end is connected to the bearing. It is provided to operate the upper articulation during the lowering and raising the panto.
7. Anti Balancing Rod: It is the rod provided between the bearing and transverse rod. The purpose of it is to keep the panto pan in horizontal position at all times.
8. Transverse Rod: It is fitted across the upper articulation on top and rotates on sleeves provided upper articulation. The purpose of this rod is to give the support to the panto pan.
9. Panto Pan: It is provided on the upper articulation, made out of the light alloy to wearing strips are provided on top surface, which keeps contact with contact wire. The panto pan is lubricated with graphite grease which acts as lubrication between wearing strips and contact wire.
10. Actuating Rod: This rod is connected to the panto servomotor with the lower articulation drum. One end of the cam of the lower articulation, which is having elongated hole, and other end is connected with rocker arm. An insulator is provided to separate the servomotor and panto. The servomotor operates this actuating rod.
11. Panto Servomotor: It consists of pneumatic control cylinder with piston and spring inside, fitted separately on the loco roof. The piston provided in the servomotor is connected through rocker arm. The spring, which is provided inside the servomotor is,

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called lowering spring. The compressed air is admitted into servomotor by energizing VEPT1 & VEPT2, which are remote controlled from Loco Pilot's desk by ZPT key.

12.Panto COC: These are two isolating COCs provided for stopping pneumatic pressure to the panto. The normal of COC is open. If any panto is damaged or air leakage is noticed, the concerned COC can be closed and loco can work with another panto.

13.Throttle Valve: It is a valve provided to admit or withdraw the air gradually from the servomotor, thereby the sudden raising and sudden dropping of panto is controlled.

Precautions before raising the panto

1. Loco should be under wired track.
2. Ensure DJ in open condition (indicated by the lamp LSDJ).

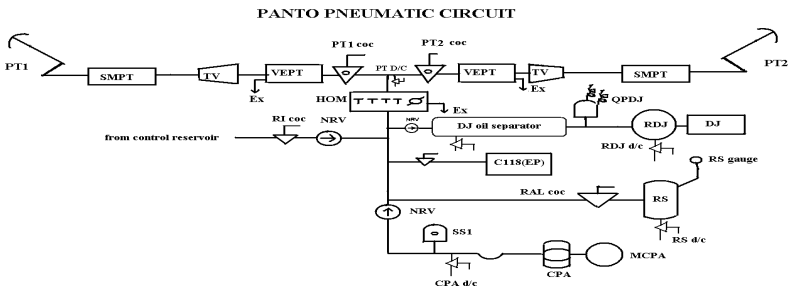
Panto can be raised in three ways:

1. With the help of MR pressure more than 6.5 Kg/cm^2.
2. With the help of RS pressure more than 6.5 Kg/cm^2.
3. If there is no pressure in MR & RS, build up pressure in RS above 6.5 Kg/cm^2 with MCPA.

Raising the Panto with the help of 'MR' Pressure:

If the pressure is more than 6.5 Kg/cm^2 in MR, the same pressure can be used for raising the panto. The MR pressure should be checked in Cab1 center locker RS gauge.

1. Normally R1 COC should be in open condition.
2. RAL COC should be in open condition.



3. HBA should be on '1' to energise the control circuit.
4. Additional CCBA, CCBA and CCPT in good condition.
5. BL key should be unlocked and ensure that red lamp LSDJ is glowing.
6. Operate ZPT from 0 to 1, rear VEPT energises and rear panto raises.
7. Check actual raising of the panto and ensure that it makes proper contact with contact wire.

Raising the Panto with the help of 'RS' pressure:

Panto can be raised with the help of RS pressure if it is above 6.5kg/cm^2.

When RS pressure is less than 6.5kg/cm^2 ,Item 1 to 5 mentioned above should be fulfilled.

1. Switch on ZCPA to create RS pressure up to 8 kg/cm^2
2. After building up 8 kg/cm^2, raise panto, close DJ and close BLCP.

Raising the Panto when there is no MR and RS Pressures:

When there is no pressure in the reservoir or insufficient pressure in MR and RS, panto can be raised by building up the pressure in RS with the help of MCPA.

1. Before raising the panto items 1 to 5 of precautions above should be fulfilled.
2. Start MCPA by closing ZCPA from 0 to 1 position.

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3. When pressure is created to 8 kg/cm^2 then stop MCPA.
4. Raise panto and close DJ then start MCP

Note: MCPA should not work for more than 10minutes in DJ open condition.

Reasons for using the rear panto:

1. It gives smooth passage for the panto.
2. It avoids the sparks coming on the Loco Pilots desk
3. In case of any damage to the panto, the damaged panto parts will be thrown-out on the train.
4. At the time of entering into the unwired track or any defect is noticed in OHE, if DJ could not be opened while approaching neutral sections, there is possibility for the Loco Pilots to lower the panto which can avoid a failure.

Securing the Damaged Pantograph

1. Keep ZPT on 'O'
2. Stop the train immediately.
3. Contact TPC through emergency telephone giving the particulars.
4. TRD staff obtains power block.
5. Ground the loco and ensure that OHE is earthed through loco body.
6. Take out ladder and fix it on loco body.
7. Climb on the loco roof and attend to the defect.
8. If it is a damaged pantograph, remove the broken pieces, tie up the projecting and hanging parts which cannot be removed, with a coir rope. Remove the HPT from the roof insulator clip and fix in the earthing clip.
9. After completion of work, ensure that no tool is left over on the loco roof.
10. Get down from the loco roof and remove the ladder and secure it in its place.
11. Remove the earthing poles from the contact wire first and then remove the cable connections from the loco body.
12. Close the damaged pantograph cut out COCs.
13. Un ground the loco and energise when the power is restored.

Trouble Shooting For Pantograph Not Rising

Electrical:

1. Ensure HBA is on '1' position.
2. Battery voltage is above 85
3. Ensure CCBA & CCPT are in good condition.
4. Ensure ZPT is in '1' or '2' position and ZPT wires are intact.
5. Ensure electrical terminals of VEPT are intact and VEPT is energised.

Pneumatic:

1. Ensure MR / RS pressure is above 6.5 Kg/cm^{2}.. and RAL COC is in open position.
2. Ensure PT 1 & 2 COCs are opened.

3 Tap Throttle valve

Mechanical:

1. No mechanical irregularities in panto mechanism.

RS Pressure is not building Up

1. Ensure MCPA is working.
2. Ensure RAL COC is open.
3. Ensure SS1 is not in stuck up position (if mal functioning, close SS1 COC if provided).
4. Ensure RS pressure gauge is working.
5. Ensure CPA drain COC, RS drain COC, RDJ drain COC, panto pipe line drain COC and DJ oil separator drain COCs are in close position.
6. Check for any air leakages in pipeline leading to panto and DJ and arrest if found.
7. Check CPA intake strainer for any blockage, clean if blocked.
8. Tap NRV work MCPA for 10 minutes and observe SS 1.
9. If still pressure is not creating, close RAL COC and create pressure in panto and DJ pipelines until SS 1 blows. If pressure is created, raise panto, close DJ and close BLCP. After creating pressure in MR then switch off MCPA. If pressure is not creating after closing RAL COC, open RAL COC.
10. If still pressure is not created, close R 1 and try. If pressure is created, raise panto, close DJ and close BLCP. After creating pressure in MR then open R 1 COC.
11. If still pressure is not creating, place ZPT in HOM and turn to 7'^{0} clock position and start MCPA. If successful raise panto close

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DJ immediately start MCP. Stop MCPA only after MR pressure is raised to 7 kg/cm^2.

- If still unsuccessful contact TIC.

RNG : 3.7

BATTERIES

Ten batteries are provided in the loco. They are of lead acid type. These batteries are kept in 4 boxes, two boxes on either side attached in under frame. Batteries are to be counted from cab 2 left side i.e from HBA switch. Battery box No.1 and 2 will be in cab 2 left side, having two and three batteries respectively. Battery box No. 3 and 4 will be in cab 2 right side having three and two batteries respectively. Each Battery is having 5 cells which are connected in series to give an output of 11volts.The maximum Battery voltage is 110 volts and minimum battery voltage to run AC loco is 85 volts.

Purpose

1. To create pressure by working MCPA, to raise the pantograph and to close the DJ initially.
2. To feed the control circuits when CHBA fails
3. For the working of Flasher light when loco is failed.

Protection for the batteries

1. To protect the positive cable of the Batteries Additional CCBA fuse is provided and located in Battery box No.1.
2. Fuse CCBA of 35amps is provided for the protection of batteries.
3. When CCBA melts after energising the loco, no trouble will be experienced because the Battery charger (CHBA) is feeding control circuits. But after tripping DJ, it will cause impossibility to close DJ (ICDJ).
4. When CCBA/ADDL.CCBA is fused, the batteries will not be charged.
5. Fuse CCLS is directly connected from the batteries through HBA to protect the signaling lamp circuit.
6. An intentional bonding is provided in the negative level of batteries through HOBA to protect the control circuits from the positive bonding by melting the fuse, and also trips DJ in case of bonding in HT circuit.

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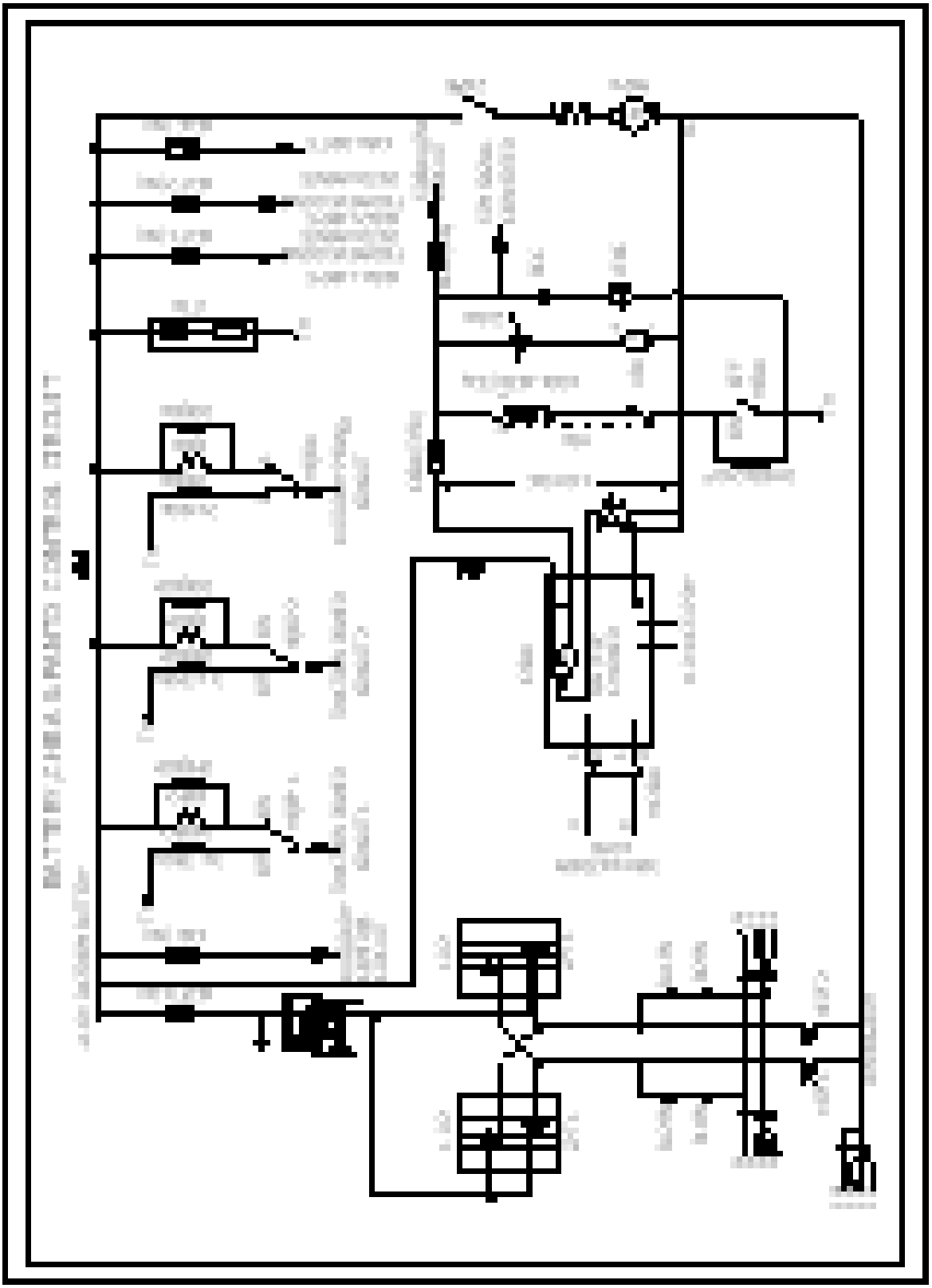
7. LTBA is provided to protect the batteries from any accidental contact of HT circuit with the LT circuit.

LECC: It is a test lamp provided to know the condition of the fuse and also to know the negative bonding, if any, in the circuit.

Testing of negative bonding

1. When HOBA is in normal position (ON) if a good fuse is kept in the terminals of the ECC, the lamp LECC will glow brightly.
2. When HOBA is in OFF position, if a good fuse is kept in the terminals of the ECC, if LECC glows dim when compared to the previous glow there is no negative bonding.

If the lamp glows with same brightness negative bonding is existing in the loco.



CHBA (BATTERY CHARGER)

1. It is a staTIC device provided in the loco for charging the Batteries and also to feed the control circuits after energising the loco.
2. It is located in Motor Chest number 2, towards corridor number 1.
3. It receives 380 volts of AC single phase supply through U & V phases of ARNO and steps down by a transformer to 110 volts.
4. The AC supply is taken for working of Notch repeater and after converting into DC it will be utilized for charging the Batteries and also to keep the control circuits in energise position.
5. An isolating switch HCHBA is provided with 0 & 1 positions. (Normal position is '1'). By this isolation switch the CHBA can be isolated by keeping in '0' position.
6. A charger ammeter is provided on the body of CHBA, which indicates charging current. Normally it should be 2 to 3 amps in charging side. But it should not be more than 7 amps.
7. Relay QV61 is provided to check the working of CHBA. It remains in energised condition when CHBA is working normal.
8. When CHBA is failed and not working, QV61 will deenergise and closes its N/C I/L on LSCHBA branch, so that green lamp LSCHBA will glow on the Loco Pilots desk.
9. By keeping the switch HBA on '1' position we can check Battery voltage by pressing the toggle switch ZUBA.
10. After energising the loco, if ZUBA is pressed, the voltage will be 5 to 10 volts more than the Battery voltage which is nothing but CHBA voltage.
11. The charging of Batteries is done through Addl.CCBA, CCBA and HBA.
12. Batteries can not be charged if any one of Addl.CCBA or CCBA is melted or when HBA is kept on '0' position.
13. The charger ammeter reading, if shows on charging side, indicates the CHBA is working.
14. The charging rate of Batteries to be recorded by Asst.Loco Pilot in the loco logbook, at every neutral section.

Note: A blocking diode is provided inside the CHBA to avoid feeding back of batteries current to CHBA, when loco is in de-energised condition. If the diode is punctured, relay QV61 will deenergise thereby LSCHBA lamp will extinguish, which gives wrong indication to the Loco Pilot even though CHBA is not working. When CHBA is defective and not working, QV 61 relay will deenergise and closes it's N/C I/L on LSCHBA and lamp LSCHBA will glow.

LSCHBA GLOWING ON RUN:

1. Ensure auxiliaries sound is good other wise trip the DJ immediately.
2. If the auxiliaries sound is good, check the working of CHBA.
   a) Check and ensure fuses on CHBA are intact.
   b) Check the MCBS on CHBA, if tripped reset the same.
   c) Check the CHBA ammeter to show in charging side.
   d) Check the indication lights on CHBA for glowing.
3. Clear the block section without tripping DJ.
4. Stop the train after clearing the section.
5. Keep HBA in '0'. If DJ is tripped, conclude CHBA is failed, then keep HCHBA on '0' to isolate CHBA. Work the train further as following.
   a. Check and ensure the battery voltage above 85 volts, always.
   b. Inform to TIC and section controller.
   c. Work the train for 6hrs in day time and 4hrs in night time.
   d. Minimize the usage of battery supply by least utilization of MP/EEC, PVEF, PSA, MPJ, MPS, cab lights / compartment lights etc.,
6. On keeping the HBA in '0' position, if DJ is not tripped, conclude QV61 is defective and giving wrong indication through LSCHBA. Work the train further by ignoring LSCHBA, duly ensuring the working of CHBA, frequently.
7. Make entry in loco log-book and inform to TIC.

RNG : 3.8

CONTACTORS

Contactor is a device which opens or closes a high tension circuit and it is remote controlled from Loco Pilot's desk.

A Contactor is having a driving mechanism, which consists of Actuating Rod, Armature, Return Spring, Insulation Axis and Electromagnet.

Remote control:

It consists of low tension circuit with a switch for remote controlling of Contactor through driving mechanism operated by an electromagnet. In case of single phase contactor, only one set of fixed and mobile contacts are required and for a three phase contactors, three sets of mobile contacts and fixed contacts are required.

Purpose of contactors:

It is dangerous to operate high tension circuits by human being manually. So, these Contactors are operated from Loco Pilot's desk, remotely.

Electro Magnetic Contactor

A contactor is used to open or close the HT circuit with the help of an electro magnet is called electro magnetic contactor.

When the switch is closed, the coil gets energized by 110 volts supply from battery and attracts armature. There by the mobile jaw lifts up and contacts the fixed jaw by means of an axis. Hence the concerned motor gets three phase 380 volts supply from ARNO. Flexible shunt facilitates the free movement of mobile jaw while opening and closing.

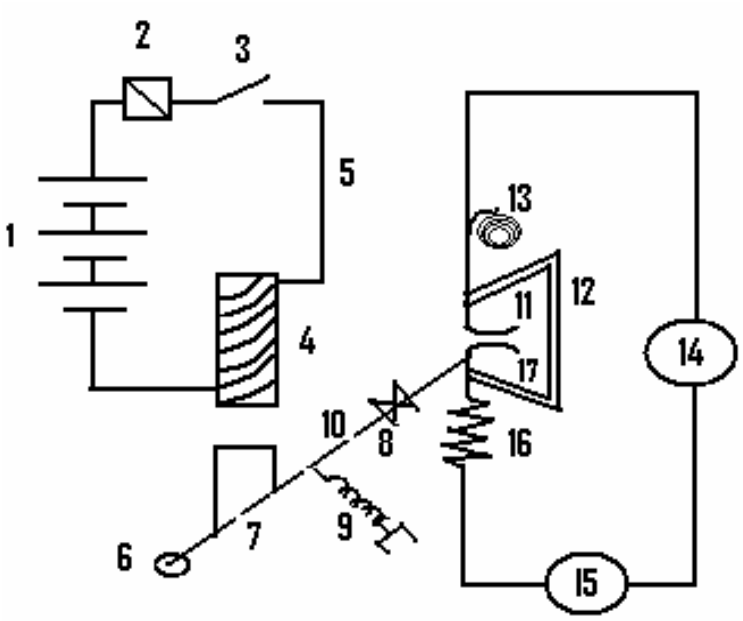
When the switch is opened, the electro magnet de magnetizes and releases the armature and the axis returns to original position with the return spring tension. The HT circuit is isolated from LT circuit by means of an insulator. The arc produced during opening or closing of contactor is blown out on to arc-chutes by means of blow out coils. There are two types of EM contactors:

1) Three phase EM contactor: It consists of three mobile jaws and three fixed jaws.

Eg : 3Ø contactors: C101, C102, C103, C105, C106, C107, C111&C121.
1Ø contactors: C118 (Only in non-modified locos)

Contactor	Purpose
C101	For MCP-1
C102	For MCP-2
C103	For MCP-3
C105	For MVMT-1
C106	For MVMT-2
C107	For MVRH
C111	For MPV-2
C121	For MPV-1
C118	For giving starting phase to ARNO

1. Battery
2. Fuse
3. Switch
4. Electro magnet
5. Connecting wires
6. Axis
7. Armature
8. Insulator
9. Return spring
10. Actuating rod
11. Fixed Jaw
12. Arc-chute
13. Blow out coil
14. Motor
15. ARNO
16. Flexible shunt
17. Mobile Jaw



Main Parts Of Contactor Assembly

1. Battery: Contactor will work with the Battery supply of 110 volts. When the switch is closed in the control circuit by Loco Pilot from the Loco Pilot's desk, the battery supply is fed to the coil of the contactor and the contactor will be closed.
2. Switch: It is for the opening or closing of control circuit.
3. Electro Magnet: when the coil is energised by electricity. On closing the switch, it becomes a magnet and attracts the armature.

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4. Armature: It is fitted on the actuating rod and moves towards the electromagnet, when the control circuit is closed.
5. Actuating Rod: One end of this rod is fitted to the axis and the other end is connected to the mobile jaw of the Contactor. Armature also fitted on to this rod. This actuating rod moves with the movement of the armature when the control circuit is operated by the switch, as a result it operates the mobile jaw and it closes the contact.
6. Return Spring: It is fitted to the armature on account of its tension it will bring back actuating rod when the control circuit is opened. Since the magnetic attraction is lost, the mobile jaw will be moved away from the fixed jaw.
7. Axis : It is the point on which one end of the actuating rod is attached for rotating
8. Insulator: It is provided on the actuating rod to prevent the contact between the HT and LT circuits.
9. Mobile Jaw: It is provided on one side of Contactor with flexible shunt.
10. Fixed Jaw: It is the other side of the Contactor, which is fixed in the circuit for closing and opening of HT circuit by the action of mobile jaw.
11. Flexibile Shunt: It is attached to the mobile jaw to facilitate the movability of the mobile jaw to operate according to the actuating rod for closing and opening the circuit.
12. Blow Out Coil: It will work in conjunction to blow out the arc, which develops at the time of opening the circuit.
13. Arc-Chute: It is made by the Asbestos sheet and can with stand high temperature. The Arc-chute encloses the fixed jaw and the mobile jaw without disturbing the movement. It prevents the spreading of arc to near by circuits. Arc-chute comprises of several long compartments to elongate and break the arc. The Arc-chute should withstand not only the high temperature, but also it should be good insulator.

Probable failures in electro magneTIC contactor:

LT SIDE:

1. Cut in control circuit.
2. Less Battery voltage.
3. Defective control switch.
4. Fuse blown out.
5. Defective coil.

HT SIDE:

1. Cut in high tension circuit
2. Defective flexible shunt

MECHANICAL SIDE:

1. Mechanical jamming of contactor.
2. Defective driving mechanism.
3. Welded/ melted/pit marks/globules on contacts.
4. Improper closing of contactor.

WEDGING OF EM CONTACTOR

I. General Instructions:

1. Clear the block section by coasting or with lower notches or stop the train at convenient place.
2. Build up maximum air pressure in MR & RS, if possible.
3. Trip DJ, lower pantograph, keep HBA on '0'.
4. Check flexibility of contactor and ensure that the flexible shunts are intact and fixed properly.
5. Check the surface of the fixed and mobile contacts for any pit or burnt mark or globules or welding mark. If necessary, remove the arc chutes for checking.
6. If any abnormality mentioned above is noticed try to clean the contacts with a cloth or smooth emery sheet.
7. Wedge the contactor with suitable wedge.
8. After wedging ensure all three contacts closed fully.

Note: Do not wedge more than two contactors at a time. Inform to TIC and enter in loco logbook.

II. Precautions for Wedging:

A. While wedging C101, C102 or C103:

1. Energies the loco. Check and ensure proper working of SS2.
2. After reaching pressure to 9.5 kg/cm^2 in MR, create sufficient leakage by opening CDC drain COC to maintain between 8 to 9.5 kg/cm^2.

B. While wedging C107, C105 or C106:

1. After wedging, keep concerned isolating switch (HVRH or HVMT1 or HVMT2) in '3' position, to maintain path for Q118 initially.
2. Check the working of concerned blower for every 15 minutes.

Note: If isolating switch is not placed in '3' position, operate Q118 manually for every closing of DJ.

C. While wedging C111 or C121:

1. After wedging, place in '3' position if C111 is wedged, place in '4' position if C121 is wedged.
2. While controlling the train, apply brakes from the longer distance.

Electro Pneumatic Contactor

When opening and closing of the contactor takes place with the help of the pneumatic pressure controlled by Electro magnetic valve, it is called as Electro Pneumatic Contactor.

The Driving Mechanism of this contactor consists of servo motor operated by compressed air and an electro magnetic valve operated remotely from Loco Pilot's desk. When the switch is closed the electro-magnet attracts the plunger, thereby the Electro Valve gets lifted, causing air flow to enter into servo motor from control reservoir. Due to air pressure at bottom of the servomotor piston, it lifts the movable jaw. The mobile jaw contacts with fixed jaw causing the closing of contactor.

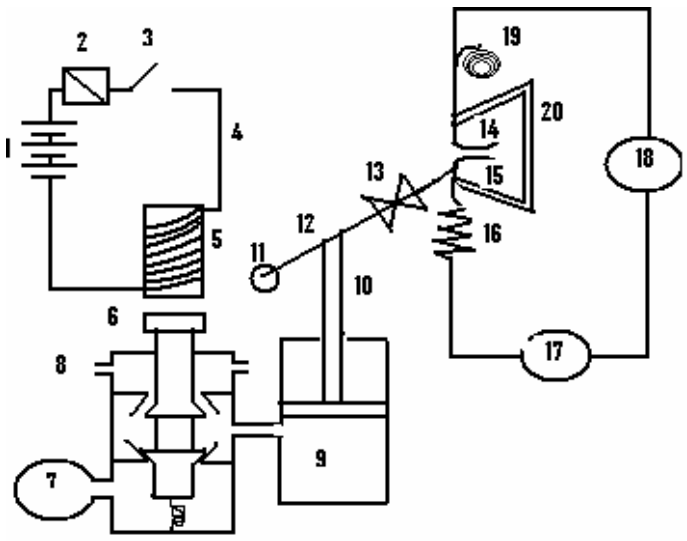
When the switch is opened in LT circuit, the Electro Magnet demagnetizes and releases the plunger causing the port to close. The air is exhausted through exhaust post. As there is no pressure at bottom side of the servomotor, piston gets lowered because of the return spring tension. The contactor opens by lowering the movable jaw along with the Servo motor piston. The arc produced is blown out on to the arc-chutes by blow-out coil.

Eg :

1. Line contactors – L1, L2, L3, L4, L5, and L6
2. Shunting contactors
3. Rheostattic Brake contactor – C 145
4. C 118(in modified locos)

Parts:

1. Battery
2. Fuse
3. Switch
4. Connecting wires
5. Electromagnet
6. Armature
7. Control reservoir
8. Exhaust port



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9. Servomotor
10. Piston
11. Axis
12. Actuating rod
13. Insulator
14. Fixed Jaw
15. Mobile Jaw
16. Flexible shunt
17. Source of supply
18. Receiver 19. Blow out coil 20.Arc chute

Probable failures in EP contactors:

LT SIDE:

1. Cut in control circuit.
2. Less Battery voltage.
3. Defective control switch.
4. Fuse blown out.
5. Defective coil.

HT SIDE:

1. Cut in high tension circuit
2. Defective flexible shunt

MECHANICAL SIDE:

1. Mechanical jamming of contactor.
2. Defective driving mechanism.
3. Welded/ melted/pit marks/globules on contacts.
4. Improper closing of contactor.

PNEUMATIC SIDE:

1. Less/No/Heavy leakage of air pressure

Note: The minimum required pressure for closing of EP contactor is 5 kg/cm^2.

All these contactors are located in HT compartment.

Rated Voltage Main Circuit : 1270 Volts of DC
Rated Voltage Control Circuit : 110 Volts of DC
Rated Current Main Circuit : 1000 Amps
Rated Air Pressure : 9 kg/cm^2.

These Contactors are used for forming the circuit of the Traction Motors. Line Contactors L1 to L6 are used to connect the motors in circuits. These Contactors are designed to open at off load. Auxiliary inter locks are provided to the Contactors, wherever necessary. These interlocks ensure the sequence of operations in the different circuits.

DRUM CONTACTOR

Drum contactor is closed and opened with the rotation of a Drum. The Drum is made up of an insulated material. The movable contact is in the form of copper segment, which is fitted on the drum. These contactors are always operated on no-load, hence arc-chutes are not required.

The reversers J1& J2 provided in Loco are Drum contactors. From CAB1 leading direction, the manual operating handles of both J1& J2 should be upward. When MPJ is moved to 'F' position from 'O' position. When MPJ is moved to ' R ' from ' O ', both the reversor J1& J2 should be thrown to downward direction and the CAB2 is in the leading direction.

The CTF 1, 2, 3 Drum Contactors are having two positions (i) Motoring or Traction, (ii) Braking

When MP is on motoring side, the CTFs are thrown upwards and when MP is on Braking side, the CTFs are thrown downwards. For ensuring the position of operation, manual operating handle is also provided.

CAM CONTACTOR

Cam contactor is opened or closed by the position of cam with movable contact. Since the cam is used as 'Driving Mechanism' it is called as Cam Contactor. The cam contactors can be operated by SMGR or manually with a handle.

While progression or regression of notches any of 3 CGRs should be closed to avoid intermittent supply. So, minimum one CGR should be in close position at any notch. When the roller is in the cavity, the movable jaw gets lowered and CGR gets opened. When the roller is on projected surface of the cam, the CGR gets closed as the movable jaw lifts up. By means of an auxiliary contact [cam contact] the GR position is indicated in Loco Pilot's Desk by pilot lamps. Heavy ARC-CHUTES are provided with locking clips on either sides, as heavy arcs are formed while opening the CGRs. TFPs gets supply from TFWR through CGRs. CGR 12&3 are located in HT2 compartment.

Notch Number	CGR1	CGR2	CGR3
0	OPEN	CLOSE	CLOSE
1/2	CLOSE	CLOSE	OPEN
1	CLOSE	OPEN	OPEN
1½	CLOSE	CLOSE	OPEN
2	OPEN	CLOSE	CLOSE
2½	CLOSE	CLOSE	OPEN
3	CLOSE	OPEN	OPEN

Rng : 3.9

RELAYS

Relay: Relay is a device, which conveys the information regarding proper working of apparatus to the operator or may cut off the supply.

Relays are of two types. They are

I. Electrical relays

II. Mechanical relays

I. ELECTRICAL RELAYS: The relay, which gives information about any abnormality in the concerned device in a closed circuit, is called electrical relay. It checks the intensity / tension in the circuit.
These are classified as;

a. Current Relays
b. Voltage Relays
c. Signaling Relays
d. Control Relays
e. Special type of relays

a. Current Relays: These relays are connected in series to the circuit and remains in de-energised condition, during the normal working of the circuit. In case of any abnormality in the circuit, this relay will energise.

In Electric Traction locomotive there are two types of current relays. They are

i. Over current relays
ii. Differential current relays

i) Over Current Relays: when the current flow is normal in the circuit, this relay remains de-energise and keeps its normally closed interlock in closed position along with the circuit. If the current flow is increased beyond the safe working limit, the relay will energise and opens it's N/C I/L in the control circuit, so the receiver stops working duly tripping DJ or causes auto regression.

In our locomotive, over current relays are – QLM, QLA, QRSI1, QRSI2, QE, QF1 & QF2.

a. QLM: It is an over current relay provided in the feeding circuit to protect the TFWR from the damages of over current, flowing in the circuit. It is connected to roof bushing bar between DJ and TFWR with a current transformer TFILM (Main Load

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Intensity Transformer). The physical location of this relay is in Relay Panel (TR) on the top row.

Normally, this relay will be in de-energised condition. So, it's normally closed interlock (N/C I/L) on the MTDJ branch of DJ control circuit will be in closed condition. In the event of over current, i.e. more than 325 Amps, this relay gets energised and opens its N/C I/L on MTDJ branch. There by opening the MTDJ coil circuit, which results in tripping of DJ and disconnects the supply from the source and thus TFWR is protected from the effect of over current. Whenever this relay is energised, a red target will be shown on the face of the relay, which is visible through glass window, there by indicating that this relay caused tripping of DJ.

b. QLA: It is a over current relay provided in the auxiliary power circuit. It is connected on the 'V' phase in series between TFWA and ARNO. This relay will be in de-energise position, normally and it's N/C I/L remains closed on the MTDJ branch of DJ control circuit for providing continuous path to MTDJ branch. This relay is physically located in relay panel (TR) on the top row.

In the event of over current (Exceeds 1400Amps.) in the Auxiliary Power Circuit, this relay gets energised and opens it's N/C I/L on the branch of MTDJ resulting in tripping of DJ, thus isolating source of supply and protecting the auxiliary power circuit from over current. Whenever this relay is energised, a red target will be shown on the face of the relay, which is visible through glass window, there by indicating that this relay caused tripping of DJ.

c. QRSI 1 & QRSI 2: These are over current relays, for Traction Power Circuit number 1 and 2, respectively, from over current. They are connected in the Traction Power Circuit between the respective TFP secondary winding RSI blocks i.e. relay QRSI1 is connected between TFP secondary winding 1 and RSI1 and QRSI2 is connected between TFP secondary winding 2 and RSI2.

RSI1 feeds traction motors 1, 2 & 3 and RSI2 feeds Traction Motors 4, 5 & 6. These relays are located in relay panel. The normal position of these relays is de-energise and their N/C I/Ls on MTDJ branch of DJ control circuit will be in closed position.

When ever over current flows through RSI block (Exceeds 3600 Amps.), the QRSI relay energises and open it's N/C I/L on

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MTDJ branch of DJ control circuit, causing tripping of DJ. Thus isolating the source of supply and protecting and circuit from the over current. When any one of these relay is energised, a red target will be shown on the face of the concerned relay, which is visible through glass window, there by indicating that this relay caused tripping of DJ.

d. QE: It is an over current relay provided in Rheostatic Braking circuit. It will remain in de-energises condition, normally. During Rheostatic Braking, when ever the draw of current into ATFEX (Exceeds 900 Amps.), this relay gets energised and causes de-energising of Q 50 by which, auto regression of GR takes place. It is located in the relay panel.

e. QF1 & QF2: These are over current relays provided in the Rheostatic Braking (RB) circuit (QF1 is connected on TM1 and and QF2 is connected on TM4). Whenever the current fed to the RFs exceeds 650 Amps., the concerned relay will get energised and causes de-energising of Q 50, by which, auto regression of GR takes place. These two relays are physically located on HT3 compartment.

ii) Differential Current Relay (QD): In WAG5 loco, there are two differential current relays called as QD1 and QD2. QD1 is connected in Traction Power Circuit number 1, between TM2 and TM3. QD2 is connected in Traction Power Circuit number 2, between TM 4 and TM 5

The physical location of QD1 is BA1 panel of HT1 compartment and QD2 is in BA2 panel of HT3 compartment. These relays senses the flow of current in the Traction Motors to which they are connected and if there is a difference of flow of current by more than 150 Amps. between the two TMs, to which the QD is connected, the concerned relay will energise and causes 3 actions through Q48 relay. They are…

1. When QD energises its N/O I/L closes on Q48 relay branch. So, relay Q48 will energise, there by it's N/O I/L will close on Q51 branch. Now, relay Q51 (Auto Regression relay) will energise, which will cause auto regression of GR.
2. Another N/O I/L will close on relay Q48 branch. So, Q 48 will energise and it's N/O I/L will close on VESA coil branch, causes auto Sanding.
3. Because of Q48 is energised, it's another N/O I/L will close on signaling lamp LSP branch. So, LSP lamp will glow on the Loco Pilots desk for giving indication.

NOTE: When QD is de-energised, Auto Regression will be stopped and LSP extinguishes, but auto sanding will not be stopped as Q 48 is having time delay of 5 Seconds.

b. Voltage Relays: This relay checks the tension of the source of all the receivers in the circuit to ensure proper working of equipment.

These voltage relays are of 3 types. They are…

i. Over voltage relay

ii. No or Low voltage relay

iii. Earth fault relay

i) Over Voltage Relay (Q20): It is an over voltage relay, which protects the Traction Motors from over voltage. It is connected across RSI1 block between positive and negative terminals. When applied voltage to the Traction Motors exceeds 865volts., this relay gets energised and closes its N/O I/L on auto regression relay Q51 branch and there by relay Q51 energises, in turn its normally open interlock (Q51 N/O I/L) closes on regression coil VE2 branch and causes auto regression of GR.

As the GR notches are reduced the voltage also will be reduced. When the voltage is reduced below 740volts, this relay will de-energise and stops auto regression.

This relay is located in BA3 panel in HT3 compartment.

ii) No Or Low Voltage Relay (Q30): This relay provides protection to the auxiliary power circuit and equipment in the event of No or Low voltage in OHE.

This relay is connected across TFWA between U and V phases. This relay energises as soon as TFWA is energised and it's N/O I/L closes on Q44 branch of DJ control circuit providing path to the relay Q44.

In case of No or Low voltage in the OHE (17.5 KV or below), this relay will de-energise and opens it's N/O I/L on Q44 branch, there by Q44 will de-energise. As a result, Q44 N/O I/L will open on MTDJ branch of DJ control circuit and trips DJ, thus providing protection to the circuit and equipment from possible damages due to No or Low voltage.

This relay is located in relay panel.

iii) Signaling Relays (QV60, QV61, QV61, QV63 & QV 64):

These relays are provided for signaling lamps, which are provided on Loco Pilot's desk on both the cabs. These are called as pilot lamps also. Whenever any abnormality takes place in any equipment of the loco, concerned signal relay will actuate through the equipment and that circuit will energise or de-energise, in turn opens or closes thus interlocks in various branches of signaling lamp

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circuit. As a result the signaling lamp will glow or Extinguish and indicates the operator about the effective or defective equipment.

The particulars of the pilot lamps and their controlling signaling relay are

1. QV60: LSDJ
2. QV61: LSCHBA
3. QV62: LSGR
4. QV63: LSRSI
5. Q48 : LSP
6. QV64: LSB

IV) Control Relays (Q100, Q50, Q49, Q52, Q51, Q52):

Q100: It is a control relay for auxiliaries control circuit. It energises when the following condition are fulfilled.

1. CCA fuse in good condition.
2. DJ is in closed condition.
3. C118 is opened and it's chronometric interlock closes on auxiliary circuit.

If, these conditions are fulfilled, relay Q100 energises and closes it's N/O I/L on Compressors, Exhausters and Blowers control circuit, for closing of concerned contactors, C101, C102, C103 on Compressors control circuit, C 121, C111 on Exhausters control circuit and C107, C 105, C 106 on Blower control circuit.
Without energising the relay Q100, the above said remote controlled auxiliary motors will not work.

Q50: (Supervisory Relay):

This relay will energise only when Traction Power Circuit is properly set to Traction or Braking side and allows either to Traction (Motoring) or braking. If the Traction Power Circuit is not properly set, this relay Q50 will not energise and therefore it does not allow braking or motoring operation. When Q50 is energised it causes relay QV64 to de-energise and LSB lamp will be extinguished on Loco Pilot's desk.

Q52 (Notch-by notch progression/ regression Relay) :

Normally, this relay will be in de-energise condition. It will energise only when graduator is in between notches and opens it's N/C I/Ls on VE1 & VE2 coil branches. When MP is kept in '+' or '-' position, only one notch progression or regression will takes place, by the action of Q 52 relay in between the notches. When MP is kept in '+' or '-' position, relay Q52 will be in energised condition

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permanently and further progression or regression will not take place. When MP is kept in '+' position, one notch progression takes place and if kept in '-' position, one notch regression take place – because of this relay.

Q51 (Auto Regression Relay):

This relay will be normally in de-energised condition. This gets feed from CCPT through 4 relay interlocks (Q48, Q20 & QRS,PR2). Whenever any of these relay interlocks closes on Q51 branch, this relay will energise and it's N/O I/Ls are provided on "VE2" parallel branch will close and VE2 will get energise. Hence, auto regression takes place.

Protection Relays (Q118, Q44, Q46, QCVAR):

These relays will trip DJ whenever there is any abnormality or non functioning of any motor or relay or I/L on Q118 branch.

Q118: It is auxiliary protection relay.

Q44: It is GR Half notch protection relay.

Q46: It is GR full notch protection relay.

QCVAR: It is ARNO protection relay.

e. Special type of relays

a) Earth fault protection Relays
b) Time lag Relays
c) Time delay Relays

a) Earth fault protection Relays: Earth fault relays are connected to the power circuit to detect earth fault and protect the circuit by cutting of the supply by opening DJ. One terminal of the relay coil is connected to the positive level of the battery and the other terminal is connected to the negative side of the power circuit.

Whenever there is an earth fault in the power circuit the battery current will flows through these relays. These relay coils in the power circuit will now find path to complete the circuit on the negative side of the battery through earth in the loco. The loco body is taken as earth for all purposes.

Eg : QOA, QOP 1 & QOP 2

i) QOA: It is an earth fault protection relay for Auxiliary Power Circuit, which protects the circuit in the event of any earth fault. This relay will normally remain in de-energised condition keeping its N/C I/L closes on MTDJ branch of DJ control circuit. One end is connected to the battery positive and the other end is connected to the Neutral of ARNO. This relay is located in the relay panel (TR). In the event of earth fault in the auxiliary power circuit, the battery current flows through relay coil into the auxiliary power circuit and enter the loco earth, through body, thereby completing the circuit on

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the negative side of the battery through HOBA switch. So that this relay energises and opens it's N/C I/L on MTDJ branch and trips DJ. Thus isolating the source of supply, which, protects the Auxiliary Power Circuit from earth fault damages. Whenever this relay is energised, a red target will drop on the face of the relay, which indicates that this relay is caused tripping DJ.

ii) QOP 1 & QOP2: These are the earth fault relays for Traction Power Circuits. The relay QOP1 is connected in Traction Power Circuit1, consisting of RSI1, SL1, J1,Traction Motor 1,2 & 3, etc. QOP2 is connected in Traction Power Circuit2, consisting of RSI2, SL2, J2, Traction Motors 4,5 & 6, etc. These relays are provided to protect the Traction Power Circuits from earth fault. These relays normally remains in de-energise condition, keeping their N/C I/L closing on MTDJ branch of DJ control circuit. When earth fault takes place in the Power circuit, concerned relay will energise, causes opening of it's N/C I/L on MTDJ branch, to trip the DJ, by which Power Circuit is saved from earth fault. One end of QOP1 is connected to positive level of battery and the other end is connected to negative level of RSI1 block. One end of QOP2 is connected to the positive of battery, and the other and is connected to the negative of RSI2 block. The physical location of these relays is in relay panel.

In the event of any earth fault in the Traction Power Circuit, the battery supply flows through QOP relay coil into the Traction Power Circuit through RSI negative, will find path through loco both through battery negative and HOBA switch there by the QOP relay gets energised and opens its N/C I/L on MTDJ branch of DJ control circuit and causes tripping of DJ. Thus the relay is provided to protect the Traction Power Circuit from earth fault.

Whenever this relay energises it drops a red target on its face, which indicates that the relay causing tripping of DJ.

VI. Special type of relays

Other than current relays and voltage relays, there are some other relays, which are used for different purposes. They are

a. Time lag relays, b. Time Delay relays

a) Time lag relays (Q 118 & Q 44): These are core temporised relays which retains residual magnetism. Therefore doesn't de-energise immediately after cutting off supply and they will de-energise only after certain time lag (according to the set time). The time lag of Q118 is 5seconds and the time lag for Q44 is 0.6seconds.
b) Time Delay relays (QTD105 & QTD106): These relays are intended for delayed closing of circuit. These Relays are used for delayed

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starting of few auxiliary Motors. There is a cascade operation of 3 auxiliaries (3 phase induction motors) in which when controlling switch BLVMT is closed, the auxiliaries MVRH, MVMT1 & MVMT2 starts through their respective 3 phase contactors C107, C105 & C106.

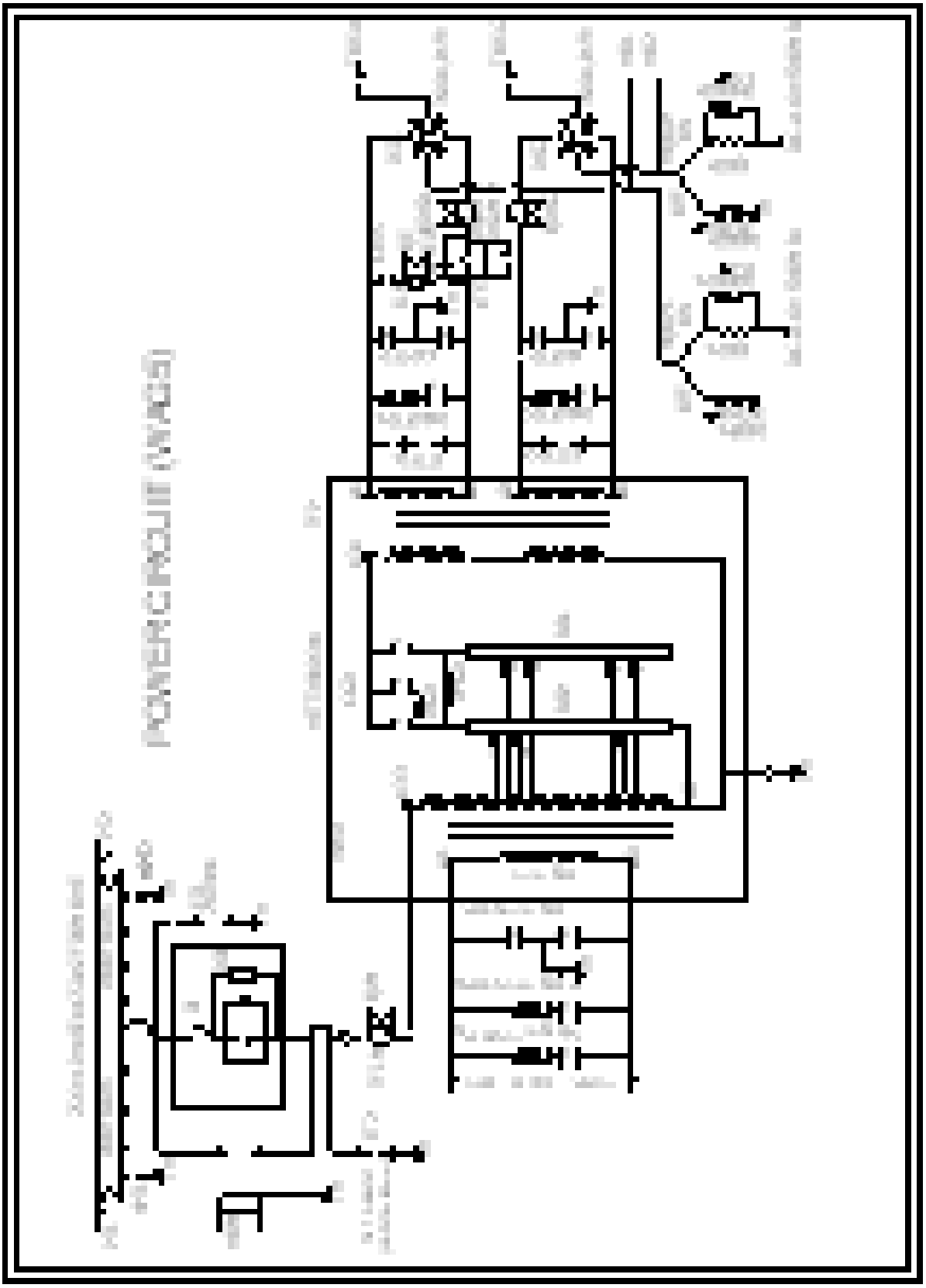
If these auxiliaries start at a time The initial supply drawn by them will cause over load on ARNO. To avoid over load, the time delay relays QTD105, QTD106 are introduced in the control circuit, so that after closing of C107, MVRH motor will start and the relay QTD105 will also energise with a time delay of 8seonds from the time C107 contactor closes, thereby the interlock of relay QTD105 will close on contactor C105 coil and the contactor closes, thus the time delay of 8seconds is ensured between MVRH and MVMT1 motors starting. Similarly C105 interlock closes on QTD106 coil and QTD106 will energise after a delay of 8seconds and closes it's interlock on C106 branch, hence C106 closes and MVMT2 motor will start working. Thus a time delay of 8seconds is maintained between starting of MVMT1 and MVMT2. By this arrangement it is ensured that these blower Motor contactors closed when BLVMT switch is closed doesn't starts at a time and they will start with a time interval of 8seconds between each motor starting, thereby overloading on ARNO is avoided.

II. MECHENANICAL RELAYS: Mechanical relays are again classified in two types. They are

a. Pressure Relays, b. Circulation Relays

a. Pressure Relays : They are QPH, QPDJ. QPH is the pressure relay provided on delivery pipe line of MPH. It ensures that the TFP oil is pumped with sufficient pressure. QPDJ is a pressure relay provided on the pneumatic pipe line of the DJ. It will ensure that the sufficient pressure is available in the system. It's contact closes when the pressure is 5.5Kg/cm^2, and opens when the pressure is reduced to 4.5Kg/cm^2. Unless the QPDJ is energised, DJ can not be closed. When QPDJ is de-energised, it's interlock will open on MTDJ branch of the DJ control circuit and trips DJ.

b. Circulation Relays: QVSI1, QVSI2, QVSL1, QVSL2, QVRH, QVMT1 and QVMT2 are the air circulation relays in our locomotive. When the concerned auxiliary is circulating the air properly, the concerned relay will energise and it's interlock will close on DJ control circuit. If air circulation is poor, that particular relay will de-energise, causes tripping of DJ.



Rng : 3.10

FEEDING POWER CIRCUIT

OHE supply is taken to main transformer by means of panto, roof bars & DJ etc. The OHE supply from the main transformer can be utilized for different purposes of the loco operations. From TFWR the supply is stepped down in auxiliary power circuit and is utilized for auxiliary operations. On the other hand, the supply as per requirement is rectified as DC and is supplied to traction motors for tractive effort.

Equipment provided in feeding power circuit:

1. Pantographs1&2.
2. HPT1 & 2.
3. Roof bars.
4. ET1 & ET2.
5. DJ assembly.
6. QLM & TFILM
7. Roof bushing bar / HT cable.
8. HOM.
9. Main transformer.
10. GR.

1. Pantograph: Two Pantographs are provided on the loco roof to collect OHE supply when raised and DJ is closed. Both pantographs are electrically connected by means of roof bars (6 fixed+ 2 hand operated).
2. HPT: It is hand operated roof bar. It is an isolation switch for pantograph which should be kept in earthing clip provided on loco roof when panto is damaged.
3. Roof Bars: Six fixed roof bars are available on loco roof to receive the OHE supply from panto to transfer to DJ. Cut in Roof bars causes no tension tripping failure. In WAP4 locos only four fixed roof bars are available.
4. DJ: It is a special type of EP contactor available on loco roof. It should be closed for energising TFWR. In case of any abnormality in loco, it trips automatically to avoid damages to the equipment and to protect the locomotive.
5. QLM: It is an over current relay provided in feeding power circuit. Due to any reason if feeding power circuit fed with the supply of 325/450 Amps or above, this relay energizes and trips DJ.
6. Roof Bushing Bar: It is used to receive the supply from DJ and send to main transformer. Its normal color is red. This

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colour should not be discolored especially at the time of QLM dropping. In place of roof bushing bar a HT cable is provided in some locos.

7. ET1: It is a surge arrestor located on loco roof to save the loco from surge voltages when DJ is in open condition. It is having two tips. One end of ET1 is connected to roof bar and other end is connected to earth (loco body). The gap between two tips is 210 mm.
8. ET2: It is provided to save the loco from surge voltages when DJ is in closed position. The gap between two tips is 70 to 90 mm (in case of 3900 KVA transformer) and 105 mm ((in case of 5400 KVA transformer).

   Note: On modified locos in place of ET2 gap less surge arrestor is provided.
9. MAIN TRANSFORMER: It is called as auto transformer and it is having 32 taps to get variable voltages. The transformer is immersed in oil tank for cooling. This oil acts as insulator as well as cooling between windings and the capacity of oil tank is 2000 Litres. One end of the transformer terminal is connected to roof bushing bar (A33 terminal) and other end is connected to earth through loco body (AO terminal). Transformer oil in the tank is circulated by MPH and cooled through radiator by MVRH. A conservator is provided on the top of the oil tank to indicate oil level present in the transformer tank. It should read above $+15^0$c(normal mark). An explosion door is provided on the top of conservator which opens in case of any short circuit in feeding power circuit. A breather is provided on the conservator for destroying the vacuum created inside the conservator due to expansion and contraction of oil. It also consists of silica gel to absorb moisture present in the air while being allowed into conservator. The transformer oil tank is placed between two trucks with a drain plug.
10. HOM: It is hand operated earthing switch provided on loco roof and operated from corridor No1. When this switch is operated main transformer and roof equipments are connected to earth and also electrical and pneumaTIC supply to pantographs is cut off and existing pressure from panto pipe line exhausts.
11. GR: Taps are connected to GR in two rows from auto transformer. Round shaped bus bars are provided in tap changer assembly by which GR rollers are made to rotate by the action of SMGR. Bus bar No1 is connected to CGR1 and bus bar No2 is connected to CGR2 through RGR and CGR3. Bus bars are immersed in GR oil (GR oil sump capacity is 70 liters at 40^0C). GR oil is circulated by PHGR. This PHGR works from 6 to 32 notches. A breather is provided near GR

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drum for destroying the vacuum created inside the GR assembly due to expansion and contraction of oil. It also consists of silica gel to absorb moisture present in the air while being allowed into GR drum. Two GR safety valves are provided, which will send out the undue pressures developed in the oil. SMGR is provided to operate GR which can be remotely operated from Loco Pilot's desk by MP or EEC. If MP / EEC failed, operate GR manually. An oil gauge is provided on left side of tap changer which should read between $+20^0$c and -20^0c.

12. RGR: It is a short time resistance, which comes into service when GR is in between notches. It can with stand the supply for 0.5 seconds and it is connected between CGR2 and CGR3. The resistance value is 1.61 ohms.
13. RPGR: It is a permanent resistance to GR and connected between two bus bars. It is provided to make continuous flow of current to traction motors. Its resistance value is one lakh ohms.
14. CGR: CGR 1, 2, 3 are cam contactors provided in the power circuit to make or break the connections between TFWR and TFP. These contactors are operated by SMGR, which are remotely operated from Loco Pilot's desk through MP/EEC. These contactors are having arc chutes. Crew should ensure that the arc chutes are connected properly. These contactors operate in the following manner.

NOTCH POSITION	CGR1	CGR 2	CGR 3
EVEN NOTCH (0,2,4,…)	O	C	C
HALF NOTCH ($1/2$, $1\,1/2$, …)	C	C	O
ODD NOTCH (1, 3, 5,…)	C	O	O

O = open and C = close

DEFECTS IN FEEDING POWER CIRCUIT

1. Defect/cut in feeding power circuit causes NO TENSION indication.
2. Due to any reason when ever over current flows in feeding power circuit then QLM relay acts and trips DJ.

When QLM is acted, act as following :

Note: Setting of QLM: HETT 5400 KVA TFR – 450 Amps. (WAG 7 & WAP 4) and HETT 3900 KVA TFR- 325 AMPS (WAG 5).

When QLM acted

1. The loco pilot should personally check the HT compartment for any smoke, smell or fire from transformer; tap changer, cgr1, 2&3 and their arc chutes, transformer terminals and roof bushings.
2. Check HT compartment for any oil splash from tap changer & transformer.
3. Check the condition of silica gel breather.
4. The loco pilot should personally look for any oil splashes from GR safety valves, tap changer and explosion door.
5. The loco pilot should check the under frame by getting down from the loco to see signs of oil leakage or flashes on the motor gear equipments.
6. In case of any abnormality is noticed such as smoke, smell, fire, oil splashes from any where or signs of flash over on the insulator, roof bushings etc., the loco pilot shall "not reset the QLM" and ask for relief loco.
7. In case no abnormality noticed, the loco pilot shall reset the relay once, and close DJ duly keeping the assistant loco pilot in the corridor in a position to observe any abnormality while closing DJ.
8. In case any smell, smoke or fire noticed, the assistant loco pilot shall shout to the loco pilot immediately to trip DJ and ask for relief loco.
9. In case no abnormality is noticed on re closing DJ, loco pilot shall work the train duly advising the assistant loco pilot to check the ht compartments for any abnormality, for every 15 minutes till the train reaches the destination/ terminal station
10. Clear remarks should be made in loco log book with particulars like GR position, TM ammeter and voltmeter readings, OHE voltage, km no. and time of QLM dropping
11. Inform TLC through en route station master with the help of walkie-talkie.
12. After reaching the destination, the loco pilot shall report all the details personally to the TLC.
13. The loco will be withdrawn from service and check for any abnormality as per extent procedure on reaching destination/ terminal station before offering for service

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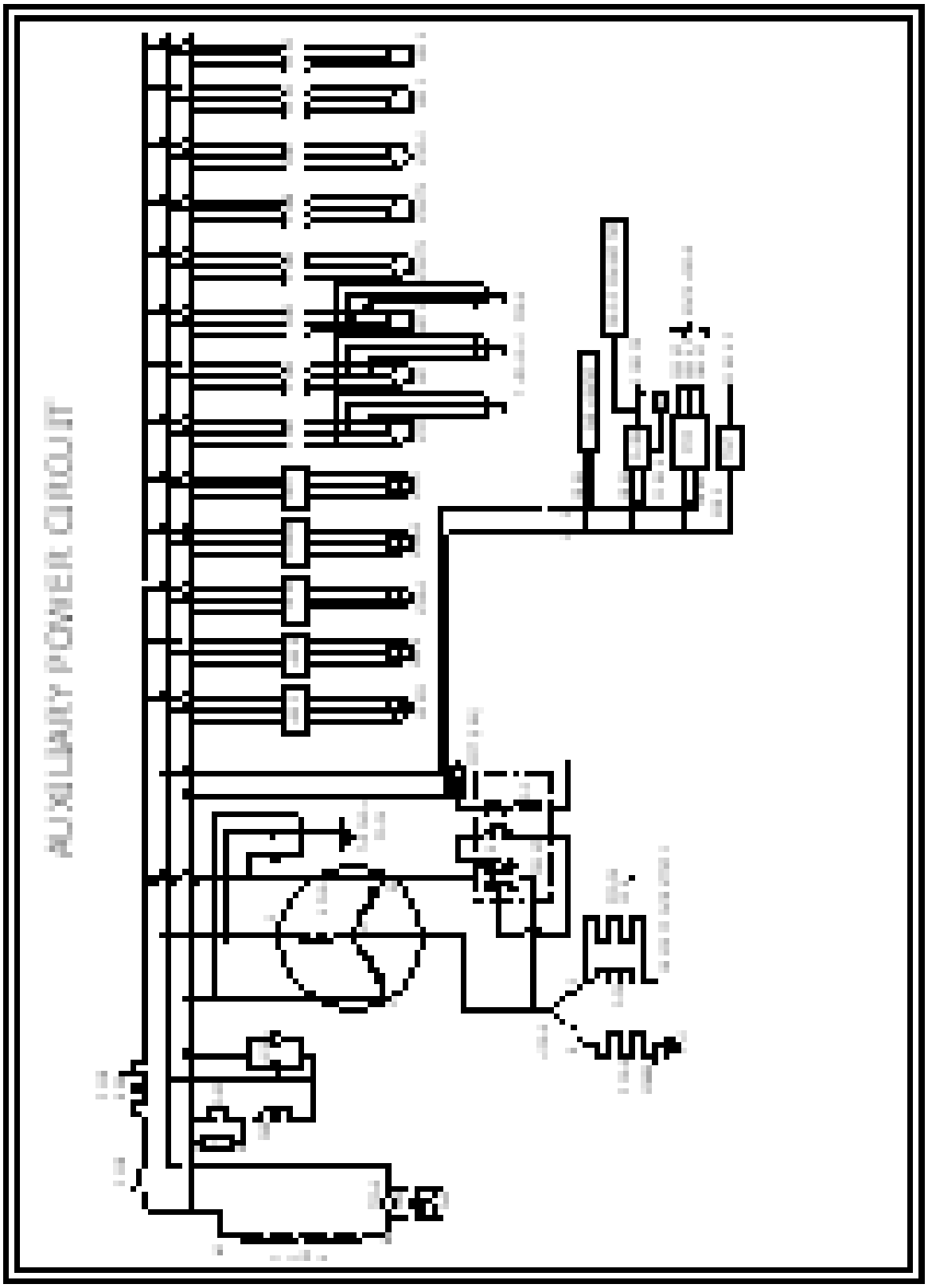

AUXILIARY POWER CIRCUIT

Rng : 3.11

AUXILIARY POWER CIRCUIT

Main transformer consists of auxiliary winding (TFWA) as it's secondary, provided to feed auxiliaries load. The supply of TFWA is single-phase 380 V±22.5%. ARNO converter is provided to convert the single phase AC to three phase AC to auxiliary motors and other loads.

ARNO Converter:

The single-phase supply of 380 volts AC is fed direct to the U and V phases of the ARNO converter. Since the ARNO Converter is connected to single-phase supply, no starting torque is developed. For starting the ARNO a split phase starting method has been employed. The W phase winding is connected to the supply phase U through a starting resistor R-118(0.4 Ohms) and starting contactor C-118 for a short duration to start the ARNO. Thus unbalanced three-phase voltage is impressed to each phase winding of ARNO Converter and the starting torque is developed. The ARNO Converter picks up speed within 4 seconds. After the ARNO has gained sufficient speed, the phase W is opened from the starting circuit by starting contactor C-118. If the starting phase fails to open within 4 seconds after ARNO gained its rated speed, there will be excessive vibration of the ARNO and causes Overheating of the ARNO. An interlock of relay QCVAR opens C-118 coil circuit, to protect against overheating.

The neutral point '0' of the ARNO is connected to an earth fault relay QOA, which performs the same function as the relay QOP, in traction power circuit. The relay QOA trips the circuit breaker (DJ) of the locomotive in the event of an earth fault in the auxiliary circuit. The switch HQOA and RQOA perform the same functions as the switch HQOP and resistor RQOP in traction power circuit. In addition, a resistance RPQOA permanently shunts the relay QOA.

The ARNO converts the single-phase input of 380V into 3-phase output as 380V± 22.5%. The ratio of negative sequence voltage to positive sequence voltage is within 5%. The 3-phase output of the ARNO converter is connected to the auxiliary motors. ARNO is provided with capacitors bank to absorb any surge voltages produced by it.

UA1 and UA

These are the voltmeters to indicate the auxiliary voltage and OHE voltage. UA1& UA2 are located in cab-1&2 Loco Pilot's desks respectively.

C-118

This is a single phase EM contactor provided to connect U phase to W phase winding through R118 resistance for 2 to 3 sec till ARNO picks up rated speed. The contactor will be normally open condition. Before closing DJ, contactor C118 is kept closed and it is opened automatically by the action of relay QCVAR to suppress the starting phase to the ARNO.

No or Low Voltage Relay (Q30)

Relay Q-30 is a low or no voltage relay and drops out, if the output of single-phase auxiliary winding voltage drops below 260 V. Its I/L opens on relay Q44 branch and trips DJ. When the OHE voltage reaches to 215 V while closing DJ, the relay Q30 will energise. It protects the loco equipment from no or low voltage. Initially this relay energises through Q45 N/O I/L, after releasing BLRDJ path is maintained through RQ30.

ARNO Protection Relay (QCVAR)

Relay QCVAR is a protection relay for ARNO to ensure proper working. It is connected across W phase and neutral phase of ARNO. When ARNO picks up its rated speed and voltage across W phase reaches 155-160 V AC, QCVAR is energised and opens starting phase by opening the contactor C118, and also when QCVAR is energised, it’s N/O I/L closes on Q118 branch and N/C I/L opens on LSCHBA branch.

Over Current Relay for Auxiliary Power Circuit (QLA)

The Relay QLA is fed by means of the current transformer (TFILA) which causes the DJ to trip, if the current taken in by the auxiliary winding exceeds the setting value of 1400A in case of WAG5 loco and 2000 Amps in WAP4 & WAG7 locos.

Earth Fault Relay for Auxiliary Circuit (QOA)

It is a safety relay for the protection of auxiliary power circuit against earth fault. If there is any earth fault in auxiliary power circuit, the relay QOA will energise and trips DJ. The switch HQOA makes it possible to isolate the relay it through a resistance RQOA in order to limit the fault current. One terminal of QOA is connected to ARNO neutral phase and another terminal is connected to battery positive.

Blower Motor For Silicon Rectifier (MVSI 1&2)

Each rectifier cubicle is provided with one blower, which is driven by the motor MVSI. The motors of rectifier cubicle are controlled by means of switch HVSI 1&2 which are provided on RSI 1 & 2 blocks respectively. The cooling of rectifier is monitored by the airflow relay QVSI 1&2. The interlock of QVSI 1 &2 are connected in series with relay Q44. In the event of any MVSI 1 & 2 fails to work, respective air flow relay QVSI does not pick up and its interlock opens on Q44 branch causing de energisation of Q44 in turn trips DJ. Incase MVSI 1 & 2 are working normal and QVSI1 & 2 relays found defective, respective relay can be by-passed through HVSI 1&2 switches. These are directly start motors along with ARNO. This is an axial flow motor with 2.2 K.W capacities.

Following are the positions of HVSI switches:

Position 0: - QVSI and MVSI isolated
Position 1: - QVSI and MVSI in service
Position 2: - QVSI in service and MVSI isolated
Position 3: - MVSI in service and QVSI isolated

Blower Motor for Smoothing Reactor (MVSL 1&2)

These motors (MVSL1&2) are used for cooling smoothing reactor 1& 2. Proper working of motors (MVSL1&2) can be ensured by airflow relays QVSL1&2 respectively.

The switches HVSL1&2 are provided on the TB board for controlling working of Motors & relays. Whenever any blower does not work, respective relay de-energises and trips DJ through relay Q118.These are directly start motors along with ARNO. This is an axial flow motor with 2.2 K.W capacity. Following are the positions of HVSL switches:

Position 0: - QVSL and r MVSL isolated
Position 1: - QVSL and MVSL in service
Position 2: - QVSL in service and MVSL isolated
Position 3: - MVSL in service and QVSL isolated

Oil Pump for Circulating of Transformer Oil (MPH)

The purpose of this motor is to drive the oil pump to circulate transformer oil. A relay QPH is provided to check working of the oil pump. QPH is a pressure relay provided on the pipeline of the oil circulating system of transformer in the H.T compartment. When the pump is not working properly, the relay causes tripping of DJ. HPH is provided on TB board for controlling MPH and QPH .The MPH is a directly start motor and starts along with the ARNO.

Following are the positions of HPH switch:

Position 0: - QPH and MPH isolated

Position 1: - QPH and MPH in service

Position 2: - QPH in service and MPH isolated

Position 3: - MPH in service and QPH isolated

Main Compressors (MCP 1, 2, 3)

The purpose of these compressors is to build up compressed air required for various purposes in the locomotive. These motors starts working through contactors C101, C102, C103.These contactors can be switched ON by switch BLCP (automatic) or by BLCPD (direct) on the Loco Pilots' desk.

Main Compressor Governor RGCP is provided to regulate the working of the compressor by opening and closing the contactors at preset value (closes at 8 kg/cm^2 and opens at 9.5 kg/cm^2). A direct switch BLCPD is provided to by pass RGCP and to make compressors to work continuously to build up pressure until Safety valve (SS2) blows at 10.5 kg/cm^2. Compressors can be selected according to requirement through HCP.

Exhausters (MPV 1-2)

The Exhausters MPV 1 & 2 are provided for creating and maintaining Vacuum on train pipe. These motors starts working through the remote control switch BLPV. When BLPV is closed, according to ZPV positions, MPV-1 or MPV-2 will work. MPV-1 starts working by closing C-121 Contactor and MPV-2 by closing C-111 Contactor. These exhausters are provided with oil sumps for lubrication and provided with dipstick to check the oil level in the sump.

Blower for Cooling Transformer Oil (MVRH)

The transformer oil cooling blower motor is provided for cooling the transformer oil in the radiator. On closing BLVMT first C-107 contactor closes and MVRH starts working. There is a relay QVRH to check the proper functioning of this blower. Switch HVRH is provided on TB board for controlling MVRH and QVRH. Switch HVRH has four positions same as HVSI.

Blower Motors For Traction Motor (MVMT 1-2)

These blower motors (MVMT-1&2) are required to cool the traction motors in bogie 1 and 2 respectively. MVMT-1 starts working through C-105 contactor and MVMT-2 starts working through C-106 contactor. The switch BLVMT is common for starting MVRH, MVMT 1 &2. The blowers will start one after the other with a time delay of 8 Sec with the help of QTD 105 and QTD 106. Airflow relays QVMT 1&2 are provided to check the proper functioning of these blowers. If the blowers are not working properly, the particular relay interlock will open on Q118 branch of DJ control circuit and trips the DJ. Switches HVMT 1&2 are provided on TB board for controlling MVMT 1&2. Switch HVMT 1&2 has four positions same as HVSI.

Horse Powers Of Three-Phase Ac Induction Motors

Type of Motor	Horse Power	Kilo Watts
MPH	4	3
MVSL 1 & 2	3	2.2
MVSI 1 & 2	3	2.2
MVRH	30	22
MVMT 1 & 2	35	26
MCP 1, 2 & 3	14.5 HP(for 1000 LPM)and 27 HP (for 2000 LPM)	10.4(for 1000 LPM) and 20.5(for 2000 LPM)
MPV 1 &2		

AUXILIARY POWER CIRCUIT EQUIPMENT - ISOLATION AND PRECAUTIONS

MPH:

When MPH is failed, keep HPH on '0'. Ensure MVRH is in working order. Ensure TFP oil level is not increasing abnormally clear the section with restricted current rating 750A / 500A.

When relay QPH / MPH / PH is defective Loco Pilot will experience operation 'B' part I. So, keep HPH on 'O' and take necessary precautions as mentioned above as we cannot ensure the proper working of MPH.

MVSL:

When MVSL is defective, isolate concerned RSI block by keeping respective HVSI, HVMT & HVSL on '0' and work the train with normal current ratings and 50% of the maximum permissible load.

When relay QVSL / MVSL / VSL is defective Loco Pilot will experience operation 'B' part I. So, keep concerned HVSL on '3' position work the train further duly watching the working of MVSL frequently.

MVSI:

When MVSI is defective isolate concerned RSI block by keeping respective HVSI, HVMT & HVSL on '0' and work the train with normal current ratings and 50% of the maximum permissible load.

When relay QVSI / MVSI / VSI is defective Loco Pilot will experience operation-I. So, keep concerned HVSI in '3' position work the train further duly watching the working of MVSI, frequently.

MCP:

Three compressors MCP1, MCP2 & MCP3 are provided and controlled by HCP. VEAD is provided to drain out moisture from MR1 & MR2 through auto drain valves. If one CP is failed, Loco Pilot can isolate the same by changing HCP position. If MCP is burnt, relay QOA will drop. At that time isolate the defective MCP through HCP and ensure concerned contactor is opened fully other wise disconnect the cables of compressor at terminal box.

MPV:

Two exhausters MPV1 & MPV2 are provided and controlled by ZPV. This switch is provided to isolate defective MPV or to select required MPV.

MVRH:

MVRH is provided to cool transformer oil. If MVRH is not working Loco Pilot will experience DJ tripping through operation-O. When ever MVRH is isolated observe the restricted current rating of 750/500A duly observing the transformer oil level.

MVMT:

Two ventilation motors MVMT1 and MVMT2 are provided to cool TMs 1, 2, 3 & 4, 5, 6 respectively. If MVMT is failed Loco Pilot will experience DJ tripping through operation-O. If MVMT is burnt, DJ will trip through QOA. To isolate defective MVMT keep concerned HVMT on '0' and ensure concerned contactor is opened fully. If MVMT1/MVMT2 is isolated, isolate concerned RSI block and work the train with 50% of the maximum permissible load.

TROUBLE SHOOTING FOR QOA ACTING

1. DUTIES OF CREW IN CASE OF QOA DROPPING (TARGET CAN BE RESET):

   A. check the following auxiliary power circuit equipment for any smoke, burning smell, fire, high temperature or any abnormality.

      a0, a1 terminals, RCC panel, ARNO, Q30, RQ30, C118, R118, UA 1, UA2, QCVAR, MPH, MVSI-1&2, MVSL-1&2, power switches: HPH, HVSI-1&2, HVSL-1&2, CHBA, , RTPR, cab heaters, TFVT, TFS, EM contactors: C101, C102, C103, C105, C106, C107, C111, C121, remote controlled motors: MCP 1, 2& 3, MVMT-1&2, MVRH, MPV 1& 2 and capacitors banks of ARNO and MCPs.

   - If any thing found abnormal, isolate the equipment, reset the relay and resume traction.
   - If every thing is normal, reset the relay target, and resume traction.

   B. If QOA drops again after a long interval

      - Check auxiliary power circuit for any abnormality.

- If every thing is normal, reset the relay target and resume traction.

C. If QOA drops very frequently,

- Place HQOA on '0' position,
- Resume traction duly observing the auxiliary power circuit equipment frequently.

NOTE: If QOA drops while closing DJ check all auxiliary power circuit equipment for any abnormality (observe the following instructions)

a) If QOA drops while closing BLCP, check MCPs and C101, C102, C103 for any abnormality. If QOA drops while closing BLVMT, check MVRH, MVMT 1&2, and contactors C105, C106 & C107 for any abnormality.

b) If QOA drops while closing BLPV check MPV 1&2 and C111 & C121.

c) If any abnormality is noticed in the above equipment, isolate the defective equipment and resume traction.

- If un-successful contact TLC.

2. Duties of crew in case of QOA dropping (target can not be reset):

a) Check the auxiliary power circuit for any smoke, burning smell, fire or any abnormality. If any abnormality is found, isolate the equipment and resume traction.

b) If the target does not reset, keep the isolating switches HPH, HVSL 1&2, HVSI 1&2, and CHBA in '0', ZRT and BLRA 'OFF' one by one and try to reset the target.

c) If the target is reset, isolate the corresponding auxiliary motor and resume traction.

d) If un-successful place HQOA on '0' and resume traction duly observing the instructions.

Note

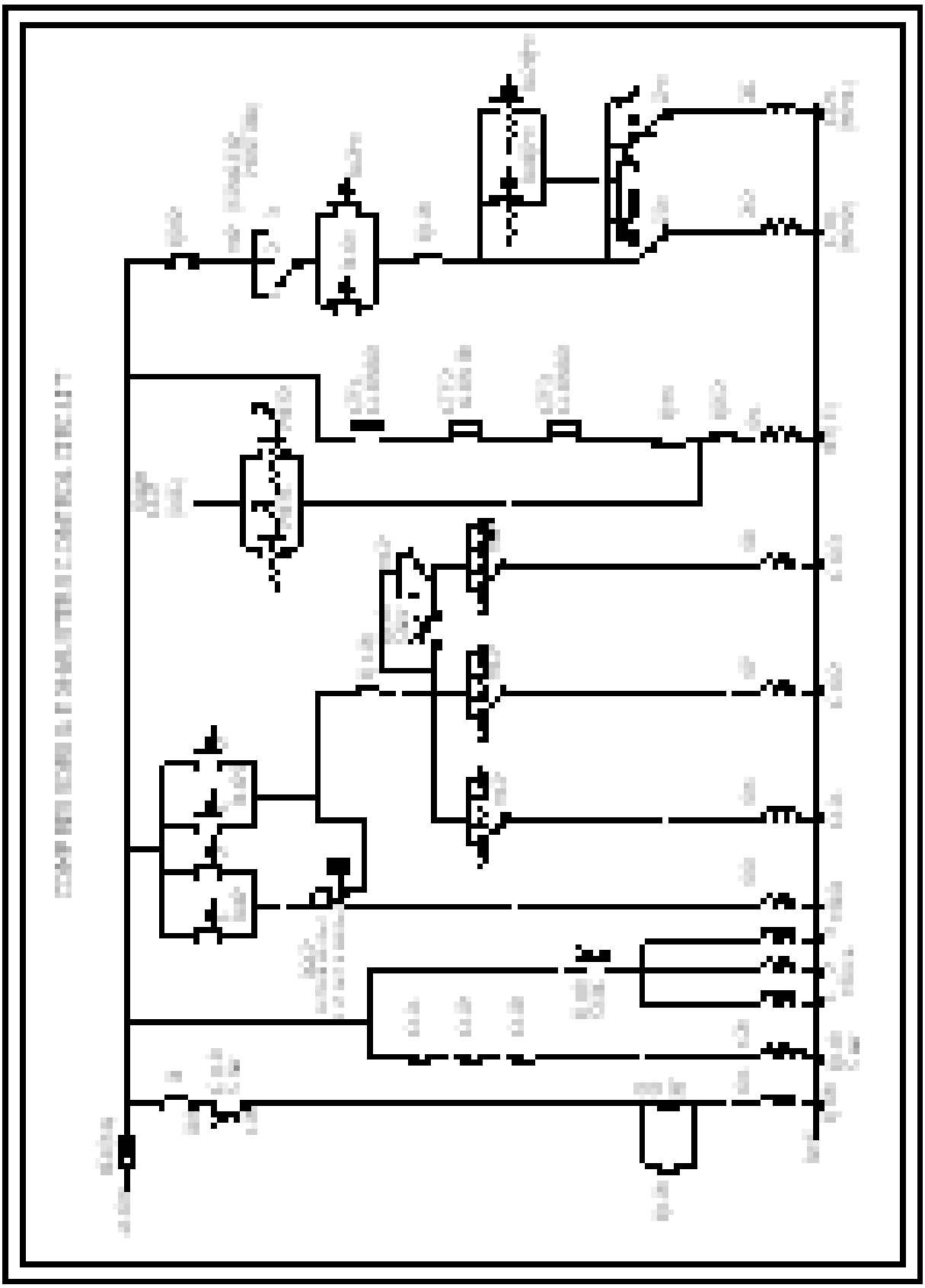
- If any auxiliary motor is burnt, place concerned isolating switch on '0' and ensure its contactor is opened fully.
- After isolating any equipment, inform to TLC.
- If QOA drops even after placing HQOA on '0', place HOBA in 'OFF' and try. If un-successful contact TLC.
- When HQOA is kept on '0' position depute assistant Loco Pilot for every 15 min. to watch for any abnormality in auxiliary power circuit equipment. Inform TLC at next stop and make remark in loco log book.

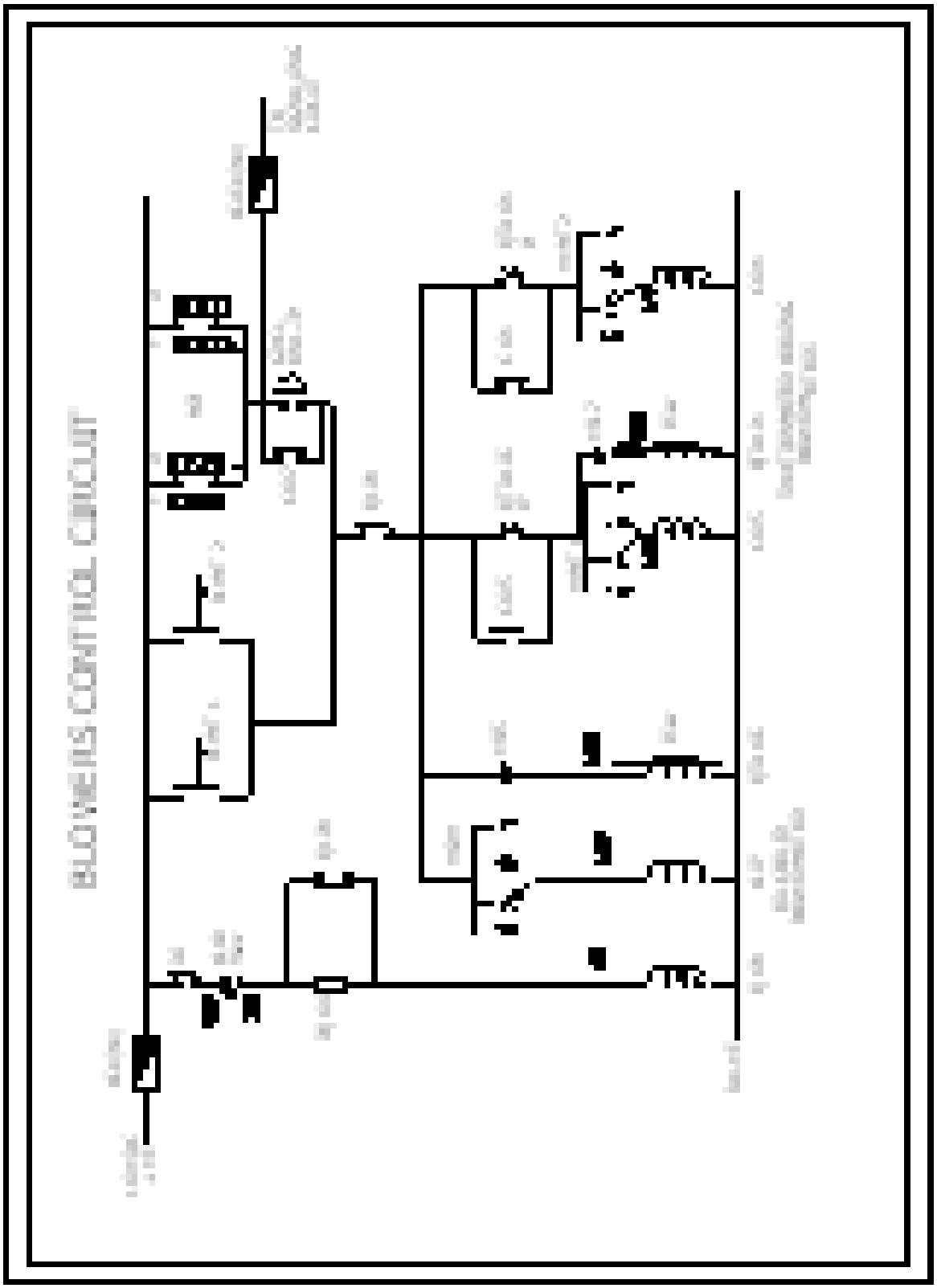
TROUBLE SHOOTING FOR 'QLA' ACTING

check the following auxiliary power circuit equipment for any smoke, burning smell, fire, high temperature or any abnormality.

a0, a1 terminals, ARNO, Q30, RQ30, C118, R118, UA 1, UA2, QCVAR, MPH, MVSI-1&2, MVSL-1&2, power switches: HPH, HVSI-1&2, HVSL-1&2, CHBA, , RTPR, cab heaters, TFVT, TFS, EM contactors: C101, C102, C103, C105, C106, C107, C111, C121, remote motors: MCP 1, 2& 3, MVMT-1&2, MVRH, MPV 1& 2.

a) If any abnormality is noticed in any equipment, isolate the same and resume traction.
b) If no abnormality reset the QLA, close DJ resume traction and find out QLA dropping occasions.
c) If QLA acts second time, check APC don't reset the relay, contact TIC.
d) If unsuccessful, contact TLC for advice.




BLOWER IS CONTROL CIRCUIT

RNG : 3.12

AUXILIARY CONTROL CIRCUIT

This circuit is intended to give 110 volts supply to the auxiliary motor contactor coils.

Q100 Branch :

This is auxiliary controlling relay. After closing DJ, this relay energizes through CCA fuse, DJ N/O I/L, C118 chronometric I/L and Q100 N/C I/L. Once Q100 is energised, N/C self-I/L opens and path is maintained through RQ100. Q100 is having three N/O I/Ls. One N/O I/L closes on compressors control circuit branch, second N/O I/L closes on exhausters control circuit branch and third N/O I/L closes on blowers control circuit branch.

Note: If EP C118 is provided, C118 chronometric I/L will not be available. To substitute this, Q100 is provided with time delay of 5 seconds, and named as QTD 100 / QTDX.

Blowers Control Circuit :

After closing BLVMT 1/2, all blower contactor's coils get supply through Q100 N/O I/L. First, C107 coil gets supply through HVRH switch closes on '1' or '3' position. Along with C107, QTD 105 also energizes through VS15 diode. QTD105 relay's N/O I/L close after 8 seconds on common path of C105, QTD106. C105 contactor closes through HVMT1 closes on '1' or '3' position. After closing of C105 it's N/O I/L closes on its same path to avoid chattering of contactor, this N/O I/L also used to give supply to QTD106 during wedging of C105 contactor (if QTD105 is not energised). Along with C105, QTD 106 also energizes through VS17 diode. QTD106 relay's N/O I/L close after 8 seconds on C106 coil branch. Third, C106 contactor closes through QTD106 N/O I/L and HVMT2 close on '1' or '3' position. After closing of C106 it's N/O I/L closes on its same path to avoid chattering of contactor.

Compressors Control Circuit :

After closing BLCP, compressor contactors coils gets supply according to HCP position through BLCP 1/2, RGCP I/L and Q100 N/O I/L. RGCP is provided to close the compressor contactors when MR pressure is 8kg/cm^2 or less and to open the compressor contactors when MR pressure is 9.5kg/cm^2 or more (cut in 8kg/cm^2 cut-out 9.5kg/cm^2). When pressure reaches to 9.5kg/cm^2, RGCP I/L opens on

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compressor contactors coils and closes on VEAD to drain out moisture from MR 1 & 2 through ADV 1& 2. Again VEAD de energizes at 8kg/cm^2 through RGCP. When compressor contactors are opened, through N/C I/Ls of C101, C102 & C103 time lag relay Q119 energizes. Through Q119's N/O I/L, Un-loader valves energize to remove the back up pressure from each CP delivery pipe. Q119 is also having one N/C I/L on last MCP contactor coil. This interlock is provided for late start of last MCP after 5 seconds when we select MCP3 along with any other MCP (parallel to this Q119 N/C I/L HCP switch closes on '3' position is also provided to start last MCP when it is only selected). To select required No. of MCPs switch 'HCP' is provided. This switch is having 8 positions (0, 1, 2, 3, 1/2, 2/3, 1/3 & 1/2/3). Switch BLCPD is provided to bypass RGCP interlock. When this switch is closed, RGCP interlock bypassed and compressor contactor coils will get continuous supply and MR pressure creates maximum up to 10.5 kg/cm^2..

Exhausters control circuit :

To close MPV contactors C111 or C121, HCP should be on '1' or '2' or '3' position, relay QRS2 should be in energize position, Q100 should be in energize position and BLPV should be in close position. To select the required MPV, a switch is provided called as ZPV. This switch is having 4 positions (1, 2, 3 & 4). When ZPV is in 1 or 2 positions and when BLPV & BLQPV are closed, both exhausters works to create vacuum faster in train pipe. 3 & 4 positions are called isolation positions. When Loco Pilot applies A9 to emergency, relay QRS de energizes and exhausters also stops working.

ZPV position	When BLPV closed	When BLQPV closed along with BLPV
1	C111 closes MPV2 works	C121 also closes
2	C121 closes MPV1 works	C111 also closes
3	C111 closes MPV2 works	Isolation position of MPV1 Only C111 closes
4	C121 closes MPV1 works	Isolation position of MPV2 Only C121 closes

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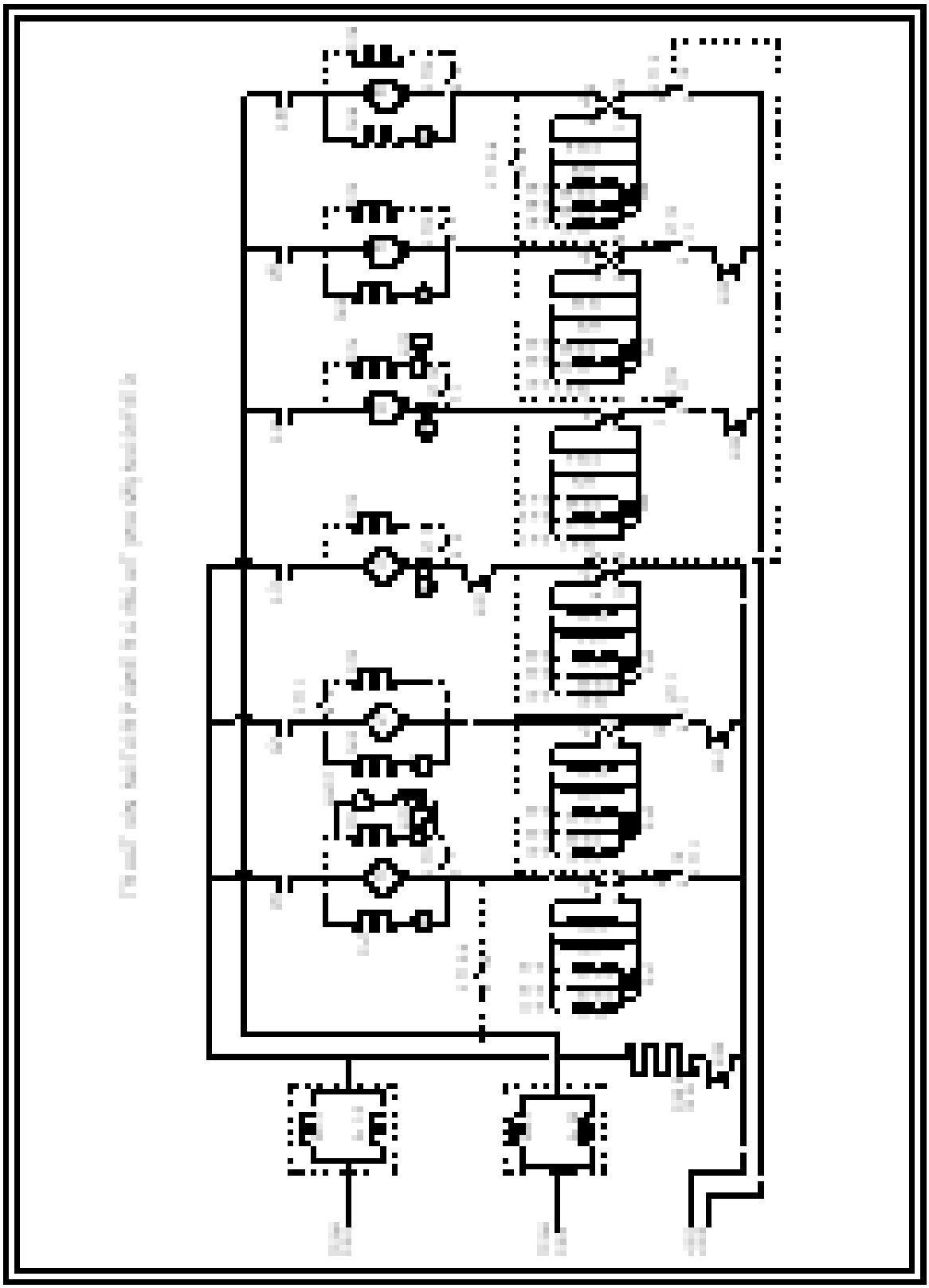

Rng : 3.13

TRACTION POWER CIRCUIT

Description :

Traction power is intended for giving tractive effort to the loco. The power according to the requirement is tapped from TFWR is separated by one primary and two secondaries. These traction transformers are called as TFP-1 and TFP-2. From these traction transformers supply goes to RSI blocks where AC is converted as DC and is supplied to traction motors through line contactors.

TFWR :

This is the main transformer, which gets energised initially when DJ is closed. The tap changer is connected to the working taps and the supply is drawn through the bus bars and CGR contactors to primary winding and then circuit completes through Auto transformer A0 terminal.

TFP1 & TFP2 :

These are secondary transformers having equal capacity in all respects. TFP1 gives supply to RSI-1 and TFP-2 gives supply to RSI-2 blocks. These two secondaries energize automaTICally when ever the TFP is energised by the tap changer. a6, a5 are the terminals connecting TFP-1 and a3, a4 are the terminals connecting TFP-2 with RSI-1 & 2 respectively. These terminals are located in HT2 compartment (in WAG7&WAP4 TFP-1 terminals are a3, a4 and TFP-2 terminals are a5, a6.

QRSI-1/QRSI-2 :

These are over current relays to protect RSI Blocks 1 & 2 respectively from over current. If over current flows in Traction Power Circuit, this relay energizes and trips DJ.

Note:

Setting of QRSI:

HETT 5400 KVA TFR – 4000 AMPS (WAG 7 & WAP 4).

HETT 3900 KVA TFR – 3600 AMPS(WAG 5).

RSI-1 & RSI-2 :

These are rectifier blocks to convert AC to DC through bunch of diodes. If diode is punctured, LSRSI glows on Loco Pilot's

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desk. From RSI -1 supply goes through SL1 and from RSI - 2 supply goes through SL2. Motors MVSI1 & MVSI 2are provided to cool the RSI blocks.

SL-1 & SL-2 :

SL1 consists of two windings as SL-1/1 & SL-1/2 to purify pulsating DC coming out from RSI-1 block. Similarly SL-2 having SL- 2/1 & SL-2/2 to purify pulsating DC coming out from RSI-2 block. These are cooled by motors MVSL-1 and MVSL-2 respectively.

Line Contactors :

There are six line contactors L1 to L6 to give path to TMs 1 to 6 respectively. These line contactors are controlled by switches HMCS-1, HMCS-2, HVSI-1, HVSI-2, HVMT-1 & HVMT-2.

J-1 & J-2 :

These are drum contactors which are operated by MPJ. J-1 controls direction of flow of current in TMs1, 2&3. J-2 controls direction of flow of current to TMs 4,5&6. Towards cab-1 leading both J_1 & J_2 operating handles should be in up direction and down direction while moving from cab-2 leading.

CTF 1, 2 & 3 :

These are the drum contactors operated by MP. These contactors are used for traction to braking and vice versa. For traction side these contactor's handles should be up side and handles should be downwards for braking.

RPS :

RPS is a permanent resistance to TM field to absorb leftover AC pulses going to traction motor fields. These are located in cowl box. RPS resistances are cooled by MVRH.

QD-1 & QD-2 :

These are differential current relays. QD-1 is connected between TM2 & 3 and QD-2 is connected between TM 4&5. When ever the difference of current is more than 150Amps, this relay energise and causes auto regression of few notches, auto sanding and LSP lamp glows on Loco Pilot's desk.

The following are the reasons for QD action :

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1. Wet / greasy rails.
2. Slipped pinion.
3. Locked Axle.
4. Excess load.
5. Brake binding on formation.
6. Gradient.
7. Defective shunting contactor.
8. Defective line contactor.
9. Defective traction motor.
10. Defective track.

** When QD is energised, Loco Pilot should ascertain the reason and take necessary action.

Q 20 :

Q20 is an over voltage relay for the protection of traction power circuit from over voltage. When ever traction power circuit is fed with more than 865 volts, this relay energizes and regress few notches automatically.. This relay is connected across +ve and –ve levels of RSI 1 out put. When Q 20 is energised, causes auto regression of GR by closing its N/O I/L on Q 51 branch of SMGR control circuit and sounding of SON in both cabs(In few locos LSOV also will glow).

If Q 20 is energised at less TM voltage, work the train by using MPS. If still losing time, Inform to TIC at next station.

Note: Q20 setting is 865 volts. But TM voltage is restricted to 750 volts

Ammeters & Voltmeters :

Ammeters and voltmeters are provided to know the current / voltage going to traction motors. AM-1/1 & AM-1/2 connected to TM 3, AM-2/1 & AM-2/2 connected to TM 4. U1 connected to TM1, U2 is connected to TM6.

Modified Meters Connection

CAB 1			CAB 2		
U1	U2	A3	A4	U5	U6
TM1	TM2	TM3	TM4	TM5	TM6

Defects Normally Experienced On Line

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1. DJ tripping through QRSI 1/ QRSI 2
2. DJ tripping through QOP1 / QOP2
3. Auto regression of GR through QD action.
4. Auto regression through Q20.
5. Auto regression through QE / QF1 /QF2 while using RB.
6. Non closing of all line contactors / any one line contactors.
7. Improper setting of J1 &J2.

Traction motor current ratings:

LOCO	Type Of TFP	Type Of TM	Starting Current			Continuous Current	Max. Voltage
			2min	10 min	60min		
			Amps	Amps	Amps	Amps	Volts
WAG 5	HETT 3900	TAO 659	1100	1000	840	750	750
WAG 5	HETT 3900	HS 15250A	1200	1150	840	750	750
WAG 7	HETT 5400	HS 15250A	1250	1150	960	900	750
WAP 4	HETT 5400	HS 15250A	1250	1150	960	900	750
WAM 4 6P	HETT 3900	TAO 659	1100	1000	840	750	750
WAM 4	BOT 3460	TAO 659	1100	1000	750	667	750

If QOP1 is energised, check the following items for any abnormality.

1. a5, a6 terminals
2. RSI 1
3. SL 1
4. J1
5. CTF 1, 2, 3
6. L1, L2, L3
7. Shunting contactors & resistances
8. QD1
9. SJ1, SJ2 & SJ3
10. Q20 & RQ20

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11. Ammeters and voltmeters
12. Traction motors 1,2,3
13. RCC Panel

In WAG 5 loco if QOP 1 acts check C145, ATFEX, RB compartment, QE, QF1 & QF2 additionally. In WAG 7 loco if QOP-1 acts during RB check equipments concerned to TPC-2 also.

If any abnormalityis noticed, isolate concerned equipment.

If no abnormality is noticed, reset the relay and resume traction.

If QOP1 is energised second time, isolate one by one Traction Motor by HMCS1. If QOP1 is not energizing after isolating particular Traction Motor, keep concerned Traction Motor in isolated position and work the train further.

If QOP1 is not resetting, check the Traction Motors also for any banding failure. If no abnormality is noticed, keep HQOP1 in OFF and clear the section. Stop the train in station, ground the loco, normalize HQOP1 keep J1 in neutral and reset QOP1.If succeeded, conclude the defect is with TMs and isolate the motors both in positive and negative sides. If not succeeded, inform to TIC keep HQOP1 in OFF and resume traction.

Make an entry in loco logbook.

If QOP2 energised, check the following items for any abnormality

1. a3, a4 terminals
2. RSI 2
3. SL 2
4. J2
5. CTF 1, 2, 3
6. L4, L5, L6
7. Shunting contactors & resistances
8. SJ4, SJ5 & SJ6
9. QD2
10. Ammeters and voltmeters
11. Traction motors 4,5,6
12. RCC Panel
13. MVRF

In WAG 7 and WAP 4(with RB) locos if QOP 2 acted check C145, ATFEX, RB compartment, QE, QF1 & QF2 additionally. In WAG 7 and WAP 4(with RB) locos if QOP-2 acted during RB check equipments concerned to TPC-1 also.

If any abnormality is noticed, isolate concerned equipment.

If there is no abnormality, reset the relay and resume traction.

If QOP2 is energised second time, isolate one by one Traction Motor by HMCS2. If QOP2 is not energizing after isolating particular Traction Motor, keep concerned Traction Motor in isolated position and work the train further with 5/6th of maximum permissible sectional load.

If QOP2 is unable to reset, check the Traction Motors also for any banding failure. If no abnormality is noticed, keep HQOP2 in OFF and clear the section. Stop the train in station, ground the loco normalize HQOP1 keep J1 in neutral and reset QOP1.If succeeded, conclude the defect is with TMs and isolate the motors both in positive and negative sides. If not succeeded, inform to TIC keep HQOP1 in OFF and resume traction.

Make an entry in loco logbook

Isolation Of Traction Motors In Different Locos:

LOCO	TM	POSITIVE	NEGATIVE
WAM 4 (RB) WAG 5 WAG 7 WAP 4 (With RB)	1	HMCS 1 IN 2	J 1 – 8
	2	HMCS 1 IN 3	J 1 –10
	3	HMCS 1 IN 4	J 1 –12
	4	HMCS 2 IN 2	J 2 – 8
	5	HMCS 2 IN 3	J 2 –10
	6	HMCS 2 IN 4	J 2 –12
WAP 4	1	HMCS 1 IN 2	J 1 – 8
	2	HMCS 1 IN 3	J 1 -10
	3	HMCS 1 IN 4	J 1 –6
	4	HMCS 2 IN 2	J 2 – 6
	5	HMCS 2 IN 3	J 2 –10
	6	HMCS 2 IN 4	J 2 –8
WAM 4 P	1&4	HMCS 2	J1 – 6
	2&5	HMCS 3	J1 – 8
	3&6	HMCS 4	J2 – 8

The following items to be checked when QRSI 1 energised.

RSI 1, SL1, J1, CTF1,2,3, a6,a5 terminals, RCC panel, MVRF, Q 20, L1,L2, L3, TM1,2,3, QD1, SJ1,2,3, Ammeters & Voltmeters with resistances, Shunting contactors and resistances.

If any abnormality is noticed, isolate concerned equipment. If no abnormality is noticed reset the relay target and work further.

If QRSI 1 is energising repeatedly or energising at less current, isolate one by one Traction Motors and try. If still energising in all positions of HMCS 1, isolate Truck 1 and work with 50% of maximum sectional load.

The following items to be checked when QRSI 2 energised

RSI 2, SL2, J2, CTF1,2,3, a3,a4 terminals, RCC panel, L4,L5, L6, TM4,5,6, QD2, SJ4,5,6, Ammeters & Voltmeters with resistances Shunting contactors and resistances.

If any abnormality is noticed, isolate concerned equipment. If no abnormality is noticed, reset the relay target and work further.

If QRSI 2 is energising repeatedly or energising at less current, isolate one by one Traction Motors and try. If still energising in all positions of HMCS 2, isolate Truck 2 and work with 50% of maximum sectional load.

LSRSI Glowing On Run:

1. Do not bring MP to '0'.
2. Note down the readings of Ammeters, Voltmeters, Line voltage, Notch position, MPS position, Speed and Gradient.
3. Now, bring MP to '0'.
4. Take necessary precautions and check the projection of tell-tale fuses.
5. If two fuses are projected in same RSI block, isolate concerned block and work further.
6. If one fuse is projected in a block (or in each block), remove the trigger fuse and work further duly not reaching the earlier current ratings.

Make entry in loco logbook and inform to TIC if necessary.

RHEOSTATIC BRAKING

It is one type of electrical braking. This can be used in the following circumstances.

- To maintain constant speed on falling down gradients.
- To control the speed of the train while approaching signals, speed restriction etc,.

Advantages of RB:

- Less wear and tear of brake blocks wheels and track.
- Increases the life of bearings.
- Easy and safe to run heavy loads over steep gradients.

Principle of RB Working

- During application of RB, all the traction motors are disconnected from the power supply and each resistor tray of DBR unit is connected across the traction motor armature through CTF contacts.

- Simultaneously, the main fields of all the traction motors are get connected in series through CTF contacts, thus making the traction motors to work as generators.

- Excitation current to the field windings, which are already connected in series, is fed from ATFEX that is connected across one of the secondary windings of main transformer.

- Current in the separately excited fields of each TMs may be increased or decreased by progression/ regression of tap changer through MP depending upon the dynamic braking effort required to control the speed of the train.

- Armatures, which are already in motion, runs in the magneTIC field start generating current.

- Hence all the kineTIC energy of the moving masses is converted into electrical energy generated by traction motors and dissipated in the form of heat energy in the forced air-cooled braking resistance bank (DBR).

Procedure of Using RB:

Just before using RB, apply A9 to minimum reduction for bunching of the formation.

- Keep MP from 0 to P, the following actions take place

  a. CTF 1, 2 & 3 set to braking side.
  b. C 145 contactor closes and ATFEX comes into service.
  c. All line contactors remain in open condition.
  d. LSB signaling lamp glows and extinguishes.
  e. All TM field coils are connected in series through CTF 1, 2 & 3 contacts.
  f. All TM armatures are connected to RF resistances through CTF 1, 2 & 3.

- Keep MP from 'P' to 'N' in braking side and move to '+' for progression.

  a. The progression of GR causes excitation of magneTIC field of each TM.
  b. Ensure LSDBR is extinguished below 5 notches (in some locos below 10 notches).
  c. Then only progress the notches as per requirement and keep GR on same notch till required speed is achieved.
  d. After achieving the required speed, reduce the notches accordingly.

- To move to traction side keep MP from 'N' to 'P' and then to '0'.

  a. Ensure glowing and extinguishing of LSB, which indicates proper setting of CTF contactors towards traction side and opening of C145.

Working of RB

- When notches are progressed in braking side, AC supply from TFP 1 goes to ATFEX, from there to RSI 1 where rectified to DC and smoothened by SL 1.
- Therefore DC current is fed to all TM fields (RSI1 to MF 1, 2, 4, 5, 6 to MF 3 and back to RSI1) in series.
- During RB all the traction motors work as generators.
- While progressing notches in braking side the 6 TM fields get excited and magneTIC flux is created.

- As the armature is already in motion it cuts the magneTIC flux and EMF is generated in armature.
- This generated EMF is fed to RF resistances.
- Current in the separately excited fields of each TM may be increased or decreased by progression / regression of tap changer through MP depending upon the dynamic braking effort required to control the speed of the train.
- Hence kineTIC energy of moving train is converted into electrical energy by TMs and dissipated in the forced air-cooling braking resistance bank.
- The retardation force will be developed in the TM armature.
- Current generated in the TM armature depends on the braking excitation current and speed of the train.
- RF resistances are cooled by MVRF (DC series motor), which is connected to TM 1 armature out put.
- When MVRF is working effectively, LSDBR signaling lamp extinguishes through QVRF relay.
- Generation of Current & induced EMF during RB is limited to 600 Amps & 325 volts.

Protective Equipment in RB:

QE:

It is an over current protection relay for excitation. During RB, if excitation current exceeds 900Amps to ATFEX, this relay will energize and cause auto regression of GR by de energising Q50 relay. When this relay energizes, a red target drops on the face of the relay.

QF 1 & 2:

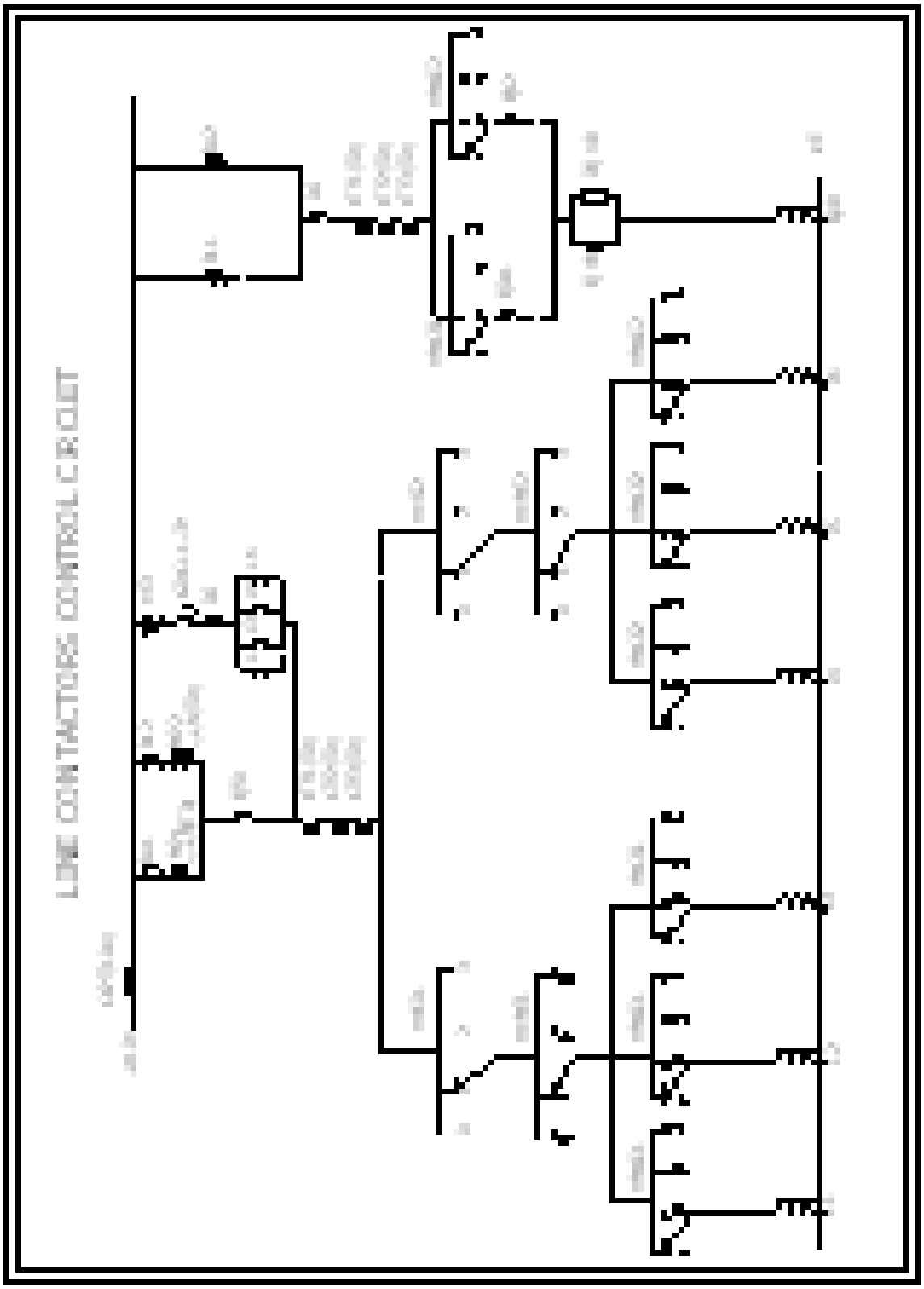
These are over current protection relays for generated current. During RB, if generated current exceeds 700 Amps, this relay will energise and cause auto regression of GR by de energising Q50 relay. QF 1 is connected in series with RF 1 and QF 2 is connected in series with RF 4. When this relay energizes, a red target drops on the face of the relay.

SWC:

It is a pressure switch. During RB, if loco brake cylinder pressure exceeds 1kg/cm^2 by any reason, SWC acts and its interlock opens on Q50 relay braking path, there by GR comes to '0'.

Note:

- In WAG7 and RB provided WAP4 locos RSI 2 out put is connected to all TM fields in series (RSI 2 to MF 1, 2, 3, 4, 5 to MF 6 and back to RSI 2).
- During RB, ammeters and voltmeters will indicate the amount of current and voltage generated in TM armatures. During RB, ammeter deviates down wards and voltmeters deviate upwards as usual.
- RB can be operated only when all TMs are in service.
- Do not use RB When Q50 relay is wedged.
- Do not use RB when MP is not working.
- Minimum working range of DBR is 30 kmph.


LINE CONTACTORS CONTROL CIRCUIT

Rng : 3.14

LINE CONTACTORS CONTROL CIRCUIT

The rectified dc from RSI blocks is supplied to TMS through line contactors. For achieving this, line contactors should be closed. These line contactors will close, when MP is moved from '0' to 'N' position.

Conditions For Closing Line Contactors:

1. CCPT should be in good condition.
2. Unlock the BL
3. MP to be placed in 'N' position
4. Relay Q 50 should be in energised position
5. CTF1, CTF2 and CTF3 should be in running side
6. HVSI 1, HVMT 1, HVSI 2 & HVMT 2 switches should be in '1' or '3' position
7. HMCS 1 & HMCS 2 switches should be in '1' position
8. To close line contactors, control air pressure should be more than 5 kg/cm^2.
9. Both EP COCs should be in open position and EP drain COC in close position.

Energising:

1. When the above conditions are fulfilled, L1,L2,L3,L4,L5,L6 coils will get feed through CCPT, BL I/L, MP IN 'N', Q 50 N/O I/L, CTF1, CTF2 & CTF3 I/Ls closes in running side, HVSI 1, HVMT 1, HVSI 2 & HVMT 2 switches in '1' or '3' position and HMCS 1 & HMCS 2 switches in '1' position
2. Once the line contactors are closed the N/O I/Ls of L1, L3, L4 & L6 will close. Now dual path will be maintained through these I/Ls, GR closes on '1-32' I/L, DJ N/O I/L, provided on parallel to MP.

TROUBLES RELATED TO LINE CONTACTOR CONTROL CIRCUIT

1. Total Loss of Tractive Effort with GR Progression:

When MP is moved from 'O' to 'N' then to '+' LSGR extinguishes, NR deviates but ammeters do not deviate and loco will not move. This is due to line contactors not closing.

TROUBLE SHOOTING:

A) Place HVSI 1 & 2, HVMT 1 &2 on '3' position; if successful resume traction taking necessary precautions.

B) If un-successful
   - Open DJ.
   - Operate BL key 2 or 3 times.
   - Close DJ and resume traction

C) If un-successful, clean the interlocks of Q50 and try to resume traction.

D) Operate all three CTFS 1 or 2 times manually after taking safety precautions.

E) If EP 1or EP2 COCs are in closed, open the same.

F) If EP drain COC is opened, close the same.

G) If there is any air leakage in the pipelines leading to BA1, BA2 & BA3 panel, try to arrest the same and resume traction,

H) If un-successful contact TIC.

2. Auto Regression With LSP Glowing:

When MP is moved from '0' to 'N' then to '+' LSGR extinguished, GR comes to '0' with LSP glowing. Causes

1. Train brakes not released or wet rail / oil substance on the rails.
2. Slipped pinion or locked axle,
3. Any one of the line contactor is opened or any cut in the pair of QD connected TMS.
4 Whenever any shunting contactor is welded in which QD is connected.

TROUBLE SHOOTING:

A) check for
   - BP pressure in the gauge.
   - Any brake binding or
   - Any abnormality on train. if every thing is normal apply sand and try to resume traction.
   - Press ZQWC while starting the train.

b) If unsuccessful, take one or two notches and observe both ammeters.

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i. In modified locos, if A3 Is not deviating (in non modified locos if am 1/1 or am 1/2 is not deviating) place HMCS1 on 4 and resume traction.

ii. In modified locos, if A4 is not deviating (in non modified locos if AM 2/1 or am 2/2 is not deviating) place HMCS2 on 2 and resume traction.

iii. If both ammeters are deviating (L2 / L5 not closed)

- Place HMCS 1 on 3 and try.
- If unsuccessful normalize hmcs1 and place HMCS2 on 3 position.
- If unsuccessful place both HMCS on 3 position and try.
- In modified locos observe the deviation of all meters. If any meter is not deviating isolate the concerned TM.

c) If auto regression takes place while operating mps then avoid mps operation.

d) If auto regression takes place due to slipped pinion

- Stop the train and apply brakes.
- Depute assistant loco pilot to stand near the truck and take one notch.
- Observe for any spinning noise or rotation of traction motor pinion.

If any one of the tm pinion rotates or spinning noise is heard, isolate the corresponding tm and clear the block section with permissible load, other wise contact TIC.

E) IF AUTO REGRESSION TAKES PLACE DUE TO LOCKED AXLE

- Detach the loco from the formation.
- Depute Assistant Loco Pilot by the side of the loco, to observe moving of wheels.
- Move the loco and observe whether all loco wheels are rotating freely.
- If any wheel is not rotating request for assistance from TIC.

NOTE:

- First notch auto regression with LSP indicates L2 / L3 OR L4 / L5 not closing.
- First notch auto regression with out LSP indicates improper locking of rear cab BL or defective Q50 N/C I/L, Q51 N/O I/L on VE2 branch.
- Lower notches auto regression with LSP indicates QD action due to defective track, bad weather, defective formation, welded shunting contactors, slipped pinion and locked axle.
- Higher notches auto regression with LSP (after operating MPS) indicates QD action due to shunting contactors not closing.
- Higher notches auto regression without LSP indicates Q20 action due to over voltage to TMS or defective q20.
- Auto regression without LSP in various notches indicates QRS2/ ACP/ AFL action or on notches if DJ trips.

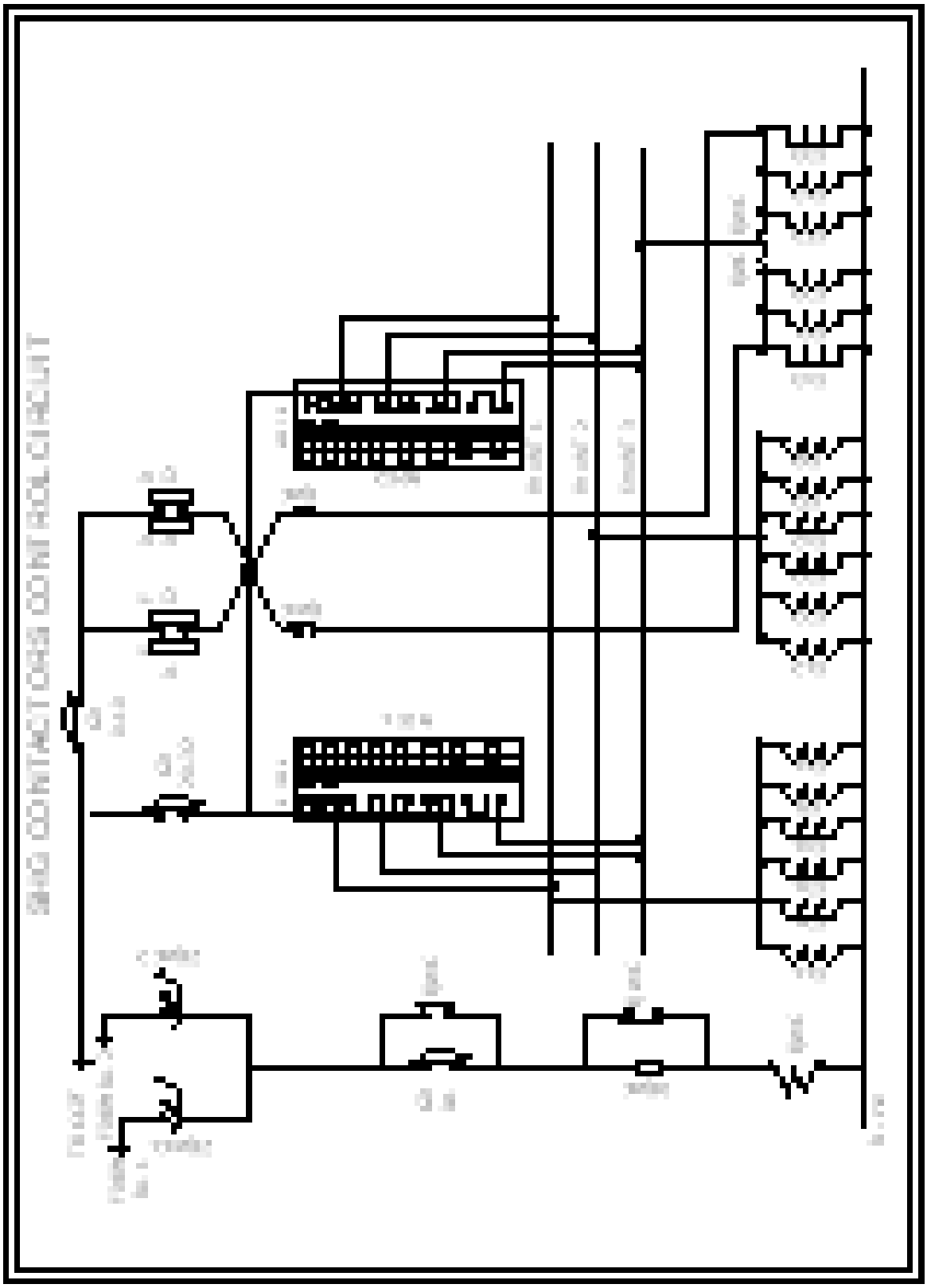
3. PARTIAL LOSS OF TRACTIVE EFFORT

When mp is moved from '0' to 'n' and then to '+', GR is moving but tractive effort is effected and not moving properly (poor engine hauling).

Reason: The line contactor, which is not connected with QD, is not closed.

1. Bring mp to '0' and check the position of HMCS 1&2.
2. If any one is other than '1' position, find out the cause.
3. If normal, place HMCS 1&2 on position '1' and resume traction.
4. If HMCS 1&2 are on '1' position, check for any air leakage from
   - Line contactors.
   - Electro valves and
   - Pneumatic pipe lines. If any air leakage, try to arrest the same and resume traction.
5. If there is no air leakage or it can not be arrested, trouble shoot as follows
   - If u 1 does not deviate isolate TM 1.

     If U 2 does not deviate isolate TM 4.



Rng : 3.15

CONTROL CIRCUIT OF QWC

QWC relay is provided to reduce the action of QD while starting the train from yard and on gradients. This relay gets feed from CCPT (10 Amps) fuse. When ZQWC is pressed, through GR '0-1' I/L, QWC N/C I/L, relay QWC energizes. When QWC is energised, it's N/C I/L open and path is maintained through RQWC. QWC maintains in energize position even after taking second notch through QWC N/O I/L parallel to GR '0-1' I/L.

In non-modified locos (only 6 shunting contactors I.e., S1, S2, S3, S4, S5 & s6), when QWC is energised its N/O I/L closes on the branch of S1, S2 & S4 and also on S3, S5 & S6. Now from CCPT fuse, through GR '0-15' I/L, J1 'F' & J2 'F' I/L and QWC N/O I/L shunting contactors S3, S5 & S6 coils energised and contactors S3, S5 & S6 gets closed when cab1 leading. During cab2 leading, when ZQWC is pressed supply from CCPT fuse, through GR '0-15' I/L, J1 'R' & J2 'R' I/L and QWC N/O I/L shunting contactors S1, S2 & S4 coils energised and contactors S1, S2 & S4 gets closed. In non-modified locos QWC action is up to 15^{th} notch.

In modified locos in which 18 shunting contactors are provided and when ZQWC is pressed, S13, S23 & S43 closes during cab2 leading and S33, S53 & S63 closes during cab1 leading. In modified locos QWC action is up to 10^{th} notch only.

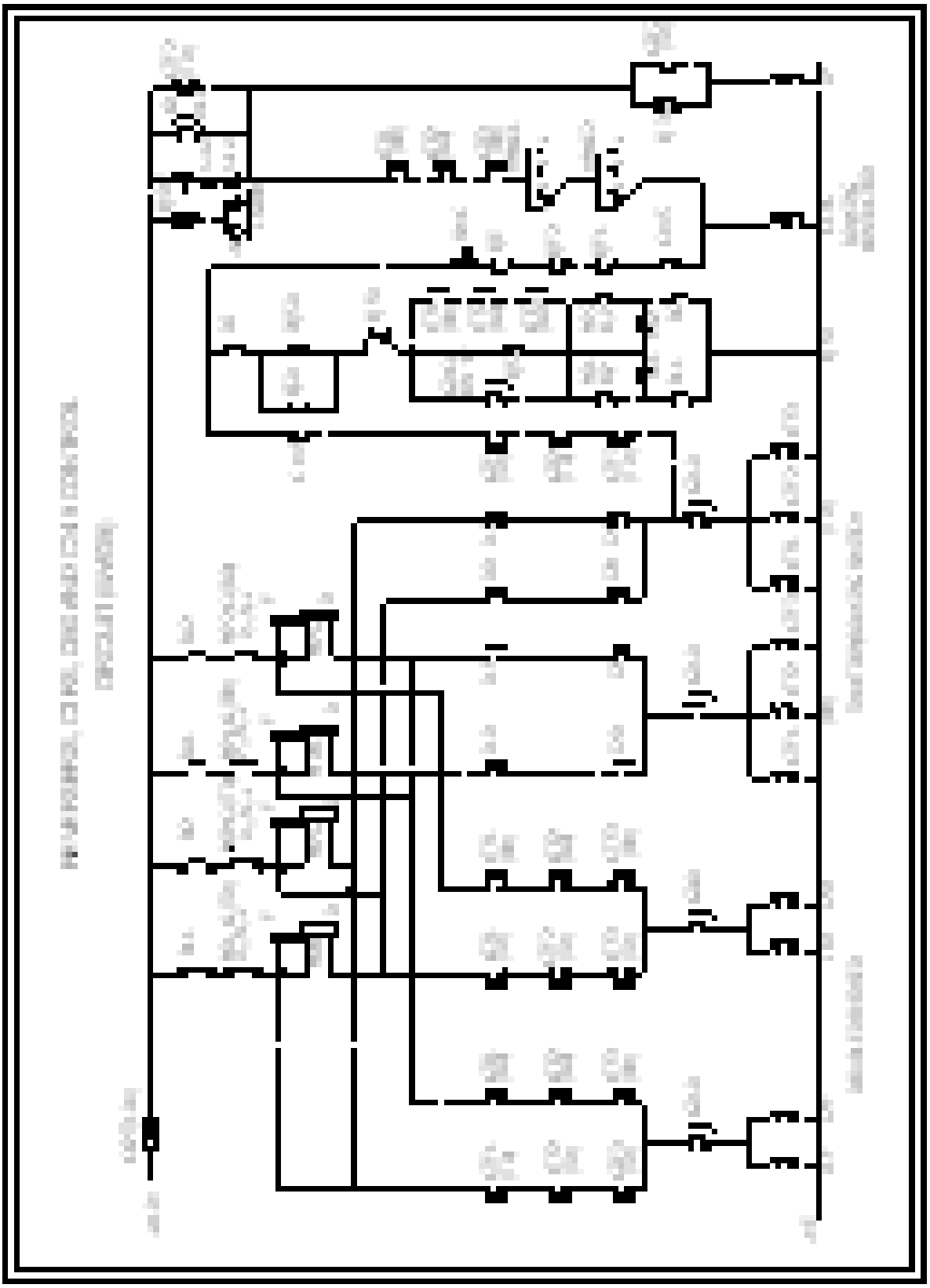
RNG3.16:
CONTROL CIRCUIT OF SHUNTING CONTACTORS

For field weakening in modified locos three sets of shunting contactor and shunting resistances (four set in case of WAP4 locos) are provided for each traction motor. Field weakening can be achieved by MPS from Loco Pilot's desk. MPS can be operated only when MP is on 'N'. MPS is having 5 positions; those are 0, 1, 2, 3 & 4. But fourth position works only in WAP4 locomotives.

When MPS is moved to first position, S11, S21, S31, S41, S51 & S61 will close and RS11, RS21, RS31, RS41,R S51 & RS61 will be connected across to the fields of traction motors 1 to 6 respectively and speed will increase gradually. When MPS is moved to 2nd position, S12 to S62 closes and RS12 to RS62 will be connected across the field of traction motors. In the same way when MPS moved to 3rd position S13 to S63 closes and RS13 to RS63 will be connected across the field of traction motors.

MPS should be operated in the following manner –

1. After applying maximum voltage to traction motors i.e., 750 volts.
2. After stabilizing current to traction motors.
3. GR should be in between 20-32 notches.
4. 30 seconds of time gap should be given for each MPS operation either for progression or for regression.



Rng : 3.17

CONTROL CIRCUIT OF REVERSERS, CTFs,C145 & IP (E)

This circuit is provided to operate reversers, CTFs, C145 and IP (E) valve. This circuit ensures correct preparation of the loco on traction side and on braking side. This circuit is fed through fuse CCPT (10 Amps).

Reversers J1 & J2:

These are the drum contactors to change the direction of flow of current in traction motor fields.

In cab1, if MPJ1 is put to forward position or in cab2, if MPJ2 is put to reverse position, through running I/Ls of CTF 1, 2 and 3 and through GR '0' I/L, J1 'F' & J2 'F' electro valves energizes. When J1 'F' is energised, it allows pneumatic pressure to operate the drum contactor J1 and its handle goes upwards. Similarly when J2 'F' is energised, pneumatic pressure enters to operate the drum contactor J2 and its handle goes upwards.

In cab1, if MPJ1 is put to reverse position or in cab2, if MPJ2 is put to reverse position, through running I/Ls of CTF 1, 2 and 3 and through GR '0' I/L, J1'R' & J2 'R' electro valves energizes. When J1 'R' is energised, it allows pneumatic pressure to operate the drum contactor J1 and its handle goes downwards. Similarly when J2 'R' is energised, pneumatic pressure enters to operate the drum contactor J2 and its handle goes downwards.

CTF1, CTF2 & CTF3:

These are drum contactors identical to reversers J1 & J2. When MP is on traction side, CTF1, CTF2 & CTF3 traction coils energizes through J1 & J2 'F' I/Ls or through J1 & J2 'R' I/Ls. During traction, CTF1, CTF2 & CTF3 handles are set to upwards.

When MP is kept on 'P' position on braking side, CTF1, CTF2 & CTF3 braking coils energizes through J1 & J2 'F' I/Ls or through J1 & J2 'R' I/Ls. During braking, CTF1, CTF2 & CTF3 handles are set to downwards.

Energisation of Q50 Relay on Traction Side:

This is a supervising relay provided to ensure correct preparation for the traction as well as braking side. When ever cab1 MPJ is kept on 'F' or cab2 MPJ is kept on 'R' position, J1 & J2 drums set to upward position. When ever cab1 MPJ is kept on 'R' or cab2 MPJ is kept on 'F' position, J1 & J2 drums set to downward position.

Traction side supply for relay Q50 goes from CCPT fuse and through BL1, MPJ 'F' or MPJ 'R', J1 'F' & J2 'F' OR J1 'R' & J2 'R', CTF1 (Rng), CTF2 (Rng), CTF3 (Rng), C145 N/C, DJ N/O (now closes), Q50 N/C, GR '0', MP '0' and BL1 interlocks, the circuit completes for Q50 relay and energizes. When Q50 is energised, it's N/C I/L open and path is maintained to Q50 through RQ50. Q50 N/O I/L closes parallel to GR '0' and MP '0' I/Ls, so the path to Q50 is maintained even after moving MP to 'N' position and GR is moved away from '0'.

When ever Q50 is energised, the following I/Ls will close or open on different control circuits that are given below.

i. NC interlock opens on QV64 branch in signaling lamp circuit. Hence LSB extinguishes.

ii. NO interlock closes parallel to MP '0' and GR '0' interlock on Q50 control circuit.

iii. NO interlock closes on line contactors control circuit.

iv. NC interlock opens parallel to RQ50 in Q50 control circuit.

v. NC interlock opens on VE2 coil in tap changer control circuit.

vi. NO interlock closes on VE2 coil in tap changer control circuit.

vii. NO interlock closes on VE1 coil in tap changer control circuit.

Energisation of Q50 relay on braking side:

This relay energizes whenever MP is kept on 'P' position on braking side to indicate preparation is correct on braking side. To energize Q50 on braking side, CTF1, CTF2 & CTF3 drum contactors should be thrown to braking side and contactorC145 should close. When ever MP is kept on 'P' position, CTF 1, 2 & 3 running side interlocks opens on Q50 traction side and at the same time CTF1, CTF2 & CTF3 braking side interlocks get closed on C145 / Q50 branch. Braking side supply for relay Q50 goes from CCPT fuse and through GR '0-10' in parallel with QVRF N/O I/L, TH1 and TH2 N/C I/Ls, CTF1 (Br), CTF2 (Br), CTF3 (Br), HMCS1 closes on '1' position, HMCS2 closes on '1' position, C145 coil energizes. Just above C145 coil, the supply also goes to Q50 braking side. Now C145 N/C I/L opens on Q50 traction path and N/O I/L closes on Q50 braking path. Then through QE, QF1 & QF2 N/C I/Ls, SWC N/C I/L (opens at 1kg/cm^2 of BC pressure), C145 N/O I/L, DJ N/O I/L, Q50 N/C I/L, Q50 coil, GR '0'/CTF 1,2 & 3 braking side, Mp closes on '0'/'P' and BL I/L, circuit completes and Q50 energizes on braking side. So signaling lamp LSB glows for a movement and extinguishes. This indicates preparation for braking side is correct. When Q50 is energised, it's N/C I/L open and path is maintained to Q50 through RQ50. Q50 N/O I/L closes parallel to GR '0'/CTF1, 2 & 3 Br I/Ls and MP '0'/'P' I/Ls, so the path

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to Q50 is maintained even after moving MP to 'N' position and GR is moved away from '0'.

IP electrical valve:

This is a vigilance electro valve which gets energised in traction side as soon as battery is switched on. Traction side this valve gets supply from CCPT fuse and through CTF2 (Rng) I/L (parallel with GR '0-10' I/L), CTF2 (Rng) I/L (parallel with Q30 N/O I/L).

In braking side, this will energize through GR '0-10' / QVRF N/O I/L, two thermal relays N/C I/Ls and through Q30 N/O I/L. During Rheostat braking side, if DJ tripping / no tension takes place, IP valve de energizes causing destruction of BP pressure through IP mechanical valve

Rng : 3.18

Q48 CONTRL CIRCUIT

This relay energizes when ever QD1 Or QD2 is energised. When ever this relay energizes, the following actions will takes place.

a. Few notches auto regression of GR.
b. Auto sanding.
c. Red pilot lamp LSP glows on Loco Pilot's desk.

Relay Q48 gets feed through CCPT (10 Amps) fuse, BL interlock, CTF1 (Rng), CTF2 (Rng), CTF3 (Rng) I/Ls, HMCS 1/2, QD1/2 and Q48 N/C I/Ls. After energisation of Q48 relay, its N/C I/L opens and path is maintained through RQ48. When Q48 is energised it's three other N/O I/Ls closes in three different circuits.

1. N/O I/L of Q48 closes in the branch of Q51 there by Q51 energizes causing auto regression of GR.
2. N/O I/L of Q48 closes in the sanders control circuit there by VESA1&2 or VESA3&4 energizes causing auto sanding.
3. N/O I/L of Q48 closes in the branch of LSP control circuit and causes the lamp LSP to glow.

When ever QD1 is energizes due to the current difference in between TM2 and TM3, QD1 N/O I/L closes in Q48 branch (below HMCS1). Similarly when ever QD2 is energizes due to the current difference in between TM4 and TM5, QD2 N/O I/L closes in Q48 branch (below HMCS2).

Q48 gets energizes when QD1 or QD2 Or both acts only if HMCS1 or HMCS2 is placed in 1 & 3 position in non modified locos. In modified locos HMCS1 in 1 on 2 OR HMCS2 is in 1 or 4 position

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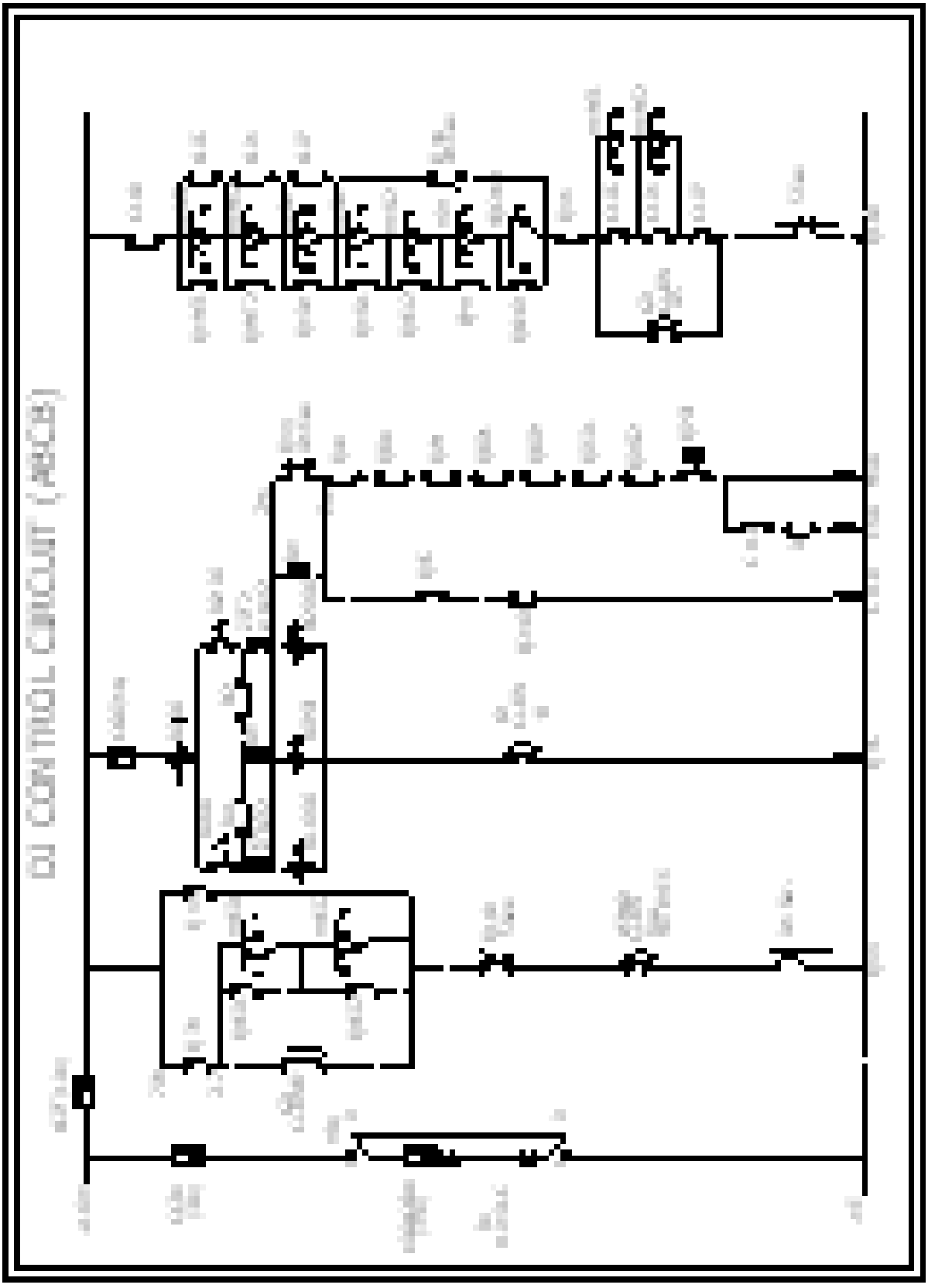

RNG3.19:
DJ CONTROL CIRCUIT

DJ control circuit is provided

1. To give starting phase to ARNO.
2. To protect the loco if any of eight auxiliary motors is not working.
3. To protect the loco if ARNO us not working.
4. To protect RGR.
5. To ensure that GR is on '0' while closing DJ.
6. To protect feeding power circuit from over current and short circuit.
7. To protect auxiliary power circuit from over current and earth fault.
8. To protect traction power circuit from over current and earth fault.
9. It trips DJ if GR is struck up on full notches while doing quick regression with MP.

Types of DJ

1. In DJ, there are two types ABCB and VCB.
2. In VCB there are three types double interrupter VCB, single interrupter horizontal VCB and single interrupter verTICal VCB.
3. In ABCB DJ control circuit there are six branches (Q118, Q45, Q44, C118, EFDJ and MTDJ).

   In ABCB DJ closing coil is EFDJ and tripping coil is MTDJ.
4. In VCB DJ (double interrupter and single interrupter verTICal) control circuit there are five branches (Q118, Q45, Q44, C118 and MTDJ). In these two types closing coil and tripping coil is MTDJ.
5. In single interrupter horizontal VCB there are six branches (Q118, Q45, Q44, C118, EFDJ and MTDJ) like ABCB. In this DJ closing coil is EFDJ and tripping coil is MTDJ.

AIR BLAST CIRCUIT BREAKER

Air Blast circuit breaker consists of two contacts namely primary contact and secondary contact fitted on the loco roof. The primary contact is provided inside the horizontal insulator and the secondary contact is provided on the rotating verTICal insulator. The secondary contact insulator is connected through fork and actuating rod to the piston of the DJ servomotor.

To close DJ, pneumaTIC pressure admitted into DJ servomotor on right hand side (piston rod end). To open DJ, the pneumaTIC pressure admitted on left side of the piston. The air admission is controlled on right hand side by an electro valve coil EFDJ and on left hand side by an electro valve coil MTDJ. To close DJ, the pneumaTIC pressure in RDJ should be above 6.5 kg/cm² and to energise the electro valve coils the battery voltage should be above 85 volts. To close DJ, switch 'ON' BLDJ and press BLRDJ switch. In the DJ control circuit, first MTDJ coil will energise and closes the passage of air in to the DJ servomotor left hand side. Later when EFDJ coil is energised, the air from RDJ through EFDJ valve enters on the right hand side of the piston moving the piston to left hand side. Along with the piston through its fork and actuating rod the secondary contact moves along with the insulator touching the fixed contact of the primary of DJ assembly. Through the primary contact in the insulator and the flexible shunts the current flows from the secondary contact to the main transformer (TFWR) after closing of DJ the secondary contact is held in closed position by mechanical locking through the retaining spring. After closing DJ on releasing BLRDJ after opening of C118 contactor, the EFDJ coil will be deenergise. Due to which admission of air on to the right hand side of the DJ servomotor is stopped and at the same time air enters to close DJ is exhausted through exhaust port. To open DJ, MTDJ coil is to be de energised. When BLDJ switch is opened or due to any other reason when MTDJ coil is de energised the air from RDJ finds its way to MTDJ valve into the DJ primary contacts insulator to push the piston of primary contacts mobile contacts. By this action fixed mobile contacts of the primary contacts are separated and 1 lakh ohms resistance is introduced in the circuit. After 0.04 sec due to action of the retardation valve the air admitted from the MTDJ valve will enter on left hand side of the piston DJ servomotor and open the secondary contact. Before opening of the secondary contacts, arc between primary contacts minimized due to insertion of 1 lakhs ohms resistance in the circuit, After opening of the primary contact, due to spring action the mobile contact will be pushed back and the air exhausted. Recently the air blast circuit breakers are replaced by vacuum circuit breaker because of advantages.

VACUUM CIRCUIT BREAKER

Vacuum circuit the breakers are replacing the air blast circuit breakers used on electric locos/EMU's due to following advantages.

1. Less maintenance
2. Greater safety
3. Greater reliability
4. Simplified control
5. Noiseless operation`

CONSTRUCTION:

The main switching unit consists of two vacuum interrupters connected in series and are mounted in the horizontal support insulator. Each interrupter houses a pair of contacts. The interrupters operating rods are connected to a pneumatic dual piston. Operating mechanism is mounted in the main cradle between the interrupters, which closes the contacts by the application of air supply.

The contacts are held normally open by heavy-duty springs. It is fixed to the spring plate. The relay valve body is bolted to one side of the air cylinder. The control air pipe and main air pipe, which are made up of special nylon, are routed between the relay valve and the base of the circuit breaker inside the insulator.

The regulated and filtered air pressure of 5 kgs/cm^2 is supplied from air reservoir QPDJ setting is kept at cut in 4.65 kgs/cm^2 and cut out 4.0 kgs/cm^2.

Operation:

When the magnet valve is energised, control air is admitted to the bottom chamber of the air relay valve and pushes the puppet valve upwards to allow operating air through main pipeline in to the cylinder via 2mm diameter choke.

The operating air in the cylinder piston moves outwards against the pressure of springs, thus closing the contacts in those interrupters. Air cylinder has small and large ports. When the magnetic valve is energized air enters in to the cylinders first the small port and then at through energised touch with each other by the large port, thus the contacts are fully closed. When the magnet valve is de-energised the cylinder exhausts to atmosphere thus causing the piston to accelerate rapidly inwards by the face of

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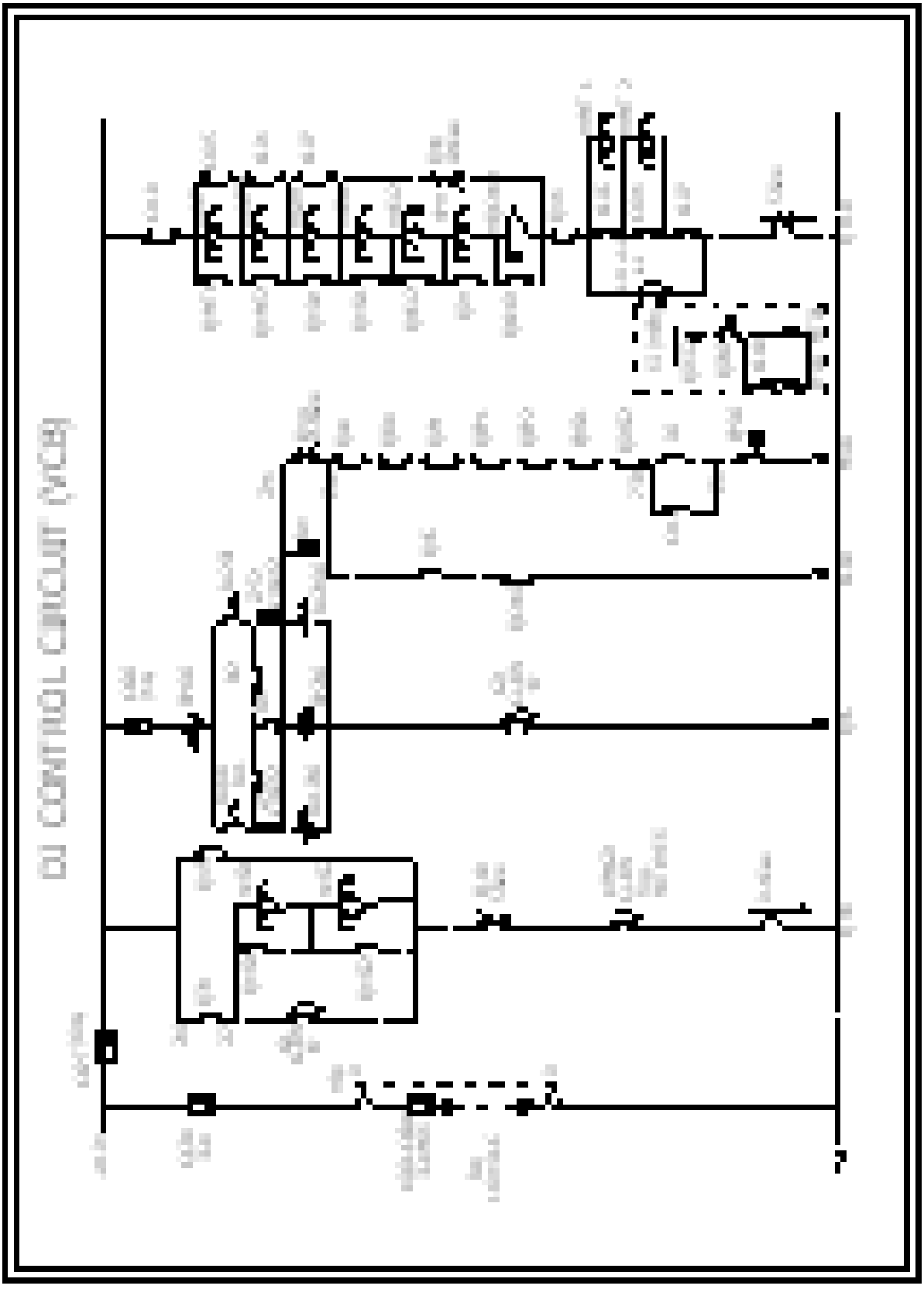
s p r i n g s .


EI CONTROL CIRCUIT (VCB)

ENERGISATION OF DJ CONTROL CIRCUIT

1. Before closing DJ, ensure that loco is on track and under OHE.
2. To close DJ, Add. CCBA, CCBA, CCPT & CCDJ fuses should be in good condition.
3. Keep HBA on '1' position and ensure BA voltage is more than 85 volts.
4. After keeping HBA on '1' position, relay Q118 energizes through contactors C118, C105, C106 & C107 N/C I/Ls, relays Q44 & Q46 N/C I/Ls and GR '0 - 5' I/L. Q118 N/O I/L closes on Q44 branch.
5. Start MCPA and create more than 6.5 kg/cm^2 of pressure in RS reservoir.
6. In ABCB loco Pressure relay QPDJ energizes at 5.5 kg/cm^2 and de-energize at 4.5 kg/cm^2 and its N/O I/L closes on MTDJ branch (In VCB locos QPDJ energizes at 4.65 kg/cm^2 and de-energises at 4.0 kg/cm^2).
7. Unlock BL key and ensure four pilot lamps are glowing (LSDJ, LSCHBA, LSGR& LSB).
8. Insert ZPT on '0' and move to '1'. Now it's one I/L closes in panto electrical control circuit to raise rear panto and another I/L closes on common branch of Q45, C118, EFDJ and MTDJ (In VCB locos closes on common branch of Q45, C118 & MTDJ).
9. Ensure panto is raised and touching to contact wire.
10. Close BLDJ and press BLRDJ, relay Q45 energizes through CCDJ, BP1DJ N/C/ I/L, BLDJ N/O/I/L, ZPT I/L (closes on '1' or '2' position), BLRDJ N/O I/L and through GR '0' I/L.
11. When Q45 is energised one of its N/O I/L closes on Q44 branch, second on C118 coil branch, third one on Q30 branch in auxiliary power circuit and fourth one parallel to QLA in auxiliary power circuit.
12. Then Q44 energizes through Q45 N/O I/L, Q118 N/O I/L and ASMGR closes on '0' and on full notches I/L.
13. When Q44 is energizes its N/C I/L opens on Q118 branch (Q118 will not de energize because of 5 seconds time lag) and its N/O I/L closes on common path of C1118, EFDJ& MTDJ.

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14. C118 coil energizes through CCDJ, BP1DJ N/C/ I/L, BLDJ N/O/I/L, ZPT I/L, Q44 N/O I/L, Q45 N/O/ I/L, QCVAR N/C I/L. C118 contactor closes in auxiliary power circuit and starting phase gets ready before closing DJ.
15. When C118 contactor is closed its N/C I/L opens on Q118 and N/O I/L closes on EFDJ branch (In VCB locos closes N/O I/L closes on MTDJ branch).
16. EFDJ energizes through the safety relay N/C I/Ls, C118 N/O I/L, DJ N/C I/L. Simultaneously MTDJ also energised.
17. When EFDJ is energised air pressure is supplied to DJ servomotor to close DJ. When MTDJ is energised air pressure is stopped to DJ servomotor to keep DJ in closed condition (In VCB locos MTDJ energizes through the safety relay N/C I/Ls, C118 N/O I/L and QPDJ I/L When MTDJ energizes, pressure enters into puppet valve to lift puppet valve and DJ closes).
18. When DJ is closed LSDJ extinguishes through QV60 relay.
19. After closing DJ, EFDJ de energizes through DJ N/C I/L. Now the existing pressure in DJ servomotor is exhausted through exhaust port and DJ remains in closed condition through retaining spring (In VCB locos after closing DJ, path is maintained through DJ N/O I/L).
20. As the DJ is closed and OHE supply is available TFWR and TFWA energizes, UA meter needle deviates and Q30 energizes (Q30 energizes at 215 volts of TFWA output) as these are connected to auxiliary power circuit. Q30's N/O I/L close on Q44 branch.
21. ARNO initially works as single-phase AC induction motor and after few seconds' works as an alternator. When it produces an out put of 155 volts QCVAR energizes causing automaTIC suppression of starting phase by opening its N/C I/L on C118 coil branch.
22. When C118 contactor is opened, its N/C I/L recloses on Q118 branch and opens on EFDJ branch (In VCB locos, C118 N/O I/L opens on MTDJ branch).
23. Now ARNO receives single-phase AC supply and produces 3-phase AC supply. Along with ARNO five direct auxiliary motors will start to avoid no load working of ARNO and simultaneously their relay I/Ls closes on Q118 and Q44 branches.

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24. Along with ARNO five static devices also starts working. One of those is CHBA. When CHBA is working signaling lamp LSCHBA extinguishes and release BLRDJ.
25. After releasing BLRDJ, relay Q45 de energizes and its N/O I/Ls opens in different branches.
26. Q44 gets path through Q30 N/O I/L, GR '0' I/L and so on. Simultaneously Q44 gets supply through QVSI-1 and QVSI-2 also.
27. Now DJ is maintained in closed condition through Q118, Q44 and MTDJ branches.
28. After closing DJ, close BLCP to start MCP.
29. After closing BLVMT and after starting of MVRH, MVMT-1 & MVMT-2, Q118 gets path through QVMT-1, QVMT-2,& QVRHI N/O /Ls.
30. After taking first notch GR '0' I/L open on Q44 branch and path is maintained through QVSI-1 and QVSI-2 I/Ls.
31. After taking sixth notch GR '0-5' I/L open on Q118 branch and path is maintained through C105, C106& C107 N/O I/Ls.
32. From 6th notch to 32 notches there is no change in DJ control circuit.

TRIPPING FAILURES (ABCB)

Whenever DJ is tripped on line prepare the loco as following to pickup correct abnormal sign.

1. Keep MP on zero.
2. Open all top row BL switches.
3. Ensure LSGR is glowing.
4. Ensure Safety relays are normal.
5. Ensure C107, C105 & C106 open fully.
6. MR / RS pressure above 6.5 Kg/cm^2.
7. Battery voltage is above 85 volts.
8. Ensure pantograph is raised fully
    - Close BLDJ, press BLRDJ and observe the LSDJ, UA needle, Auxiliaries sound & LSCHBA.
    - After extinguishing of LSCHBA, release BLRDJ. If LSCHBA not extinguishes, release after re glowing of LSDJ.

- Pick up the correct abnormal sign as following manner.

SL No	INDICATION/OPERATION	ABNORMAL SIGN	PROBABLE REASONS
1	On closing BLDJ and pressing BLRDJ, LSDJ remains glowing	ICDJ	a. Less air pressure in MR or RS b. Q118/ Q45/ Q44/ C118/ EFDJ may not energise. c. Check A conk for any slackness.
2	Close BLDJ, press BLRDJ. LSDJ extinguished, UA needle not deviated, no auxiliaries sound, LSCHBA not extinguished and after 5.6 seconds LSDJ re-glows	NO TENSION	a. Derailment/ Accident (reducing of Vacuum / BP levels in loco) b. Defect/cut in Feeding Power/ auxiliary power Circuit. c. Defect in OHE/ track/ formation d. Cut in Feeding Power circuit. e. Foreign body on loco roof
3	Close BLDJ and press BLRDJ LSDJ flickering	'A' BEGINNING	a. Less air pressure or QPDJ defective b. Check QOA/ QLA/ QLM for energisation. c. Cut in MTDJ branch or defective MTDJ coil
4	Close BLDJ and press BLRDJ. LSDJ extinguished, UA needle deviated, auxiliary sound may heard LSCHBA not extinguished after 5.6 seconds LSDJ re glows.	'A' ENDING	a. Defective ARNO b. Defective QCVAR
5	Close BLDJ and press BLRDJ. LSDJ extinguished, UA needle deviated, Auxiliary sound heard, LSCHBA also extinguished, after releasing BLRDJ, while counting 15seconds LSDJ re-glows.	OPERATION 'B' PART-I	Defect in a. MVSL1/VLS1/ QVSL1 b. MVSL2/VSL2/ QVSL2 c. MPH/PH/QPH d. QCVAR N/O I/L

6	Close BLDJ and press BLRDJ. LSDJ extinguished, UA needle deviated, auxiliary sound heard, LSCHBA also extinguished, on releasing BLRDJ, LSDJ re glows immediately	OPERATION 'B' PART-II	Defective Q30
7	Close DJ, close BLVMT, while counting 30 seconds LSDJ re-glows.	OPERATION 'O'	Defect in a. MVRH/VRH/QVRH. b. MVMT1/VMT1/QVMT1 c. MVMT2/VMT2/QVMT2
8	Close DJ, close BLVMT and take one traction notch. While counting 15 seconds LSDJ re-glows.	OPERATION 'I'	Defect in a. MVSI1/VSI1/QVSI1 b. MVSI2/VS2/QVSI2 or c. Sluggish operation of GR.
9	Close DJ, close BLVMT and take six traction notches. While counting 15 seconds LSDJ re-glows.	OPERATION 'II'	a. All contactors not closed b. Any one of C107 / C105 /C106 not closed c. C107,C105&C106 closed but N/O I/Ls defective.
10	DJ trips in various occasions other than above indications.	TWAC	a. Defective QPDJ b. Slackness of CCDJ /CCPT/CCA c. Moisture in system d. Defective SMGR e. Defective ZPT I/L f. Momentary defect of any I/L in the DJ control circuit.

Tripping Failures (VCB)

Before closing DJ, ensure the following:

1. MP on zero, GR is on zero.
2. Open all top row BL switches.
3. Safety relays are normal.
4. Ensure C107, C105 and C106 open fully.
5. MR / RS pressure above 6.5 Kg/cm2.
6. Battery voltage is above 85 volts.
7. Ensure pantograph is raised fully.

- Close BLDJ, press BLRDJ and observe the LSDJ, UA needle, Auxiliaries sound & LSCHBA.
- After extinguishing of LSCHBA, release BLRDJ. If LSCHBA not extinguishes, release after re glowing of LSDJ.
- Pick up the correct abnormal sign in the following manner.

SL No	INDICATION/OPERATION	ABNORMAL SIGN	PROBABLE REASONS
1	On closing BLDJ and pressing BLRDJ, LSDJ remains glowing	ICDJ	a. Less air pressure in RS or MR b. Less air pressure in VCB unit c. Q118/ Q45/ Q44/ C118/ MTDJ not energised. d. Defective C118 N/O I/L
2	Close BLDJ, press BLRDJ. LSDJ extinguished, UA needle not deviated, no auxiliaries sound, LSCHBA not extinguished and after 5.6 seconds LSDJ re-glows	NO TENSION	a. Derailment/ Accident (reducing of Vacuum / BP levels in loco) b. Cut in Feeding Power Circuit. c. Defect in feeding power circuit. c. Defect in OHE/ track/ formation e. Foreign body on loco roof.
3	Close BLDJ and press BLRDJ LSDJ flickering	'A' BEGINNING	a. Less air pressure or QPDJ defective b. Check QOA/ QLA/ QLM for energisation.
4	Close BLDJ and press BLRDJ. LSDJ extinguished, UA needle deviated, auxiliary sound may hear LSCHBA not extinguished after 5.6 seconds LSDJ re glows.	'A' ENDING	a. Defective ARNO b. Defective QCVAR
5	Close BLDJ, press BLRDJ. LSDJ extinguished, UA needle deviated, auxiliary sound heard LSCHBA also extinguished just before releasing BLRDJ, LSDJ re-glows (LSCHBA flickering)	'A'ENDING PART II	Defective DJ N/O I/L
5	Close BLDJ and press BLRDJ. LSDJ	OPERATION 'B'	Defect in

	extinguished, UA needle deviated, Auxiliary sound heard, LSCHBA also extinguished, after releasing BLRDJ, while counting 15seconds LSDJ re-glows.	PART-I	a. MVSL1/VLS1/ QVSL1 b. MVSL2/VSL2/ QVSL2 c. MPH/PH/QPH d. QCVAR N/O I/L
6	Close BLDJ and press BLRDJ. LSDJ extinguished, UA needle deviated, auxiliary sound heard, LSCHBA also extinguished, on releasing BLRDJ, LSDJ re glows immediately	OPERATION 'B' PART-II	Defective Q30
7	Close DJ, close BLVMT, while counting 30 seconds LSDJ re-glows.	OPERATION 'O'	Defect in a. MVRH/VRH/QVRH. b. MVMT1/VMT1/QVMT1 c. MVMT2/VMT2/QVMT2
8	Close DJ, close BLVMT and take one traction notch. While counting 15 seconds LSDJ re-glows.	OPERATION 'I'	Defect in a. MVSI1/VSI1/QVSI1 b. MVSI2/VS2/QVSI2 or c. Sluggish operation of GR.
9	Close DJ, close BLVMT and take six traction notches. While counting 15 seconds LSDJ re-glows.	OPERATION 'II'	a. All contactors not closed b. Any one of C107 / C105 /C106 not closed c. C107,C105&C106 closed but N/O I/Ls defective.
10	DJ trips in various occasions other than above indications.	TWAC	a. Defective QPDJ b. Slackness of CCDJ /CCPT/CCA c. Moisture in system d. Defective SMGR e. Defective ZPT I/L f. Momentary defect of any I/L in the DJ control circuit.

Tripping Failures - Trouble Shooting:

ICDJ – Q118 Not Energised

1. Ensure C118 fully open and operate it for few times.
2. Ensure C107, C105 & C106 are fully open and operate them for few times
3. Clean the I/Ls of Q44 & Q46(Q44&Q46relays should be in de energise).
4. Operate GR manually for few notches and bring back to '0'
5. If still unsuccessful, operate Q118 manually
6. If manual operation of Q118 is failed, wedge Q118 in energise position and work further with necessary precautions

ICDJ – Q45 Not Energised

1. Ensure CCDJ is in good condition, if blown out, keep HOBA in OFF, renew the fuse and work further
2. Ensure BP1DJ is not in pressed condition and its wires are intact
3. Operate BLDJ for few times
4. Keep ZPT in '2' and try
5. Try with BP2DJ
6. Operate GR manually for few notches and bring back to '0'
7. Try from rear cab
8. If still unsuccessful, operate Q45, manually

ICDJ – Q44 Not Energised

1. Clean the I/Ls of Q45 and try
2. Clean the I/Ls of Q118 and try
3. Operate GR for few notches and bring back to '0'
4. If still unsuccessful, operate Q44, manually
5. If still unsuccessful, wedge Q44 in energise position and work further with necessary precautions

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ICDJ – C118 Not Energised

1. Clean the I/Ls of Q44 and try
2. Clean the I/Ls of Q45 and try
3. Clean the I/Ls of QCVAR and try
4. If C118 is of EP type, ensure MR/RS pressure is above 6.5 kg/cm^2 and EP C118 COC is in open position
5. Try in LT, if closed loop wire Nos. 726 - 731
6. If still unsuccessful, take precautions, operate C118 for few times and ensure flexibility, coil connections are intact
7. If still unsuccessful, ask for relief loco

ICDJ – EFDJ Not Energised

1. Tap the safety relays gently and try
2. Operate re-setting knobs of safety relays
3. Operate C 118 manually for few times
4. Create maximum pressure in RS and try
5. Keep HQOP1/HQOP 2 in 'OFF', HQOA in '0' one by one and try
6. In VCB locos, try by lopping 733 –739 with precautions
7. In VCB locos, check VCB unit air pressure is 5 kg/cm^2

- If still unsuccessful, ask for relief engine.

No Tension:

1. Ensure BP/Vacuum levels are intact, if dropped, put on FL stop the train and check the formation.
2. Check track, formation, OHE for any abnormality
3. If every thing is normal, try once again
4. Change ZPT and try
5. If still unsuccessful, lower both pantographs, contact TPC, act accordingly
6. If could not contact with TPC and meanwhile if supply is restored, work the train further with speed restriction of 60/30 Kmph up to next station, inform to SM and act accordingly

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'A' Beginning:

1. Check for dropping of QOA/QLA/QLM, if any relay energised, act accordingly.
2. Create maximum pressure in RS and try.
3. Tap QOA, QLA&QLM, operate re-setting knobs and try.
4. Keep HQOA in '0' and try

- If still unsuccessful, ask for relief engine.

'A' Ending:

1. Check ARNO, any abnormality is noticed, ask for relief engine
2. If ARNO is good, keep HQCVAR in '0', work further with necessary precautions

Note: While closing DJ, after deviation of UA needle count 4 seconds and then release BLRDJ (LSCHBA will not extinguish).

'A' Ending-Part 2:

Loop wire Nos. 733 – 739 with necessary precautions and work further.

Precautions:

1. Check in LT and ensure C 118 is opening and closing properly
2. After closing DJ ensure C 118 is opened.

Operation B Part 1:

1. Keep HVSL1& HVSL 2 IN '3', HPH & HQCVAR IN '0', duly checking motors working clear the section find out where the trouble is by normalising the switches. If relay is defective, Keep concerned switch in '3', position and work further with precautions. If any motor is not working, isolate the motor and work with precaution.

Operation B Part 2:

1. Loop 700&717 wires and work with precautions. If looping of wires is not possible, wedge Q45 in energised position and work with precaution.

Operation '0':

1. Keep HVRH, HVMT 1 & HVMT 2 IN '3', duly checking motors working clear the section and find out where the trouble is by normalising the switches. If relay is defective, Keep concerned switch in '3', and work further with precautions. If any motor is not working, isolate the motor and work with precaution.

Operation '1':

1. Keep HVSI 1, HVSI 2 IN '3' and close DJ. If still trouble is existing, trouble shoot for sluggish operation of GR
2. If DJ not tripped, clear the section by duly checking motors working and find out where the trouble is by normalising the switches one by one. If relay is defective, Keep concerned switch in '3' and work further with precautions. If motor not working, isolate motor and work with precaution.

Operation '2':

1. All contactors not closed
2. Any one of the contactors of C107/ C105/ C106 not closed
3. C107, C105 & C106 closed but their I/Ls defective.

If no contactor is closed:

a) Check CCA fuse.
b) Check for energisation of Q100.
c) Ensure C118 chronometric I/L is good otherwise, loop wire Nos. 089 –100
d) If still Q100 not energised, wedge it in energise condition and work with precaution.

If Any One of the Contactors of C107/ C105/ C106 Not Closed

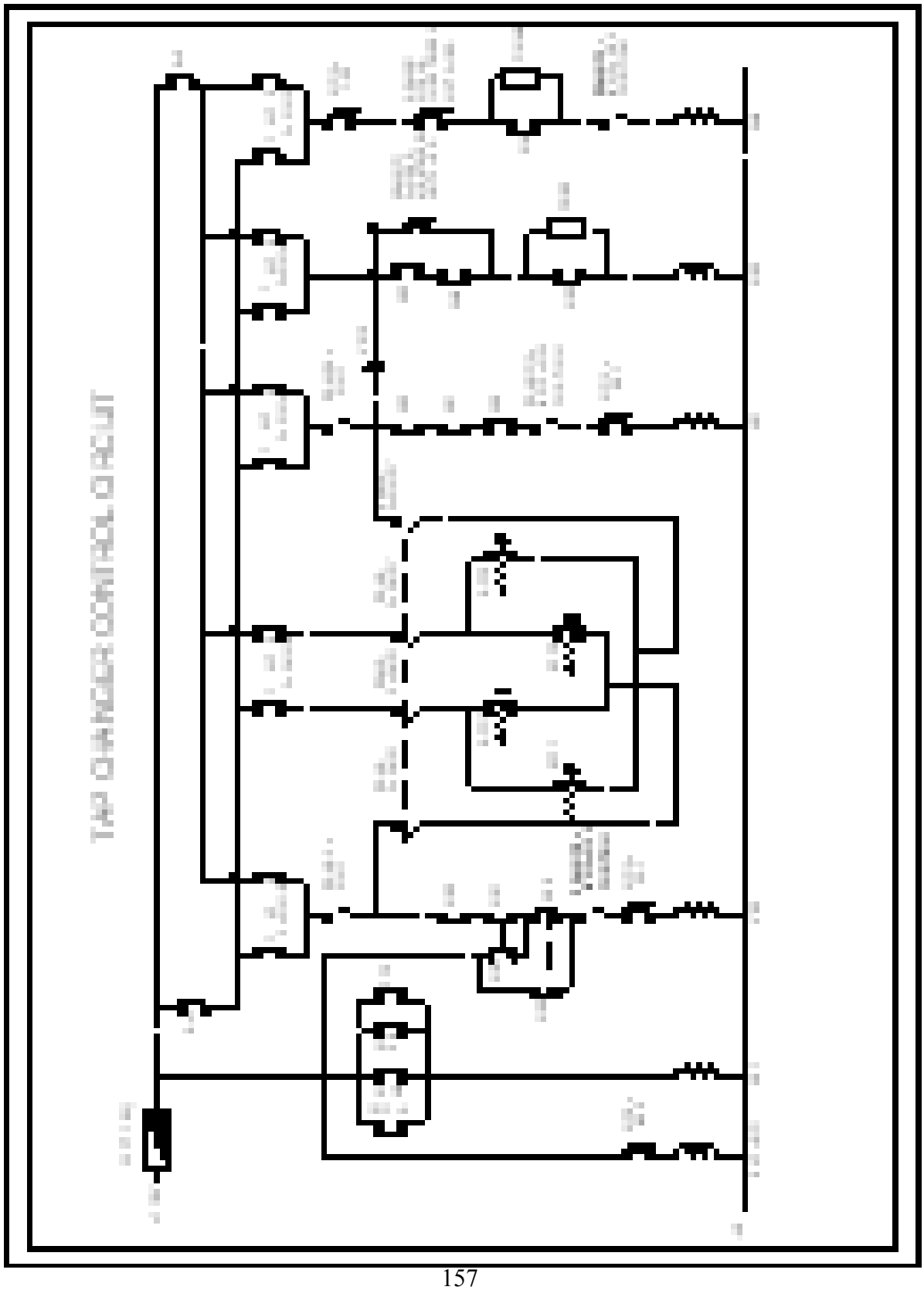
a) Keep concerned switch in '3' and try.
b) Check QTD 105 and QTD 106 for energisation.
c) If still not closing, check the condition of contactor coil wire connections and flexibility of contactor.
d) If still unsuccessful, wedge contactor and work with precautions.
e) When C107/ C105/ C106 wedged, keep concerned switch on '3' position to give initial path to Q 118.

If Any I/L Not Closed

a) Keep HVMT 1 & HVMT 2 switches in '3' and close DJ. If still trouble is existing, conclude C107 N/O I/L is defective, work by wedging Q118 in energise position with precautions.
b) After keeping HVMT 1 & HVMT 2 switches in '3', if DJ not tripped, clear the section, normalize one by one switches and find out where the trouble is, keep concerned switch in '3' and work further with precautions.

TWAC:

a. Renew CCPT, CCDJ, CCA and try
b. Work the train with maximum pressure, always
c. Change ZPT position and try
d. Keep HQOP 1 & HQOP 2 in 'OFF' and HQOA in '0' and try.
e. Increase SMGR pressure for 0.5Kg/cm2 and try
f. Wedge Q118 in energise position and try
g. Wedge Q44 in energise position and try
h. Change the cab and try
i. Operate GR manually and try and contact TIC if failed.


TAP CHANGER CONTROL CIRCUIT

Rng : 3.20

SMGR CONTROL CIRCUIT

This circuit is having progression coil branch (VE1), regression coil branch (VE2), Auto regression branch (Q51), notch by notch regression branch (Q52), GR full notch protection branch (Q46), GR oil pump branch (EVPHGR).

Notch By Notch Progression

When MP is kept in '+' position, VE 1 will energise through

1. CCPT should be in good condition
2. MP closes on '+' I/L
3. BL I/L closes when unlocked
4. ZSMS closes on '1' position
5. Q52 N/C I/L
6. Q51 N/C I/L
7. Q50 N/O I/L
8. ZSMGR closes on 6^{o} clock position (Pacco switch should be projected)
9. GR closes on 0-31 I/L
10. SMGR pressure is between 2.5 to 3.5 Kg/cm^2
    - Now VE 1 coil will energise and GR moves from o to 1 notch.
    - At half notch Relay Q 52 Will energise in the following manner.

Initially

1. MP closes on '+'
2. ASMGR closes in between notches I/L
3. Q52 N/C self I/L
4. Relay Q52 in de energise condition (Closes it's N/C I/L)

After energising maintaining path of Q52…

1. MP closes on '+'
2. Q52 N/O I/L
3. Q 46 N/C I/L
4. RQ 52

- When Q 52 is energised, its N/C I/L will open on VE 1 coil branch. So, VE 1 de energizes and further progression is stopped
- To take another notch, leave MP (It will move to 'N' position and Q52 de energizes)
- Again move MP to '+' position to take next notch.

Notch by Notch regression:
When MP is kept in '-' position, VE 2 energizes through

1. CCPT should be in good condition
2. MP closes on '-'
3. BL I/L
4. ZSMS closes on '1' position
5. Relay Q52 N/C I/L
6. Relay Q51 N/C I/L
7. Relay Q50 N/O I/L
8. ZSMGR closes on 6^{o} clock position (Pacco switch should be projected)
9. GR closes on 32-1 I/L
10. SMGR pressure is between 2.5 to 3.5 Kg/cm^2

- Now VE 2 coil energises and GR regress.
- In between notches, Relay Q 52 energizes in the following manner.

Initially…

1. MP closes on '+'
2. ASMGR closes in between notches I/L
3. Q52 self I/L (Q 52 N/C I/L)
4. Relay Q51 in de energise condition (Closes it's N/C I/L)

After energising maintaining path of Q52…

1. MP closes on '-'
2. Q52 N/O I/L
3. Q 46 N/C I/L
4. RQ 52

- When Q 52 is energised, its N/C I/L opens on VE 2 coil branch. So, VE 2 will de energise and further regression is stopped
- To regress another notch, leave MP (It will move to 'N' position and Q52 de energizes)
- Again move MP to '-' position.

Quick Regression Of GR :

For quick regression of GR, keep MP on '0' position, so that VE 2 coil only energizes permanently as Q 52 will not energise. After coming GR to '0', VE2 de energizes.

Emergency Electrical Control (EEC)

If SMGR cannot be operated with MP then work with EEC operation.

For EEC working

1. Keep ZSMS in '0' position. By which, MP path will cut off and brings BPP / BPR path into the circuit.
2. Keep MP in 'N' position, to close the line contactors.
3. When BPP is pressed, VE1 coil gets energised and GR progress only one notch.
4. In between notches Q52 energizes through VS13 diode, ASMGR closes in between notches I/L and Q52 N/C self I/L.
5. Once Q52 is energized it is maintaining path through VS13 diode, Q52 N/O I/L, Q 46 N/C I/L and RQ 52.
6. To take next notch, release BPP to de energises Q 52 and then press BPP.
7. When BPR is pressed, VE2 coil energised and quick regression takes place. Release BPR when further regression is not required. (There is no notch by notch regression facility with EEC operation since Q 52 will not come into service)
8. BPP & BPR are located on the Loco Pilot's desk.

Manual Operation of GR:

Whenever SMGR cannot be operated electrically with MP or EEC, it should be operated manually by ZSMGR handle.

Conditions to be fulfilled for manual operation of GR

1. MP should be kept on 'N' position to close the line contactors.
2. Q 44 should not be in wedged condition.
3. Rotate the ZSMGR handle from 6^0 clock to 3^0 clock position in anticlockwise direction. Now, the Pacco switch will be pressed,

electrical and pneumatic connections to SMGR will be cut off and also the existing pressure in the SMGR will be exhausted.

4. Abstract the ZSMGR handle from 3^0 clock position.
5. Insert the ZSMGR handle to SMGR shaft at 6^0 clock position.
6. Communication to be established between the Loco Pilot and Asst. Loco Pilot.

Procedure for doing the manual operation of GR

1. Rotate the ZSMGR handle from 6^0 clock to 6^0 clock position in clockwise direction, within 0.5 second for one notch progression.
2. Rotate the ZSMGR handle from 6^0 clock to 6^0 clock position in anticlockwise direction, within 0.5 second for one notch regression.

Precautions during the manual operation of GR

1. Rotate the ZSMGR handle with in 0.5 second otherwise DJ will trip.
2. Asst. Loco Pilot has to observe the RGR carefully from corridor for any smell / Smoke / Fire.
3. During the manual operation of GR, speed should not exceed 30 kmph.
4. In emergency, Loco Pilot has to trip DJ for controlling / stopping the train.
5. To recluse DJ Asst. Loco Pilot has to bring GR to '0' manually.
6. Asst. Loco Pilot is only the responsible for doing the manual operation of GR.

Q 46 branch:

For quick regression, when MP kept on '0'position Q46 relay energizes through GR closes on 1-32 I/L, ASMGR closes in between notches I/L, Q 46 N/C self I/L and ZSMGR $6^{'0}$ clock I/L. In between notches, Q46 de energizes since ASMGR I/L is opened. During quick regression with MP, if GR struck up on full notch, Q46 energizes and trips DJ (after 5.6 seconds) by opening its N/C I/L on Q118 branch. After energising Q 46, N/C self I/L will open and path will be maintained through RQ 46

Q 51 branch:

Q 51 will energize in the following occasions

1. If BP pressure drops below 2.8 kg/cm^2 with A9, QRS 2 will de energises and it's N/C I/L will close on Q 51 branch.
2. If QD 1 or QD 2 is energised, Q 48 will energise and it's N/O I/L will closed on Q 51 branch.
3. If Traction Power Circuit is fed more than 750 Volts, Relay Q 20 will energise and it's N/O I/L will close on Q 51 branch.
4. If Vacuum is dropped with out A9 or BP pressure drops below 4.4 kg/cm^2 is with out A9, PR 2 will energise and it's N/O I/L will close on Q 51 branch.

EVPHGR branch:

When GR is in between 6 to 32 notches, EVPHGR energizes through GR 6-32 I/L

TRACTION FAILURES

TOTAL LOSS OF TRACTIVE EFFORT WITH GLOWING OF LSB:

- Operate MPJ handle from forward to reverse for 2 to 3 times and finally keep it in required direction.
- Take necessary precautions and check for proper setting of J1 & J2 according to the cab leading i.e., both J1 & J2 manual operating handles should be in upwards for cab1 leading and downwards for cab 2 leading.
- Ensure CTF1, 2, 3 manual operating handles are in upwards (traction side)
- Ensure C145 is open fully.
- Clean the interlocks of Q50.
- If still un-successful, wedge Q50 in energized position.

PRECAUTIONS AFTER WEDGING Q50:

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a. MPJ should not be operated up to destination.
b. Shunting is prohibited. if required in emergency personally ensure proper setting of reversers for every operation of MPJ.
c. RB should not use.
d. When DJ is tripped on notches, keep mp on 'o' to bring GR to 'o'.

- Write remarks in loco logbook inform to tic at first opportunity.

TOTAL LOSS OF TRACTIVE EFFORT WITH OUT GLOWING OF LSB:

When MP is moved from 'o' to 'n' then to '+' LSGR not extinguished, ammeters & nr not deviated, loco not moving and Lsb extinguished.

Reason is VE1 not energized. Check the following –

1. Try by EEC operation.
2. Operate ZSMS for 2 or 3 times and try
3. Check Q52. It should be in de-energising position. If Q52 is in energized position, wedge in de-energized position. Don't keep mp in '+' for longer period, otherwise quick progression of GR will take place.
4. Check Q51. It should be in de-energising position. If it is energize
   - Check QRS2. If it is de-energised, Check CCLS fuse. If it is fused renew the same (In some locos QRS2 is having separate fuse called CCQRS2). Observe BP level rectify the same if reduced. If BP pressure is found normal, open RGEB2 COC and try. If still QRS2 is not energised, wedge QRS2 in energised position and work the train with precautions. If QRS2 is already energised, clean the interlocks.
   - Check PR2. If it is energizes, observe BP/VAC. levels. If dropped, check the formation for train parting or BP/VAC. hose pipes are given up and rectify the same. If BP/VAC. levels are found normal, wedge PR2 in de energised condition, work the train with precautions. If PR2 is already de energised, clean its I/Ls and try.
   - Still Q51 not de energising, contact TIC for advice.
5. Clean the interlocks of Q50.

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6. Ensure ZSMGR handle in 6^{o}clock position and pacco switch is in lifted condition.
7. Ensure SMGR pressure is 2.5 to 3.5 kg/cm^{2} and no leakage in the SMGR pipe line.
8. If still unsuccessful, clear the section by manual operation of GR.
9. Contact TIC for advice.

1ST NOTCH AUTO REGRESSION WITHOUT LSP:

when MP is moved from '0' to 'n' then to '+' LSGR extinguished, NR deviated to '1', GR come to 'o', without glowing of LSP.

CAUSES: Rear cab BL not locked properly.

trouble shooting:

1) Press BPT ensure LSP glows in any cab.

- Trip DJ, lower Panto, lock the BL box in front cab.
- Go to the rear cab, operate BL key for 2 to 3 times.
- Lock properly and try.

2) Clean Q50 & Q51 I/Ls and try.

3) If un successful, clear section with manual operation of gr or from rear cab.

4) If ZSMS is modified work from rear cab or by manual operation of gr.

5) After clearing the section,

- Wedge Q46 in de energized condition and work onwards with eec operation.
- Inform to TIC at first opportunity.

BANDING FAILURE:

Projection of poly-glass material from traction motor vent mesh is treated as 'banding failure'. when it occurs, isolate particular tm and clear the section with speed restriction of 15 kmph, contact tic. if banding failure is noticed at station then immediately inform to tic.

NOTE: Ignoring of banding failure leads to locked axle.

LOCKED AXLE:

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1. Detach the loco from the formation.
2. Depute assistant loco pilot by the side of the loco, to observe moving of wheels.
3. Take two traction notches, observe the wheels and find out which wheel is not rotating.
4. Contact tic for arranging of loco breakdown staff.

SLIPPED PINION:

It can be known through 1st notch auto regression with LSP.

1. Apply SA 9 and ensure application of loco brakes physically.
2. Depute assistant loco pilot to stand near the truck to observe spinning noise or rotation of traction motor pinion.
3. Take two traction notches and find out for slipped pinion.
4. Isolate concerned traction motor and work further.
5. Inform to TLC at next stopping station.

ABNORMAL SOUND FROM TM:

1. Depute assistant loco pilot to observe for any abnormal sound from the traction motor, while moving the loco.
2. If unusual sound is due to hanging part remove or secure the same and work further.
3. If unusual sound is from traction motor, isolate the same and work further.
4. If still unsuccessful, contact tic.

SMELL / SMOKE / FIRE FROM TM:

1. If any smell, smoke or fire is noticed from any traction motor, put out the fire.
2. Isolate concerned traction motor, clear the block section and contact TLC.

Rng : 3.21:
LOCOMOTIVE BOGIES

Introduction:

Bogies in locomotive are provided to permit long length of locomotive body to negotiate the curves. A small length of bogie is desirable. The length of bogies is decided by the distance between the centre of extreme wheels of bogie is known as bogie wheelbase. Bogie wheelbase shall be well proportioned to permit the bogie negotiating the curve and jerking. The bogie has two a more bogies on which the body is mounted. The distance between the centers of extreme wheels is known as the total wheelbase.

Bogies Classification: - Bogies are classified on

1. No of axles
2. Type of axle drive

The type of axle drive and no of axles in the bogie is also called the wheel arrangement. Wheel arrangements are classified as B, Bo and CO.

B: Two axles, axles are mechanically coupled

BO: Two axles, axles are independently driven

CO: Three axles, axles are independently driven

Locomotive always have two or more bodies. So the wheel arrangement of the locomotive is designed as B-B, BO-BO, CO-CO and BO-BO-BO-BO.

Wheel arrangement of locomotive: - Different types of wheel arrangement are available in Indian Railway Locomotives are as under:

Wheel Arrangement	Locomotive Type
BO-BO	WAP5
CO-Co	WAM4, WAG5, WAG7,WAG9,WAP7,WAP4
BO-BO-BO	WAG 6A, WAG 6B

Components: - The bogie of a locomotive is an assembly of following components.

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1. Bogies Frame
2. Wheels
3. Axles
4. Springs
5. Axle Boxes
6. Supports For Traction Motors
7. Supports For Brake Rigging & Brake Cylinder
8. Friction Dampers/ Snubbers.

Co-Co Trimount Bogie

Majority of the locomotives in Indian Railways is provided with this type of bogies. The bogie consists of single piece cast steel bogie frame carrying the center pivot in the cross member located towards the end of the locomotive. Center pivot carries 60% of vertical load; it receives and transmits tractive and braking forces. The side bearers take the other 40% of vertical load. The side bearers do not receive or transmit Tractive and braking forces. The frame is supported by four sets of double equalizers extending from the end axles to the center axle. Full equalization is obtaining by suitable positioning the springs and controlling their working height. The weight of locomotive body is transferred to the bogie at center pivot and two side bearers to form a three point supports. This type of bogie is known as Tri-mount Bogie.

Suspensions:

Suspensions near bogie are provided to reduce the vibration. The vibrations are picked up by the wheel, which is mounted on railway track which if self is shaking up and down due to irregularities in the surface. The suspension system also balances the vertical loads between the wheels and provides passenger comfort by reducing vibrations in the vehicle body.

The suspension between the axle and the bogie frame constitutes the primary suspension. The suspension between the bogies frame and vehicles body is called secondary suspension.

Suspension, consisting of four groups of helical coil springs. Each group of springs consists of two nests of one outer and one inner coil. To prevent uncontrolled bouncing effect of locomotive body, supported on helical coil springs damper is provided as a resisting force.

Types of dampers are:

1. Friction Damper
2. Hydraulic Damper

In Tri-mount bogie friction damper or snub bar is provided on four of the inner coils of each bogie.

FLEXI COIL BOGIE

This Bogie is provided for WAP1 & WAP4 locomotives. The bogie frame and bogie BOLSTER of FLEXI COIL bogie MARK-I are of steel cast box type. The locomotive body weight is transferred to the BOLSTER through a center pivot. The steel castled 'H' type BOLSTER is supported on the steel castled bogie frame at four corners, by pair of helical springs placed in spring pockets of main longitudinal member of the bogie frame. The BOLSTER is located with respect to bogie frame by upright pedestals, which are integral part of the bogie frame. This arrangement serves to transmit force from BOLSTER to the bogie frame and vice-versa. Spring loaded snubbing piston two Nos per bogie made of phenolic material to have high friction between BOLSTER and bogie frame for damping in both vertical and lateral modes of oscillation are also provided in the above pedestal arrangement. Lateral stops are also provided on the bolster as well as on the bogie frame to limit the side movement by flexing action of the springs. The bogie frame is in turn supported on axles by another set of springs resting on the axle boxes. The load of the locomotive super structure rests on the center pivot bowel of the bogies. The bowel is fitted with phenolic oil lubricated vertical and horizontal liners, which provided rotational freedom between body and bogie in operation.

Suspension:

This flexi coil bogie has two stage of vertical suspension in which helical springs have been used on primary and secondary stages. Primary between axle box and bogie frame and secondary between bogie frame and BOLSTER. The transfer's flexibility between the body and the bogie has been achieved by the flexi coil action of the helical springs at the secondary stage. The support of the bolster springs have been placed on wider arm to give better stability in rolling.

Bolster spring Friction Device:

It consists of a phenolic piston, steel washer and a spring contain with in a cylindrical housing in the BOLSTER, to have high friction between BOLSTER and bogies frame for damping in both vertical and lateral modes of oscillation.

ROLLAR Bearing Axle Boxes:

Movable axle journal boxes are mounted in pedestals cast integral with the frame. The movement of the boxes in the pedestals obtains the lateral play for negotiation over curves and turnouts. In conventional design of axle boxes, the axle thrust arising from flange rail reaction is exchanged between the axle and the housing in a rigid manner. To reduce the effect of the impact a resilient device has been incorporated in the path of the axle thrust. In end axle boxes, the thrust is made to pass through a conical rubber thrust pad held between inner outer thrust collars. Middle axle boxes are with floating bearing so as to permit safe negotiability over sharpest curves and turnouts.

Braking:

Pneumatic brake system is applied in this bogie. Six brake cylinders per bogies are used to operate clasp type brake rigging. Each cylinder piston is connected to the brake lever to actuate the brakes on one wheel only. Actuating adjusting rod at the bottom does the brake shoe adjustment in service.

TETRA MOUNT HIGH ADHESION BOGIE

This bogie is provided for WAG7 locomotives.

Introduction:

With increasing demand of heavy freight traffic on Indian Railways, a new high adhesion bogie has been developed by RDSO for high horse power freight locomotive to achieve higher Tractive effort of 42 tones at start. The bogie exhibits better adhesion characteristics with reduced weight transfer.

General Arrangement of Bogie:

This a three-axle type bolster less bogies with two-stage suspension, floating pivot and unidirectional arrangement of axle hung nose suspended traction motors. Bogies frame is of straight and fabricated box type construction with three transoms to carry nose suspension.

The locomotive body weight is supported on bogie frame through four rubber side bearers directly mounted on bogie side beams. Shims have been provided below outer side bearers to

distribute load on side bearers in a 60%: 40% ratio, 60% of load being supported on side bearers adjacent to and 40% of the load at remaining two side bearers. Center pivot does not take any vertical load and is used only form transfer of traction and braking forces.

The bogie frame in turn is supported on axles through helical coil springs mounted on equalizer beams. The equalizing mechanism consists of equalizers hung directly on end axle boxes and supported on middle axle box through a link and compensating beam arrangement. The equalizing mechanism enables achievement of equal axle loads on uneven track and reduces weight transfer at start.

Suspension Arrangement:

The bogies has two-stage suspension with helical coil springs between axle box and bogies frame in primary stage and side bearers (rubber sand which) between bogies frame and locomotive body in secondary stage. The lateral stiffness of rubber springs is utilized to provide to provide lateral guidance at the secondary stage.

Four vertical hydraulic dampers, one with each nest of primary springs & Two lateral hydraulic dampers are provided in secondary stage to supplement the damping provided by side bearers both in lateral and rotational modes which prevents nosing at high speed.

Two lateral rubber stops are provided on each bogie on either side of the middle axle to limit lateral movements. Vertical stops are provided on bogie frame to limit vertical movement between axle boxes and bogie frame.

Roller Bearing Axle Boxes: -

Movable axle journal boxes are mounted in pedestals or horns, fabricated integral with the frame. Lateral play for negotiating curves and turnouts is obtained by the movement of axle boxes in horns. End axle boxes are provided with rubber thrust pads to cushion lateral thrust, while 10 mm lateral plate is provided on middle axle boxes.

Rng : 3.22

STEPS TO CONSERVE ENERGY

- Switch OFF blowers when the train is expected to stop for 15 min.
- Open DJ whenever the detention of train is expected to be more than 30 min.
- Lower the pantograph when locos are idling in the yard.
- Switch off rear loco in MU locos when running with light load.
- Ensure no brake binding in the formation.
- Avoid frequent application of brakes.
- Optimise control of train with Rheostat brake.
- Avail advantage of down gradients and coast maximum extent.
- Loco Pilots should call-out energy coasting boards along with other signals, to draw the attention of the Loco Pilot at the down gradients.
- Steady and even braking at every halt with minimum application of brakes, this will help not only in increasing the life of brake blocks and wheels but also saves electrical energy.
- Account of correct tonnage/ load for goods trains and proper entry in CTRs.
- Late taking of signals or continuous running on Yellow signals to be reported.

Rng : 3.23

MAINTENANCE SCHEDULES OF LOCOMOTIVE

GOODS LOCOS			
Sl No	MAINTENANCE SCHEDULE PERIODICITY FOR GOODS LOCO	WAG-5A/B, WAG-5HA/HB & WAG-7	WHERE TO BE DONE
1	IA	45 days ± 3 days	Home shed
2	IB	90 days ± 3 days	Home shed
3	IC	135 days ± 3 days	Home shed
4	2nd IC	270 days ± 7 days	Home shed
5	AOH	18 months ± 10 days	Home shed
6	IOH	54 months ± 1 month 6 lakh Km. whichever is earlier.	Home shed
7	POH	9 years ± 3 months or 12 lakh	Work shop

		Km, whichever is earlier.	

PASSENGER LOCOS			
SL NO	MAINTENANCE SCHEDULE PERIODICITY FOR GOODS LOCO	PASSENGER LOCO WAM-4 & WAP-4	WHERE TO BE DONE
1	IA	45 days ± 3 days	Home shed
2	IB	90 days ± 3 days	Home shed
3	IC	135 days ± 3 days	Home shed
4	2nd IC	270 days ± 5 days	Home shed
5	AOH	18 months ± 15 days	Home shed
6	IOH	36 months ± 1 month 4 lakh Km. whichever is earlier.	Home shed
7	POH	6 years ± 3 months or 8 lakh Km, whichever is earlier.	Work shop

RNG3.24
TRACION MOTORS

Traction Motors used in our loco are of DC series Motors. There are six Traction Motors, one per each axle is provided. Two types of Traction Motors are being used in the locomotive. They are TAO 659 and Hitachi.

Differences between TAO 659 & HITACHI

Sl No	TAO 659	HS-15250A (HITACHEE)
1	It is DC series motor	It is DC series motor
2	continuous out put is 685 KW	Continuous out put is 630 KW
3	Starting current is 110A continuous current 750A	Starting current 1200 A Continuous current 900 A
4	Maximum Voltage is 750V	Maximum Voltage is 750V

5	Speed - 1060 RPM	Speed - 895 RMP
6	Number of TMs 6	Number of TMs 6
7	Series field with cumulative field poles	Series field with commutative field poles
8	Insulation - H class	Insulation - C class
9	Number of poles: - Main poles - 6 commutating poles - 6	Number of poles: - Main poles - 6 commutating poles - 6
10	Gear ratio - 15:62	Gear ratio - 18:64
11	Gear case capacity at maximum of dip sTICk is 20.2 ltrs lubricating and minimum of 5.2 ltrs.	Gear case capacity at maximum mark of dip sTICk is 8.5ltrs of cardium compound and at minimum mark 3.5 ltrs.
12	Oil lubricating is required	Grease lubrication is required for suspension beaming.

These Traction Motors are axle hung nose suspended type and are provided with grease lubricated roller bearing for armature shaft as well as for suspension bearing for HITACHI motors.

TAO 659 motors are provided with grease lubricant roller bearings for the armature shaft and journal bearings for suspension. They are oil lubricated by wicks (felt pads), with the wick holders which are supplied with oil by an axle driven pump. There are two oil wicks containers, which are in communication with each other through a common passage. Any surplus oil of the container will return to the oil sump. Two oil dip sticks are provided, one on the wick container and the other on the main oil sump in which the oil pump is fitted.

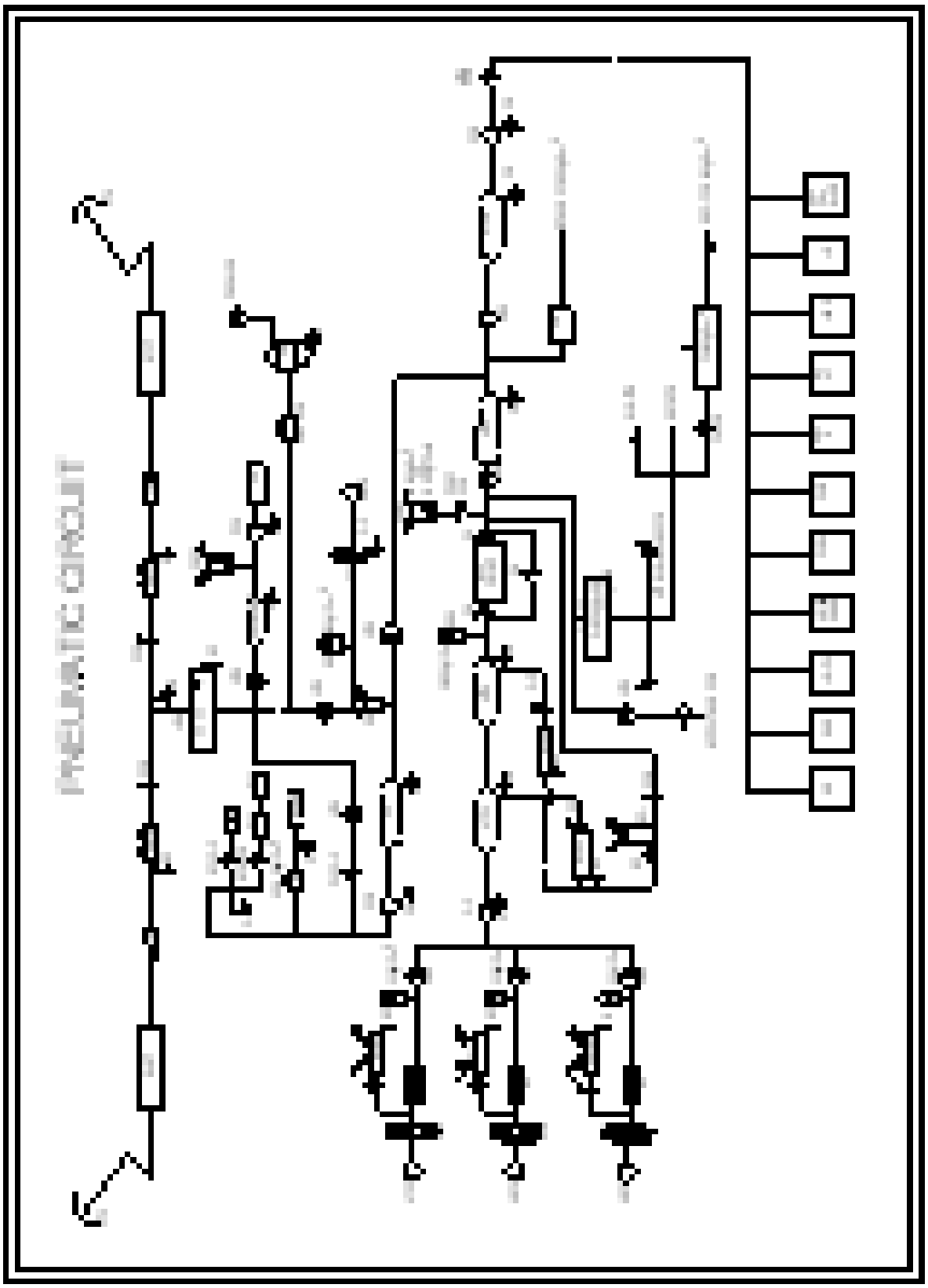
The oil should be checked on the upper sump (wick container with a dip stick). The dip stick will have minimum and maximum markings. While checking, it should be ensured that the oil level is between minimum and maximum marks. The oil level should be checked immediately after service running. Oil level below the min level (bottom mark) on the dip stick indicates lack of oil delivery. New oil is to be added through the dip stick tube on the wick container. The total oil capacity of the lubrication sump is 20.2 liters at max of oil level. The difference between maximum and minimum marks on the sump dip stick represents a quantity about 5.2lits of oil.

The Traction Motor drives the axle through a rigid straight tooth gear. One end of the armature shaft is shrunk fitted pinion, which is meshed with drive gear fitted to the axle. There fore, the tooth wheel is required lubrication. These gears are housed in a gear

case and provide lubrication. Top gears cardium compound are poured in to the gear case and the capacity of gear case is 6 liters at maximum oil level. A dip stick is provided to measure the oil level with two markings maximum and minimum. The oil should be between minimum and maximum marks. The distance between minimum and maximum are corresponds to approximately 3 liters of oil. The current reading of oil level will be available if checked at least 1 minute after the loco has come to a stop. Fresh oil is introduced through the dipstick tube. The gear case is fitted to the Traction Motor body with bolts and nuts both horizontally and vertically.

The armature winding coils are maintained in the slots by providing mounted slot wedges are laminated fiber glass slot wedges and by poly glass type. A frame of Traction Motor is magnetic steel chamber on the commutator side openings have been provided for upper air inlets and lower inspection cover. The terminal box is situated on the upper part of the motor frame, on axle side a removable cover gives access to the connection. Special provision has been made in design of the motor to ensure that loco operates satisfactorily on flooded track to a maximum flood level of 200mm above rail level.

These Traction Motors are closed with forced air circulation by a Blower, driven by AC Three Ø induction motor known as MVMT1 and MVMT2. Traction Motors: 1, 2 & 3 are cooled by MVMT1 and Traction Motors: 4, 5 & 6 are cooled by MVMT2


PNEUMATIC CIRCUIT

Rng : 4.1
PNEUMATIC CIRCUIT

Initially pressure is created with MCPA to raise panto and to close DJ. To start MCPA, BA voltage should be more than 85 volts and CCBA should be in good condition. Keep ZCPA on '1' position, MCPA starts and creates pressure in RS reservoir when RAL COC is in open position. To create pressure in RS, five drain COCs should be in close position (CPA d/c, RS d/c, RDJ d/c, DJ oil separator d/c and panto pipe line d/c). MCPA should not work for more than 10 min. MCPA can create pressure up to 8kg/cm^2 since SS1 safety valve is provided (set at 8kg/cm^2) between CPA and NRV. The amount of pressure created in RS can be seen through RS gauge. After creating RS pressure to 6.5 kg/cm^2 raise panto, close DJ, close BLCP and switch off MCPA.. .According to HCP position, MCP starts. Three Compressors are provided to deliver compressed air at 9.5kg/cm^2 to system via respective NRVs, after cooler, CDC with d/c, MR1 with d/c, MR2 with d/c, through NRV, MR3 with d/c, MR4 with d/c, CDC with d/c and MR4 COC.

One heat less twin tower air dryer is also provided after MR2 for supplying dry moisture free air to break system and electrical appliances. The air dryer is having three COCs namely A, B and C. Normally A and B (green color) COCs are open and C (red color) COC is close position.

Each MCP is provided with one inter cooler safety valve set at 5.5kg/cm^2 and independent safety valve set at 11kg/cm^2 which is provided on delivery pipe line before NRV. Pneumatic system is provided with SS2 safety valve set at 10.5kg/cm^2 which is provided between MR2 and MR3.

On each MCP delivery pipe line one un loader valve is provided. After stopping the compressor, this valve removes the back pressure from delivery pipe line.

Usage of MR1 And MR2 Pressure:

MR1 feeds MR2 reservoir and further it passes through air dryer to the following.

- Through duplex check valve (set at 4.9kg/cm^2) goes to MR equalizing pipe. From MR equalizing pipe pressure goes to sanders, wipers to feed pipe (through a COC and 6kg/cm^2 feed valve) and also to F1 selector valve port no. 15. In between MR2 and MR equalizing pipe connection is given to air intake COC

through NRV.

- This pressure also charges MR3.
- To RGCP for cut in and cut out compressors.
- To VEAD for auto draining of MR1 and MR2 moisture when MR pressure reaches to 9.5 kg/cm^2.

Usage of MR3 pressure:

- Through an NRV this pressure is charged to MR4 and CR.
- For charging BP pressure.

Usage of MR4 pressure:

This pressure after passing through CDC and MR4 COC is supplied to

- Horns.
- Both cabs A9 inlet.
- Both cabs SA9 supply.
- HS4 valve.
- VA1 release valve
- MU2B port no. 63.
- HB5 valve.
- C2B valve.
- C3W valve.
- VEF (E).
- VEF (M).

Usage of Control Reservoir Pressure:

This pressure through a CDC is supplied to

- SMGR operation.
- Through EP1 COC to BA1 panel.
- Through EP2 COC to BA2 &3 panels.
- Through EP3 COC to BA4 panel (WAG7 beyond 27200 and RB provided WAP4 locos).
- Through R1 COC RS reservoir, DJ assembly and panto pipe line.

Usage of Emergency Reservoir (RS) Pressure:

Initially this pressure is used

- To raise panto.
- To close DJ.

- To close C118 (if EP contactor).

MR Pressure Not Maintaining:

Ensure MCP is working.

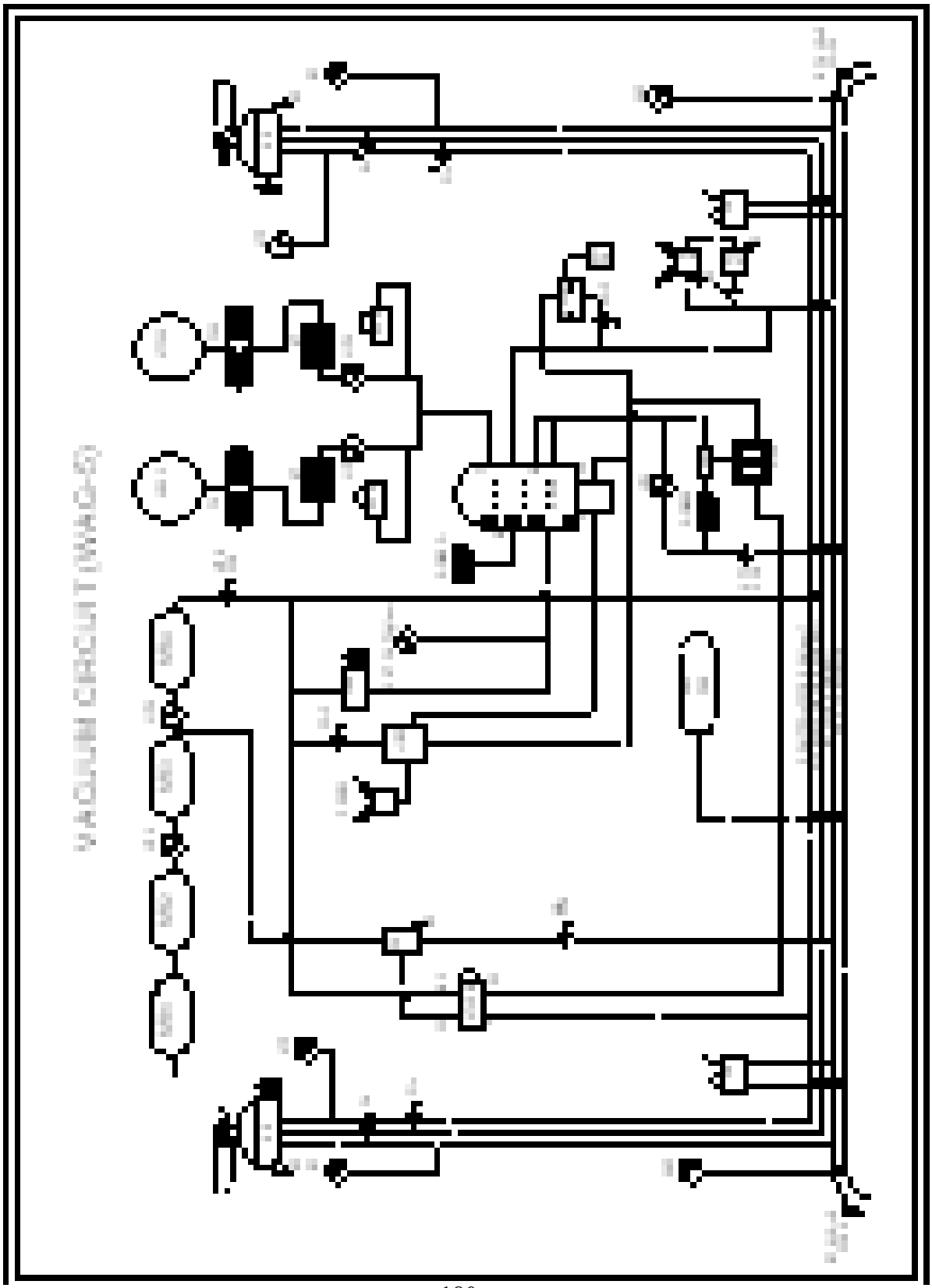
A. Close BLCPD and try.
B. CLOSE VEAD COC AND CLOSE VEUL COCS AND TRY.
C. Increase No. of CPs by HCP and try.
D. Ensure all drain COCs are closed.
E. Tap safety valves gently and ensure no safety valve is struck up in lifted position.
F. Tap NRV and try.
G. Ensure no leakage of air from sanders, wipers, horns & auto drain valves. If so, close concerned COC
H. Ensure no leakage in the system if found arrest them.
I. Ensure no leakage of BP / FP in formation, if it is air brake train.
J. If twin pipe formation, work with single pipe and try.
K. If still unsuccessful, de energizes the loco, drain out all the pressure from the system, again energize the loco and try.
L. Isolate air dryer, if provided.
M. If still unsuccessful contact TIC.

CR Pressure Not Maintaining:

1. Ensure MR pressure is 8 to 9.5Kg/cm^2.
2. Ensure MR1, 2& 3 drain COCs are in closed.
3. Ensure CR drain COC is closed.
4. Tap NRV gently (near pipe line of CR)
5. Ensure no leakage in CR pipeline.
6. If closing of CR drain COC is not possible dummy it with a suitable wooden plug.

PRECAUTIONS WHILE WORKING WITH CPA:

1. Close R1 COC.
2. Clear the section with the available pressure.
3. Keep a watch on battery voltage, which should not run down below 85 volts.
4. After clearing the section, contact tic.



Rng : 4.2

VACUUM BRAKE

GENERAL INTRODUCTION:

Braking system is very important for controlling the speed of train and also for stopping train on different occasions. Braking is achieved by mechanical arrangement connected to the piston braking cylinder. The brake causes friction against the moving wheel and thus retarding force develops causing the wheels speed to reduce. Mechanical braking system is of 2 types, vacuum brake and air brake.

WORKING PRINCIPLE OF VACUUM BRAKE SYSTEM:

The continuity of vacuum in the train formation causes brake blocks to be away from wheels and thus the brakes are released. This vacuum continuity is achieved by connecting all vacuum hose pipes from loco to brake van. Vacuum is created by exhausters provided in the loco.

INITIAL CREATION:

Ensure MR pressure 8-9.5 kg/cm^2.

1. Ensure exhauster is working.
2. Ensure both side vacuum hose pipes are on dummy with IR washers.
3. Ensure BP pressure 5 kg/cm^2.
4. Ensure HS 4 pressure is 1.4 -1.7 kg/cm^2.
5. Ensure VTP COC is open.
6. Ensure MU2B is in lead position.

When above conditions are fulfilled, in VA1B valve top port is connected to BP of 5 kg/cm^2 and bottom port is connected to HS4 pressure of 1.4 to 1.7 kg/cm^2. In this position, the spool valve will be balanced and connects exhauster port to train pipe through VA1 release valve, hence vacuum will be created in train pipe.

APPLICATION

When a9 handle brought to application position. The BP pressure will be reduced. In VA1B valve the top port pressure is reduced causes lifting at VA1B valve, by which exhauster port closes and connects train pipe to exhaust port through GD80D filter. When the level of top & bottom ports become equal, the valve will get balanced and same amount of vacuum will be maintained in train pipe.

RECREATION:

To recreate vacuum, A9 to be placed in release position. Now BP will create to 5kg/cm^2, on top port of VA1B valve will become

---

5kg/cm^2. So, exhauster port will be connected to train pipe vacuum will re create in train pipe.

VACUUM BRAKE CYLINDER:

RELEASE VALVE:

It is used to releasing. Due to any reason, if vacuum on top of the piston is more than the bottom of the piston, brakes will be binded. To overcome this problem, release valve is provided. On operating this valve, vacuum in top of the piston will be destroyed. On releasing of this valve, again vacuum will be charged. Because of equal amount of vacuum in both of the chambers, brakes will be released.

Brakes once applied can only be released either by recreating vacuum below the piston or by admitting air to chamber space by means of release valve.

ROLLING RING

Up ward moving of piston brings down rubber rolling ring. This ensures reduction of air leakage past ball valve and brakes remain in applied position for longer period.

BALL VALVE

In vacuum cylinder, the vacuum will create through by the help of ball valve. Since there is equal amount of vacuum in both chambers, piston will come down on its own weight. Due to any reason if vacuum is destroyed from train pipe, air rushes to the bottom side of the piston. Since ball valve is on its seat, air cannot go on to the top of piston.

AUXILIARY CHAMBER:

It is provided for smooth application or releasing of brakes.

VACUUM TESTS:

VACUUM BRAKE TEST (IN DUAL BRAKE LOCOS):

Ensure both cab A9 handles release, RS closed ZPV is in 1 or 2, both side vacuum hose pipes are on dummy with IR washes.

1. Ensure BP is 5kg/cm^2 and HS4 pressure is 1.4 to 1.7kg/cm^2 and MU2B lead position.
2. Ensure HCP is in single CP working position.
3. Close BLPV, C111 or C121 will close according to ZPV. Vacuum will create and needle will shoot up in gauge close HPV also to start other exhauster to work.
4. Apply SA9 ensure BC gauge reeds 3.5kg/cm^2. Take one notch. Apply A9 to emergency vacuum gauge needle will drops to ‘o’. GR will return to ‘o’ and also exhausters will stop working.

VACUUM EFFICIENCY TEST:

1. Ensure vacuum is 58 or 56 cm in loco on dummy.
2. Switch off BLPV and destroy vacuum by A9.
3. Disconnect hosepipe from dummy and couple 8mm leak hole test plate.
4. Keep A9 in release position, close BLPV.
5. Vacuum should create 53 cm with in 30 seconds.
6. Repeat the same with other PV also.

No	Type of loco	Dummy	Disc
1	Dual brake	58	53
2	Pure vacuum	56	53
3	Newly commissioned or POH locos	56	53

VACUUM BLOCKAGE TEST:

1. Ensure vacuum is 58cm in train pipe.
2. Switch off BLPV and destroy vacuum by A9
3. Remove one side of the vacuum hose pipe from dummy and hold it upwards into atmosphere
4. Close BLPV vacuum should not create more than 8 cm
5. Repeat the same for other side also

VACUUM LEAKAGE TEST:

1. Ensure both vacuum hosepipes are on dummy with IR washers, both A9 are released and both RS are closed.
2. Close BLPV, create vacuum.
3. Open BLPV, wait for 30 seconds for stabilising of needle.
4. Wait for another 60seconds, note the reading again.
5. The difference should not be more than 7cm for loco 5cm for single coach and 13cm for formation.

BRAKE BINDING IN FULL TRAIN-REASON AND RECTIFICATION:

S no	Reasons	Rectifications
1	Rough application of A9 to emergency.	Apply A9 gently
2	Non releasing of brakes when attaching or detaching of wagons take place.	Release brakes manually whenever attaching / detaching takes place.
3	Vacuum level raising abnormality.	Don't allow so, tap vac. Relief valve
4	Improper releasing of cylinders.	Release cylinders properly fully.
5	Hand brakes may be in applied position.	Release hand brakes.
6	Leakage of vac. At valve due to ACP.	Re set the clappet valve.
7	Leakage of vac. At release valve / siphon / train pipe etc.,	Arrest the leakage.

BRAKE POWER CERTIFICATION:

Formula for calculation of effective brake power percentage of a train is

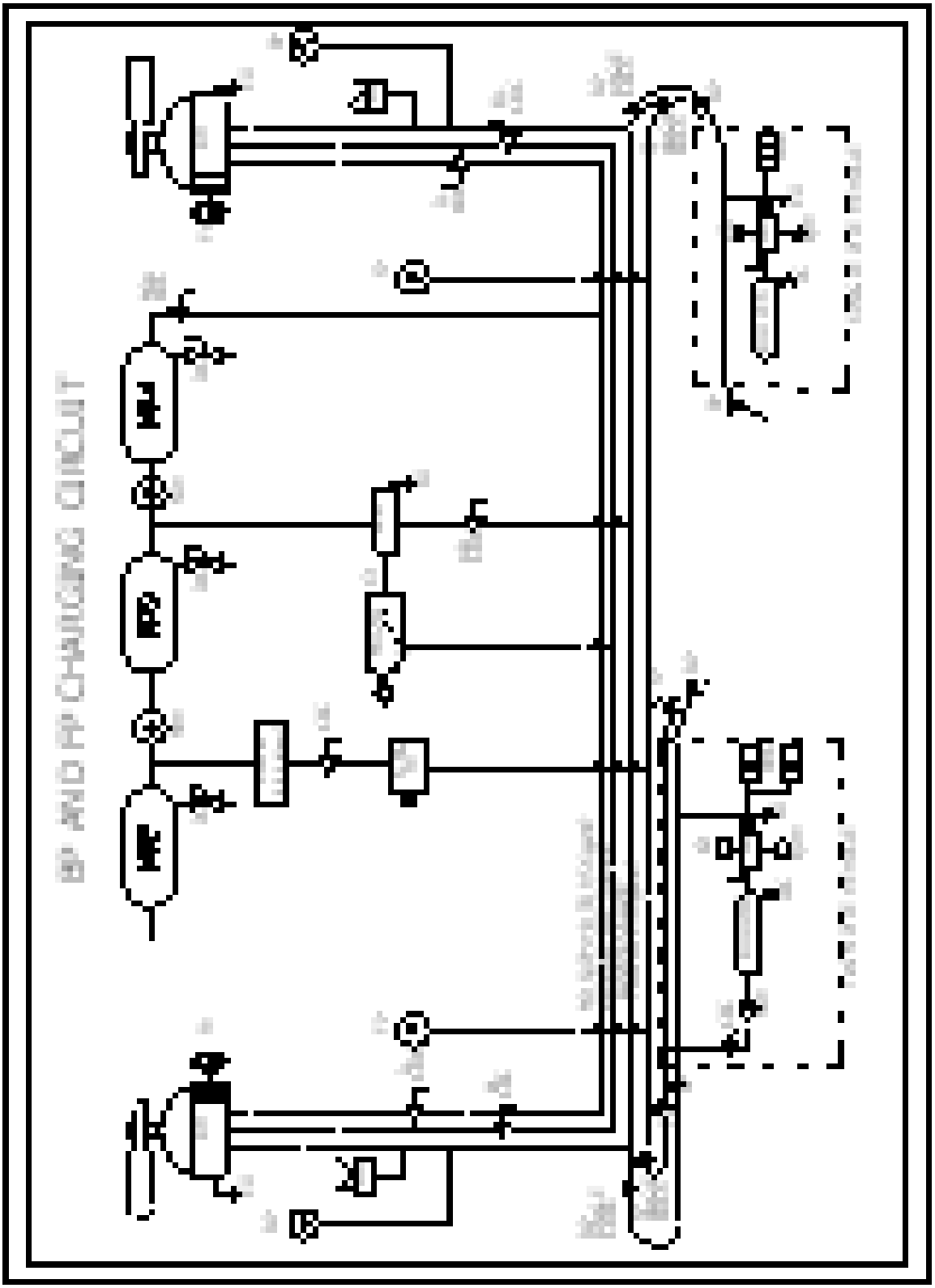
$$\frac{\text{Effective Cylinders}}{\text{Total no. Of cylinders}} \times 100$$

For certification after creation of vacuum on formation, destroy it with a9, check brake cylinders for not lifting of pistons such cylinders are defective. Check the brake blocks for correct binding on wheels. If one truck brake blocks are not touching, treat one cylinder is defective.

VACUUM LEVELS:

Train	loco	brake van
Mail / express	53 cm	47cm
Passenger	50 cm	44 cm

Goods	46 cm	38 cm


BP AND FP CHARGING CIRCUIT

RNG : 4.3
AIR BRAKE SYSTEM

DIFFERENCES BETWEEN AIR & VACUUM BRAKE SYSTEMS:

Vacuum brake	Air brake
1. Braking distance is more.	1. Braking distance is less.
2. Braking force is less.	2. Braking force is high.
3. Brake application is not in uniform.	3. Brake application will be uniform.
4. Not suitable for heavier and lengthy trains at higher speeds.	4. Suitable for heavier and lengthy trains running at higher speeds.
5. Equipment and maintenance is more.	5. Equipment and maintenance is less.
6. Atmosphere air is used for braking force.	6. Compressed air is used for braking force.
7. Distributor valve is not provided.	7. Distributor valve is provided.
8. Cut off angle COC is not provided.	8. Cut off angle COC is provided.
9. Continuity test is not required.	9. Continuity test is required.
10. During application of brakes piston will go in side the cylinder.	10. Twin pipe system is also available.
11. It takes more time for releasing of brakes.	11. After ACP, train stops.
	12. Piston will come out from the cylinder during brake application.
	13. It takes less time for releasing of brakes.

ADVANTAGES OF AIR BRAKE OVER VACUUM BRAKE

1. Enable to haul more & lengthy loads with higher speed.
2. Braking distance is less with uniform application.
3. Initial cost is more but maintenance is less.
4. Brake power deterioration is very less.
5. Effective braking force since compressed air is used for.
6. DV is provided with isolation facility.
7. While working twin pipe, can also work with single pipe, if required.
8. Releasing time is less.
9. Wagon turn round period is 6 years, where as for vacuum is 2 years.

RNG : 4.4

WORKING OF AIR BRAKE SYSTEM (BP)

I. INITIAL CHARGING OF BP PRESSURE:

1. MR pressure is 8 to 9.5kg/cm^2 and MR4 COC in open.
2. A9 I/L & O/L COCS open in working cab and close in non-working cab.
3. Both a9 handles release and RS's are closed.
4. MU2B in 'lead' and a-8 COC open.
5. BP pipe to be coupled up to last vehicle, BP angle COCS of all vehicles to be opened except loco front and last vehicle rear side.

After the conditions mentioned above are fulfilled, MR pressure is reduced by A9 to 5kg/cm^2 and is charged in control pipeline through outlet COC. This control pipeline pressure, when MU2B is in lead position (through 3 and 13 ports) acts on C2A relay valve. 8 to 9.5 kg/cm^2 of MR3 pressure is available at C2A. But it will send the same amount of pressure which is acting on it by MU2B i.e. Only 5 kg/cm^2 of pressure will be fed to BP pipe line, provided A8 is in open position, when BP pressure is 5 kg/cm^2, formation will be in release position.

II. APPLICATION:

1. To apply the brakes, keep A9 in application position.
2. Now control pipeline pressure is reduced through A9 feed valve exhaust port.
3. So, actuation on C2A also reduced say if control pipeline had 4kg/cm^2, the BP pipeline also will have 4kg/cm^2 of pressure, remaining pressure from loco will exhaust through loco C2A exhaust port. Hence BP is reduced and brakes will apply on formation.

III. RECREATION:

1. To create BP pressure again, a9 to be brought to release position.
2. Again control pipeline creates to 5kg/cm^2.
3. Actuation on C2A also will be 5kg/cm^2. So, C2A will feed 5kg/cm^2 of BP pressure in BP pipeline. because of BP is

recharged with 5kg/cm^2 of pressure, formation brakes will be released.

TROUBLE SHOOTING WHEN 'BP' NOT CREATING

1. Ensure MR pressure is above 8 kg/cm2
2. Ensure MR 4 COC is open.
3. Ensure A9 I/L & O/L COCs in working cab are open and close in non-working cab.
4. Ensure RS 1 & 2 are closed
5. Ensure both A 9 handles are in release position.
6. Ensure MU2B is in lead position.
7. Ensure A8 COC in open position.
8. Tap C2A and try.
9. Operate MU2B for few times and try
10. Change the cab and try.
11. Trip the DJ, drain out the pressure completely, again charge the loco and try.
12. If still unsuccessful, contact TLC.

MANUAL RELEASE - CONVENTIONAL TYPE:

PISTON OUTSIDE:

1. Ensure no leakage of BP pressure at DV/palm ends
2. Operate QRV of DV
3. Isolate DV and operate QRV
4. Slacken the vent plug of brake cylinder carefully.

PISTON INSIDE:

1. Slacken the SAB and try
2. Disconnect the brake pull rod pin of brake rigging.
3. Ensure no part is hanging. If required secure the hanging part with rope/wire

MANUALRELEASE - BMBC TYPE:

1. Operate QRV of DV.
2. Isolate DV and operate QRV.
3. Close brake cylinder COC of each truck.
4. Discount / puncture the flexible pipe of the truck. Now pressure will come out and piston will release. If still

unsuccessful release the safety sling by pulling the latch as the miniature SAB will rotate and brakes will release.

Note: Ensure brake blocks are away from the wheel tyre.

AIR FLOW INDICATIONS:

Air Flow indicator is provided to give an indication of air flow rate in the BP of the train. If any abnormal increasing of air flow in the brake pipe, because of train parting or loco parting or ACP or heavy leakage in the BP or guard emergency brake application and bursting of BP hose pipe would give visual indication by deviation of white needle over red needle. This abnormality is indicated by white needle.

DIFFERENCES - SINGLE PIPE & TWIN PIPE:

Sl no.	Single pipe	Twin pipe
1	BP pressure is charged not only in BP Pipeline but also in auxiliary reservoir.	One pipe is meant for BP pressure charging another one meant for auxiliary reservoirs 2 no's.
2	After application and release, for Recharging it will take time.	It will not take much time for recharging.
3	brakes releasing time is more.	Brakes releasing time is less.
4	If BP pipe is damaged, no alternative Remaining stock to work with out brakes.	If any one pipe is damaged can work the train with another pipe by conversion.
5	Since FP is not available auxiliary Reservoir will have 5kg/cm^2.	Since FP pressure is 6kg/cm^2, auxiliary reservoir will have 6kg/cm^2 of pressure.

DISTRIBUTOR VALVE

Distributor valve is heart of braking system of each wagon / coach. It connects the brake cylinder to exhaust port when a BP of 5 kg/cm^2 is available in the BP pipeline. When BP is dropped, it allows the auxiliary reservoir pressure to enter into brake cylinder and causes brakes to apply.

BP PRESSURE OVER CHARGING:

There is possibility for over charging of BP pressure in the system. In such a case, clear the section, carefully and stop the train in next station with single application of brakes.

a. Close BP angle COC in rear of the locomotive.
b. Change the cab. If BP pressure becomes normal, conclude working cab a9 feed valve is defective. Work from rear cab with necessary precautions.
c. On changing the cab also if BP pressure is excess, conclude C2A relay valve is defective. Tap C2A gently and try. If become normal, operate A9 for several times and confirm working normal. If still un-successful, ask for relief engine.

Reasons for brake binding in full train:

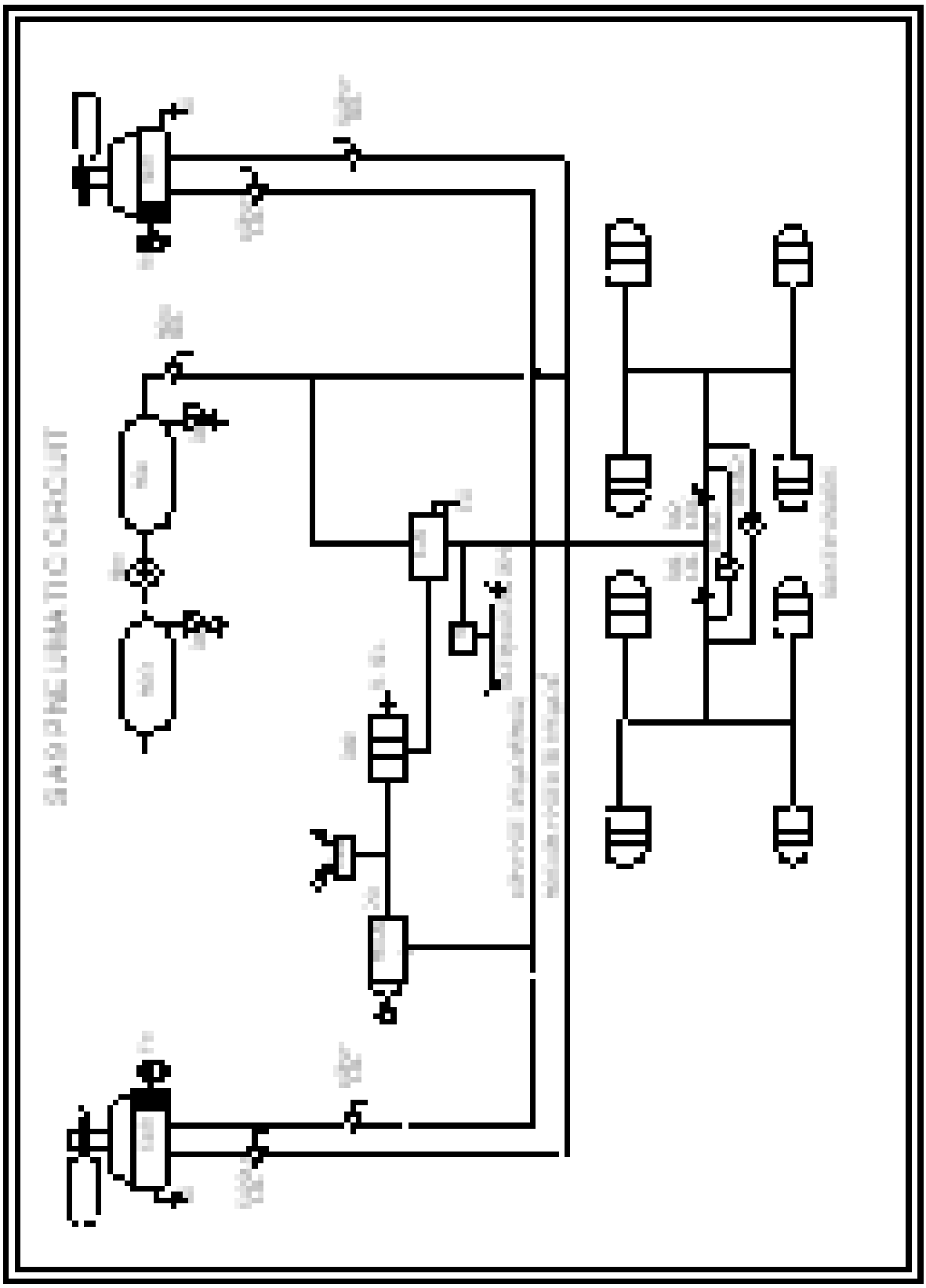
1. Defective distributor valve.
2. Leakage of pressure at distributor valve.
3. Leakage of pressure from BP palm ends / angle COCs.
4. Wrong setting of SAB.
5. Hand brake may be in applied condition.
6. Difference of pressure on loco changing.
7. Defective brake rigging i.e., levers jamming against guide brackets.
8. Improper adjustment of end pulls rod holes.
9. Brake beam bent or broken.
10. ACP on coach.

Rng4.5
INDEPENDENT LOCO BRAKES

I. APPLICATION OF LOCO BRAKES:

1. MR pressure should be 8 to 9.5kg/cm^2 and MR4 COC in open.
2. SA9 supply and apply COCs should be open in working cab and close in non-working cab.
3. Working cab sA9 handle should be in application position.
4. MU2B should be in 'lead' position.
5. Both side BC equalising pipe COCs should be in closed.

after the conditions mentioned above are fulfilled, mr pressure is reduced by sA9 to 3.5kg/cm^2 and is charged in apply pipeline through apply COC. This apply pipeline pressure, when mu2b is in lead position (through 2 and 20 ports) acts on c2b relay valve through double check valve. 8 to 9.5 kg/cm^2 of mr4 pressure is available at c2b, but c2b will send the same amount of pressure which is acting on it by mu2b i.e. Only 3.5 kg/cm^2 of pressure will be fed to loco brake cylinders provided both trucks bogie isolation COCs are in open position. The amount of loco brake cylinder pressure applied can be seen through both cab bc gauges. In both cab bc gauges, both needles should show 3.5kg/cm^2



II. RELEASING OF LOCO BRAKES:

1. To release loco brakes, keep sa9 in release position.
2. Now apply pipeline pressure is exhausted through sa9 feed valve exhaust port.
3. So, actuation on c2b becomes '0'. The existing pressure from loco brake cylinders will exhaust through c2b exhaust port.
4. Ensure BC gauge both needles showing '0'.

PROPORTIONAL WORKING

Application of loco brake along with formation brakes is called proportional working. When BP pressure is dropped, c3w valve senses the drop page of BP pressure. C3w valve senses when BP drops 0.6kg/cm^2 with in 6 seconds. When BP drops in loco, c3w acts and it takes proportionate mr4 pressure and passes via 2kg/cm^2 limiting valve and acts on VEF(M). Now VEF(M) admits mr4 pressure to c2b valve through f1 selector valve and double check valve. C2b valve now takes mr4 pressure and send to loco brake cylinders when both trucks bogie isolation COCS are in open position.

To isolate loco brake application by a9, press PVEF. Now VEF (E) energizes and admits mr4 pressure to VEF(M). Now VEF(M) exhaust port is connected to C2B. The existing pressure from C2b to VEF(M) becomes '0'. When there is no actuation on C2B, the brake cylinder pipe line is connected to C2b exhaust port there by the brake cylinder pressure become '0' and brakes are released.

Rng : 4.6
AIR BRAKE TESTS

CP EFFICIENCY TEST:

1. Keep a-9 in emergency position.
2. Start cps and build up MR pressure.
3. Release A-9, build up BP of 5 kg/cm^2.
4. Couple 7.5mm leak hole test kit to BP pipe palm end
5. Open BP angle COC and note down time.
   - When BPSW is pressed, BP gauge needle should not drop below 4.4kg/cm ^{2} in 60 seconds.
   - When BPSW is not pressed, BP gauge needle should show between 2.5 to 3.5kg/cm ^{2}.

Note: for this test required number of cps to be kept in service according to trailing load.

BP LEAKAGE TEST:

1. Ensure MR pressure is 9.5 kg/cm^2
2. Ensure BP pressure is 5 kg/cm^2
3. Bring a9 to minimum reduction position to reach BP pressure to 4.0kg/cm^2
4. Close A8, wait for 30 seconds to settle the gauge needle
5. Wait for another five minutes and note down the BP pressure reading difference of pressure should not be more than

   For loco: 0.7kg/cm^2 within 5 minutes (0.2kg/cm^2 for one minute)

   For formation: 1.25kg/cm^2 for 5 min (0.25kg/cm^2 for 1 minute)

FP LEAKAGE TEST:

1. Ensure MR pressure is 9.5 kg/cm^2
2. FP pressure is 6 kg/cm^2
3. Open FP angle COC slightly to reach FP pressure to 5 kg/cm^2
4. Close feed valve COC and FP angle COC simultaneously. Wait for 30 seconds note down the FP pressure reading
5. Wait for another 5 minutes, note down the reading
   Difference of pressure should not be more than

   For loco: 0.7kg/cm^2 within 5 minutes (0.2kg/cm^2 for one minute)

   For formation: 1.25kg/cm^2 for 5 min (0.25kg/cm^2 for 1 minute)

BP CONTINUITY TEST:

It is to be conducted in the following circumstances:

1. While clearing any stable load.
2. After power interception and after shunting.
3. After reversing the loco.
4. Before signing BPC.
5. After GDR check.

Procedure

1. Ensure BP pressure is 5kg/cm^2 in loco and in BV 4.8/4.75kg/cm^2
2. Apply a9 to bring BP pressure to 4.0kg/cm^2 and close A8.
3. Advice guard to apply brake van's emergency brake handle or open last vehicle BP angle COC (if BV is last vehicle) till BP pressure reaches to '0' in loco BP pressure gauge.
4. Loco pilot to ensure BP pressure is '0' in loco and guard to ensure BP pressure in brake van is '0'.if BP pressure not dropped to '0', check the formation.
5. Inform the guard to normalize BV emergency handle and in loco keep A9 in release and open A8 COC.

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6. Ensure BP is recreated in loco 5kg/cm^2 and in BV 4.8/4.75kg/cm^2

Note: 1. Sensitivity of DV is 0.6kg/cm^2 in 6 seconds for application of brakes. 2. In-sensitivity of DV is 0.3 kg/cm2 in 60 seconds.

General precautions before starting from mid-section:

1. BP & FP angle COCs are intact on formation. Conduct BP continuity test.
2. Ensure all distributor valves are in service.
3. If abnormality is noticed, attend the same and make necessary entry in BPC.
4. Ensure brakes are working properly on formation.
5. If it is to be attended further by TXR staff, give message to controller.

Precaution before reaching to destination:

1. While entering into station, ensure train is rolling .with brakes released condition.
2. Follow speed restrictions, if any, in station yard/ terminals.
3. Stop the train at appropriate place.
4. Ensure necessary remarks are made in loco logbook.

RNG :5.1

LOCO BRAKE TESTING

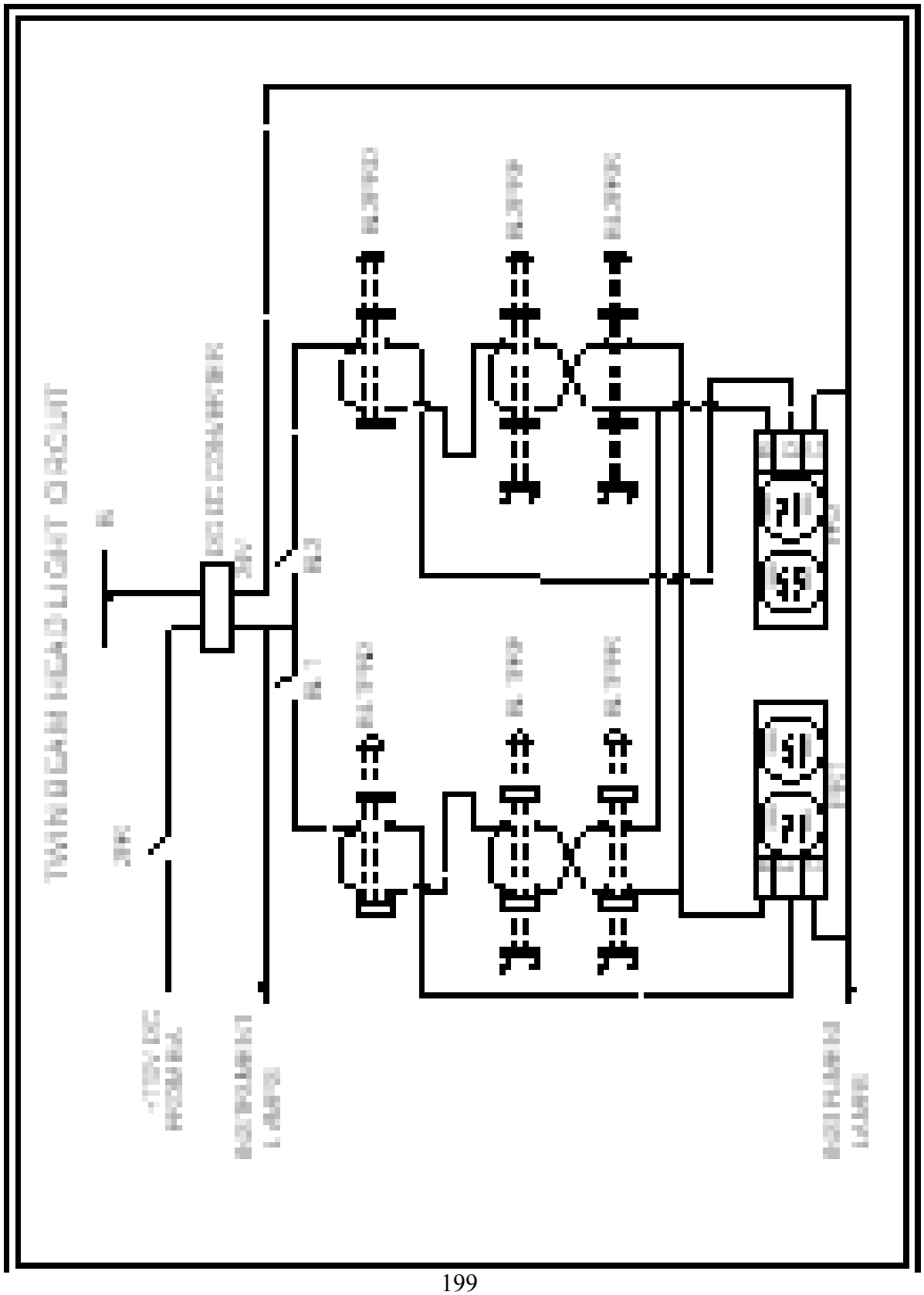
1. Keep SA 9 in application position.
2. Ensure BC gauge reads 3.5 Kg/cm^2
3. Personally ensure that all brake cylinders are applied and brake blocks are touching to the wheels.
4. Ensure nobody is standing near by the loco.
5. Take few traction notches and test the loco brake power as follows.

S.No	LOCO	GEAR RATIO	NOT TO MOVE AT (AMPS)	TO MOVE AT (AMPS)
1	WAM 4	15:62	600	800
2	WAM 4	21:58	800	1000
3	WAG 5	15:62	600	800
4	WAG 5	18:64	600	800
5	WAP 1	21:58	800	1000
6	WAP 4	23:58	800	1000

7	WAG 7	16:65	600	800
8	WAG 7	18:64	600	800

6. Release SA 9 and ensure BC gauge reads ‘o’ and brakes are released.

S.No	LOCO	BOGIE	Revised piston stroke (mm)	Clearance between brake block and wheel tyre in release position (mm)
1	WAM 4 WAG 5	Co-Co Tri Mount	95-105	10
2	WAP 1 WAP 4	Flexi Coil Mark-I	68-78	10
3	WAG 7	Co-Co Tetra Mount High Adhesion	107-117	10


TWIN HEAD LIGHT CIRCUIT
71
55
51
71

RNG : 5.2
HEADLIGHT CONTROL CIRCUIT
(TWIN BEAM)

Equipment provided

Sl No	Equipment	Purpose	Location
1	DC-DC Converter	Stabiliser for headlight	Located in Motor Chest No.1
2	PR1 & PR2	Front and Rear headlights	Loco Front side & rear side
3	ZPR	Head Light Switch	Located in Switch panel (ZRT)
4	BLPRF	Front headlight switch	Located on BL box
5	BLPRR	Rear headlight switch	Located on BL box
6	BLPRD	Head light dimmer switch	Located on BL box
7	Bi-polar switch	To keep other unit in service	Located on DC-DC Converter
8	Spare bulbs	As spare for replacement	Two with each head light unit

The Twin-beam headlight is introduced to achieve higher illumination at lower power. The 24 Volts of two Halogen lamps are used in this system for each head light unit. The DC-DC Converter is used in this system to convert 110Volts of Battery (DC) to 24Volts DC supply. As it is taking supply from batteries, the headlight will be available in open condition of DJ also. It consists of two 400W converters. A selectable switch (Bipolar/Rotating) is provided and located in front of the unit. It gives 24Volts (400Watts) of power to the twin-beam headlight (2 x 100W) and to the indication panels (approx. 160W).

The headlight beams are adjusted from individual reflectors to meet at a distance of 305 meters for long beam and 250meters for short beam.

Whenever headlight is not in use, keep ZPR/ZRT in OFF position.

While operating Bipolar/Rotating switch on DC - DC converter, ensure ZPR/ZRT in OFF.

Two fuses are provided on DC-DC converter unit, for each converter one fuse.

Note: On DC-DC converter unit each converter consists of red LED (input supply) and green LED (output supply). If both LEDs are not glowing, defect with fuse/ input supply. If only green LED is not glowing, defect with concerned converter.

Conditions for working of Head light

1. HBA should be IN '1' position should be in good condition
2. Additional CCBA & CCBA fuses
3. ZRT / ZPR to be switched ON
4. Fuse on Dc-Dc converter should be in good condition
5. Both side Head light bulbs should be in good condition

Working of front headlight

I. From leading cab, to glow front head light

1. Close BLPRF.
2. Open BLPRR & BLPRD switches
3. The supply of 24 volts from Dc-Dc converter will reach to front head light through BL1 I/L, BLPRD N/C I/L, BLPRF N/O I/L and BLPRR N/C I/L. Now, the front head light both bulbs Bright filaments (100W) will glow with bright.
4. To dim the front head light, close BLPRD. Now the supply of 24 volts will reach to the front head light through BL I/L, BLPRD N/O.Now, the front head light both bulbs Dim filaments (90W) will glow with dim.

II. From leading cab, to glow rear light

5. Close BLPRR
6. Open BLPRF & BLPRD switches
7. The supply of 24 volts from Dc-Dc converter will reach to rear head light through BL1 I/L, BLPRD N/C I/L, BLPRF N/C I/L and BLPRR N/O I/L. Now, the rear head light both bulbs Bright filaments (100W) will glow with bright.
8. It is not possible to dim the rear head light.

TROUBLE SHOOTING FOR HEAD LIGHT NOT WORKING

Close BLPRR, to test the rear head light.
If rear head light is working,

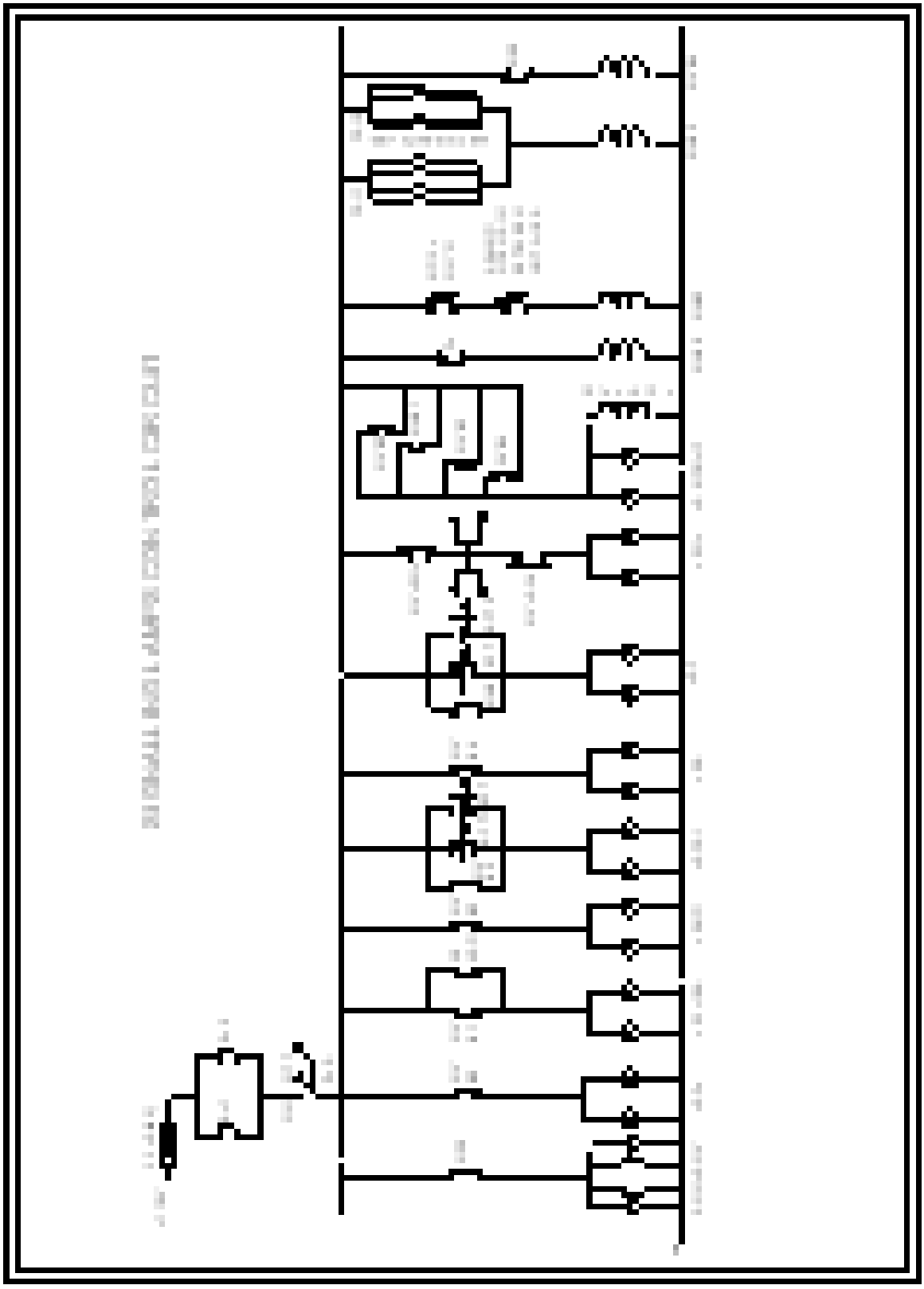
1. If front side bulb is blown out, renew the same with spare one
2. If still it is not glowing, check the bulb holder for any defect or slack terminals
3. If still unsuccessful, work the train without head light with 40kmph of speed restriction duly informing to SCOR/TIC.
4. If rear head light also not working,
5. Ensure ZRT / ZPR is closed

6. If rotating switch is provided on converter unit, change it to other position
7. Change the position of Bipolar switch on DC-DC converter unit
8. If still headlight is not working, check the fuses provided on converter unit. If any fuse melts, replace with proper fuse
9. In both converter & RTPR provided locos, change HRTPR position to keep RTPR in service.
10. If still head light is not working, keep marker lights in ON and work the train without head light with 40kmph of speed restriction duly informing to SCOR/TIC.

Replacement of Damaged Bulb

- Open the back cover from inside the cab, identify the defective bulb.
- Pull out the wire loom by holding 3way nylon connector.
- Press the bulb holder a little inwards and rotate anti clockwise.
- The spring loaded holder will come out. Remove the damaged bulb.
- Take the new bulb from the box fitted on the back cover.
- The new bulb is to be placed properly in the reflector, matching the notch & small raised portion on the bulb.
- Fix the spring loaded holder and connect back the wire loom.

Caution: *The glass portion of the Halogen lamp should not be touched by hand, which may cause cracking during operation. Lamp to be handled from metal portion only.*



Rng : 5.3

WORKING WITHOUT PILOT LAMPS

1. While closing DJ, release BLRDJ after 4 seconds of UA needle deviates.
2. Keep a good watch on UA needle and the noise of auxiliaries to get correct indication of tripping.
3. The deflection of UA needle and the noise of auxiliaries will only be the indication sign for closing DJ and TROUBLESHOOTING.
4. Keep a watch on battery voltage, battery charger tension and the ammeter on battery charger.
5. Frequently check the telltale fuses on RSI blocks. If any fuse projects out follow the instructions given in chapter 3.
6. Continue hauling the train upto next locomotive relief point.
7. Whenever MP is placed on '0' observe notch repeater needle to come to '0' and both ammeter needles and traction motor voltmeter needle come to '0'.
8. Inform TIC at the first normal stop.
9. Enter in the loco logbook stating the place from where TIC has been informed.

Rng : 5.4

HORNS ARE NOT SOUNDING

1. Check the air pressure in cab-1 center locker gauge and
2. position of low tone (LT) and high tone(HT) horns cut out COCs. If the air pressure is less, build up the same. If cut out COCs are closed open them and resume traction
3. Try to sound the horns from assistant Loco Pilot side. If they are sounding instruct the assistant Loco Pilot to sound horns wherever necessary and resume traction.
4. If they are not sounding, try to sound the horns from rear cab by assistant Loco Pilot. If successful depute the assistant Loco Pilot to sound the horns from rear cab whenever necessary. After clearing the section contact TIC for advice
5. If rear cab horns are also not sounding, check the position of MR-4 cut out COC. If it is closed, open the same, check the working of horns and resume traction.

Rng : 5.5

DUTIES OF CREW AT NEUTRAL SECTION (With Single Loco)

1. While approaching a neutral section, BLCPD to be closed and air pressure to be built up to 8 kg/cm^2 in MR-1, MR-2 and RS (see center locker gauge).
2. Accelerate the train speed if necessary without exceeding the speed limit.
3. On reaching `500 mts BOARD' check the air pressure, vacuum guage and speed.
4. On reaching `250 mts BOARD' bring MP to `0' and be prepared to open DJ.
5. On reaching `DJ OPEN BOARD' open BLDJ and observe LSDJ. If LSDJ doesnot glow, immediately lower panto by placing ZPT on `0'.
6. After opening DJ, open BLCP, BLPV and BLVMT.
7. Ensure contactors C-105, C-106 and C-107 are opened fully.
8. On reaching `DJ CLOSE BOARD', close DJ by closing BLDJ and pressing BLRDJ.
9. After closing DJ, close BLPV and BLVMT, after starting of blowers, close BLCP.

After recreation of sufficient amount of vacuum, progress the traction notches observing ammeters and voltmeter

Rng : 5.6

TESTING OF AUXILLARIES WORKING

1. Place A-9 on release and close BLPV, BLCP and BLVMT.
2. Check the working of PV-1 and PV-2 and check the drops of lube oil through sight glass (Northy type 2 to 3 drops per minute, SLM type 9 to 12 drops per minute).
3. Check the suction of air from VMT-1, VMT-2 and VRH and throwing out of air from VSI-1, VSI-2, VSL-1 and VSL-2.
4. Check the temperature of MCP-1, MCP-2, MCP-3, MPV-1, MPV-2, MVMT-1, MVMT-2 and ARNO by placing the palm.
5. Trip DJ, open BLVMT, close DJ, take one notch and check the working of blowers VRH, VMT-1 and VMT-2.

Note: For stopping the blowers, DJ should be tripped and then BLVMT should be opened. Before reclosing DJ, ensure contactors C-105, C-106 and C-107 are opened fully.

Rng : 5.7

STOPPING AND STARTING THE TRAIN ON UP GRADIENT

1. Control the train with minimum application of vacuum / BP pressure.
2. Apply sand few meters before stopping the train.
3. Immediately after the train is stopped, apply SA-9 keep A-9 on run or release.
4. When the BP pressure / vacuum is fully recreated on train, there will be a slightly back pull by the formation.
5. Before restarting, close ZQWC switch.
6. While restarting ensure full vacuum / BP pressure is recreated, press sander pedal and take one or two traction notches and release SA-9.
7. When the train is started moving, progress the traction notches without exceeding the starting current rating of 1100 Amps. and apply sand to avoid slipping.
8. After starting the train, accelerate the train beyond stalling speed.
9. If the train is not moved even after applying full starting current within 5 to 10 seconds, apply SA-9, bring MP to `0', recreate full vacuum / BP pressure and check for any brake binding and if everything is normal try to restart the train in the above said manner.
10. If the train cannot be started, contact TLC and follow GR 6.03.

Rng : 5.8

PROCEDURE OF WORKING THE AIR BRAKE TRAIN

1. Do not try to couple or uncouple the air pipes unless the angle COCs on either sides are closed fully.
2. While the loco is attached, be present and personally ensure that the FP and BP air hose pipes are correctly connected and the angle COCs are opened.
3. Ensure Box wagons load or empty handle is in the appropriate position according to the load conditions.
4. Do not work the train unless the continuity test is done when fresh BPC is issued or loco is intercepted or loco is attached or loco is reattached after shunting is performed on to the train.

5. Do not start train from the yard or crew changing point or when the loco is reattached on a train at the way side station unless the BP pressure is adequate and at least 10 vehicles behind the loco brakes are getting applied through A-9 application.

6. Keep the Air Flow Indicator red needle over the white needle before starting the train. After brake application on run, to release the brakes keep A-9 on release, wait till the Air Flow Indicator white needle to settle at the red needle. Then only notch up the loco.
7. Whenever Air Flow Indicator's white needle shoots up suddenly with A-9 handle at release, stop the train and ascertain the reason.
8. Due to any reason if the train is stopped in mid-section, keep A-9 handle in minimum reduction before attending the trouble on the train, so that the train will not roll back.
9. Whenever the train is stabled at any station after detaching the loco, open BP angle COC of the first vehicle of the formation, so that the train brakes get applied fully and this avoids rolling back of the train.
10. Whenever the loco becomes defective or dead or the train detained for more than 15 minutes due to OHE trouble etc., in mid-section or at station, keep the A-9 handle in application position and ensure BP pressure is dropped sufficiently to keep the train brakes in applied position.

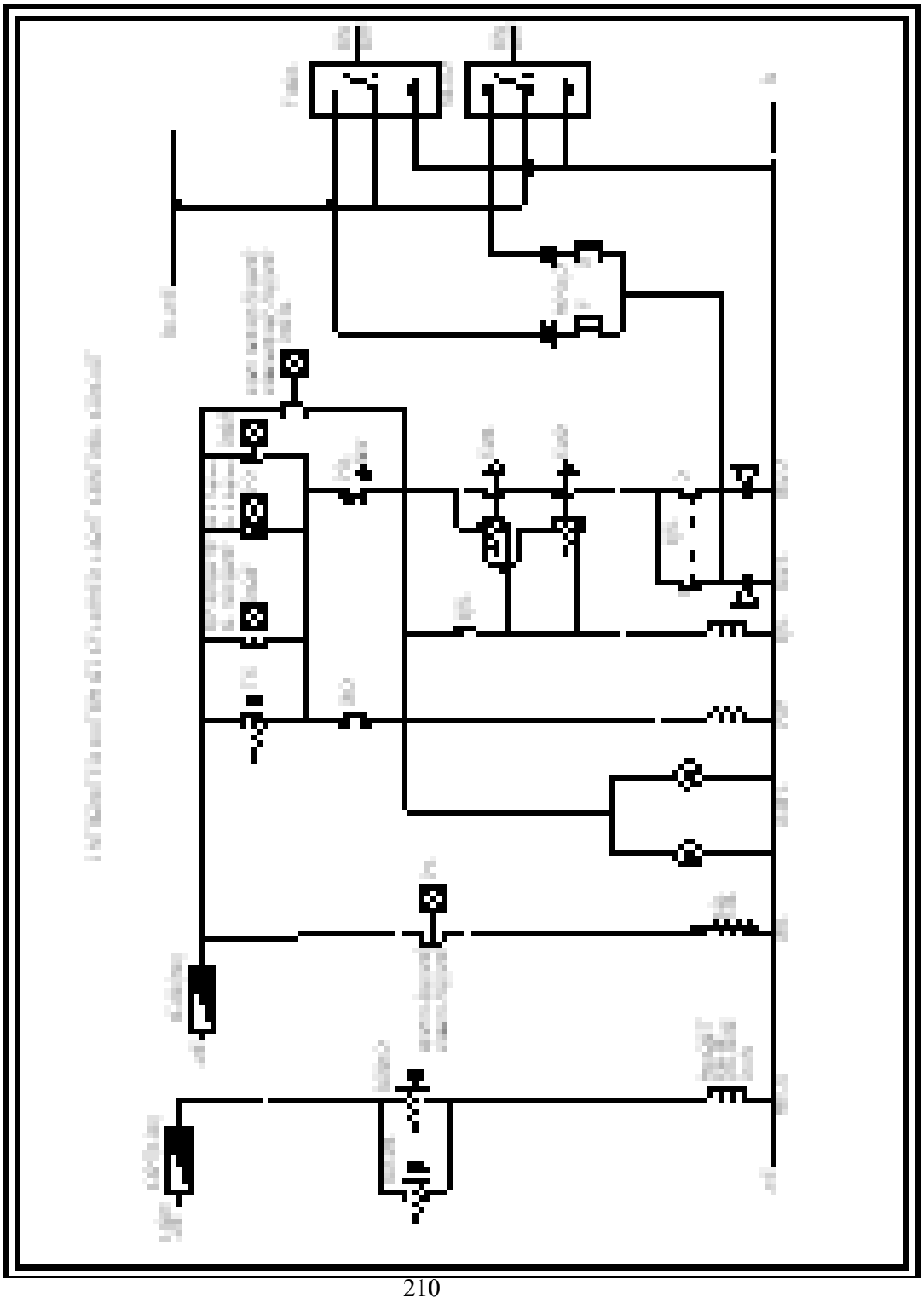
Note: On modified locos BP angle COC is provided above FP angle COC, but the extension of the BP pipe is below the FP pipe.

Rng : 5.9

ACP IS PULLED ON THE AIR BRAKE TRAIN

(Air flow indicator shoots up suddenly. If ACP circuit is available and is in service, Buzzer sounds with LPAR lamp glowing in the cab).

At times the train brakes also get applied slightly. Isolate the Buzzer by pressing BIS switch on the loco. Stop the train immediately at a convenient place. Apply SA-9 and depute the Assistant Loco Pilot to check the train. Simultaneously Guard of the train also comes from the brake van. If phone facility is available on the train, the Loco Pilot should inform the Guard and the train Superintendent to check the ACP along with the C&W staff available on the train for this purpose. After identifying the ACP pulled bogie, reason to be ascertained by the Guard or Train Superintendent for pulling of ACP. Later ACP clappet valve to be reset with the help of ACP resetting key which is available with C & W staff or Guard of the train.



Once ACP is reset the airflow indicator white needle drops back to the red needle level and lamp LPAR gets extinguished. The train should be restarted as per the rules.

Note: Whenever clappet valve could not be reset or clappet valve leaking or any leakage on ACP pipeline, close the ACP cut out COC duly informing the Guard. Message should be given to arrange C & W staff to attend at the next TXR point.

Rng : 5.10

BRAKES ARE BINDING ON A SINGLE VEHICLE

1. If brake cylinder piston has come out, close the C3W distributor valve isolating COC and then pull the releasing handle.
2. If brakes are released, normalize the isolation COC and resume traction.
3. If the brakes are getting applied again, close the isolation COC, release the brakes and resume traction (in twin pipe working, close the AR cut out COC also).
4. In case of coaching trains close the brake cylinder cut out COC whichever is getting applied. If both the brake cylinder piston gets applied, close the distributor valve isolation COC, release brakes, close AR COC and work onwards.

Mechanical jamming of brakes :

1. Check and ensure that the hand brake is released fully.
2. If the brake cylinder piston is inside the cylinder and the brakes are binding or brake cylinder piston is jammed, operate the slack adjuster. If the brakes are released resume traction.
3. If unsuccessful or the slack adjuster could not be operated or brake rigging is jammed, disconnect the pull rod at the rocker arm, secure the pull rod properly and resume traction.

Rng : 6.0
SAFETY EQUIPMENT IN THE LOCO

Rng : 6.1
USE OF FIRE EXTINGUISHERS

A. GENERAL :

1. Loco Pilot should ensure that four fire extinguishers are provided on the loco before leaving shed and its locking clip, nozzle and spring valve and seal are intact.
2. Ensure that the hole on the nozzle is clear.
3. Check that the fire extinguisher is not due for re-filling.
4. DCP fire extinguisher should be used for putting out electrical fire.
5. Read the instructions for using the fire extinguishers before using.

B. WHILE USING :

1. Whenever any smoke or fire is noticed on any equipment on loco, Loco Pilot should take the following actions.
2. Trip DJ, lower panto, open HBA and stop the train.
3. Remove the fire extinguishers from the bracket and take it nearer to the equipment on fire, cover your nose with a wet cloth.
4. Break the seal and remove the locking clip.
5. Stand opposite direction to the smoke, press the spring valve and face the nozzle towards the base of fire (if it is instructed, turn the fire extinguisher upside down).
6. Strike the knob by hand.
7. Direct the jet towards the base of fire with a sweeping action.
8. If the fire is not able to put out with one fire extinguisher, use the other three in the same way.
9. If the fire is uncontrollable, inform the section controller or station master to arrange fire engine and observe G & SR 6.03 and 6.10.
10. After putting out fire, discharge the remaining pressure from fire extinguishers.

11. Isolate the affected equipment, inform TIC and work onwards if possible.
    Make a remark in the log book regarding fire extinguisher

Rng : 6.2
SAFETY RULES CONCERNING 25 KV AC TRACTION

1. Do not approach 25 KV limits directly or indirectly within two meters radius.
2. On line before going on the roof of the locomotive, first ensure power block is obtained by TRD staff and put Earthing poles both sides of the locomotive, ground the loco and then go on the roof of the loco.
3. To carry out roof inspection in the shed always check and confirm that the correct isolating switch corresponding to the line, where the loco is standing is opened by electric shunts (ET). Ensure isolation switch is properly opened and blade of the earthing heal is properly engaged in the clip for earthing the OHE.
4. Ensure loco isolating switch handle is locked with personal padlock and retain the key in the personal custody.
5. Do not direct any part of the body above roof level of loco while changing the head light bulb.
6. Do not walk in between track under OHE.
7. Do not project any jet of water or foam towards OHE.
8. Do not touch any conductor lying close to electrified line.
9. Do not stretch hand or any conductor on the OHE from a over bridge.
10. Do not enter into HT compartment until such time, the loco is brought to a stand and grounded.

Rng : 6.3
EMERGENCY TELEPHONE

The emergency telephone tap with sockets are provided at every 900 mtrs. in the section. The location of the nearest telephone tap is indicated on the traction mast by an arrow and no. of the mast.

How to use Emergency Telephone :

1. Open the emergency telephone tap lid by the key provided for the purpose.
2. Insert the plug of the portable telephone in the emergency telephone tap socket.
3. Press the button on the side of portable telephone and call out TPC in the following manner a number of times (Hello Emergency) and after TPCs response give your message.

Rng : 6.4

GROUNDING THE LOCO FOR ENTERING INTO HT COMPARTMENT

1. Ensure to stop the train at a station or at a convenient place near a gate lodge, or at a telephone tap or at flag station, and secure the loco & train as per G & SR 6.03
2. Apply train and loco brakes.
3. Build up maximum pressure in MR and RS.
4. Trip DJ, lower panto, ensure both pantos are lowered fully and LSDJ is glowing.
5. Remove ZPT key and insert the same in BV box at 5 O'clock position and turn it in clockwise direction (7 O'clock position).
6. Operate HOM handle upwards gently. Sudden lifting may lead in HOM jaws getting stuck up.
7. Remove two fitchet keys by turning them in anti-clockwise direction.
8. Keep one key in personal custody and with the other open the HT compartment door.
9. Attend the repairs in HT compartment.
10. Ensure that no tool left in HT compartment, lock the door and remove the fitchet key.
11. Replace both the keys in the BV box and turn them in clockwise direction.
12. Operate HOM handle downwards gently.
13. Turn ZPT key back to 5 O'clock position and remove the ZPT key.
14. Raise the Panto, close DJ and resume traction.

Rng : 6.5

INSTRUCTIONS FOR EARTHING OHE, TO CLIMB ON LOCO ROOF

1. Note the time Kilometerage of occurance and nature of damage to panto and OHE.
2. Arrange to protect the train as per G & SR 6.03.
3. Contact TPC through emergency telephone tap and ask for OHE staff.
4. When power block is obtained by TRD staff.
5. Ground the loco.
6. Take out ladder and fix it on loco body.
7. Climb on the loco roof and attend to the defect.
8. If it is a damaged pantograph, remove the broken pieces, tie up the projecting and hanging parts which cannot be removed, with a coir rope. Remove the HPT from the roof insulator clip and fix in the earthing clip.
9. After completion of work, ensure that no tool is left over on the loco roof.
10. Get down from the loco roof and remove the ladder and secure it in its place.
11. Remove the earthing poles from the contact wire first and then remove the cables connections from the loco body.
12. Disconnect the earthing poles and then secure them in their place in HT compartment.
13. Close the damaged pantograph cut out COC.
14. Unground the loco and energise I when the power is restored.

Note:As per revised instruction TRD / OHE staff are only authorised to obtain power block and climb on the loco roof.

Rng : 6.6

HOW TO MAKE USE OF THE FLASHER LIGHT

Flasher light should be used in case of emergency to attract the attention of the Loco Pilot of a train coming in the opposite direction. Working condition of the flasher light should be ascertained while taking over charge of the loco at crew changing point / shed.

To put `ON' flasher light, switch ZFL should be closed at the working cab. Ensure that the head light is in `dim' condition when the flasher light is put `ON'.

Flasher Light Is Not Glowing

Ensure FL switch is closed and BA voltage is above 85 V. Change the position of filament and check the glowing of flasher light. If it glows resume traction.

If it does not glow, check the fuse CCFL. If it is fused, replace the fuse as per procedure and resume traction

If the fuse is in good condition, check the working of rear cab flasher light. If it glows replace the bulb in leading cab and resume traction. If rear cab flasher light does not glow, contact TIC

Rng : 6.7

SAFETY EQUIPMENT IN THE LOCO

Safety Fittings

1. Cattle guard
2. Rail guard
3. Earthing stud with fly nut
4. CBC locking pin
5. Safety bracket
6. Brake assembly hanger pin
7. Tie bolt
8. Nose suspension pad pin
9. Gear case bolts
10. Brake pull rod
11. Safety chain

Safety Devices

1. Brakes
2. Head light
3. Flasher light
4. Marker light
5. Speedometer
6. Horns
7. Safety relay
8. Wipers
9. Fuse
10. Pilot lamp
11. Air flow indicator
12. ACP buzzer

Safety Items

1. Earthing pole and cable
2. Field telephone
3. Fire extinguisher
4. Detonators
5. Ladder
6. Fusee
7. Wooden wedges
8. Spare coupling and hose pipe

Rng : 7.1

COMPLETE PREPARATION OF LOCOMOTIVE BEFORE LEAVING SHED

1. Ensure that the loco is under wired track and secured with hand brake.
2. Read the loco log book and note the repairs, missing fittings etc.

Loco examination on left side :

(This examination is to be started from cab – 1 end)

- Accessories drain COC above wheel no.1 should be closed.
- Check the speedometer gear box and cable on wheel No.1. If the speedometer is of Hasler or Autometer or Medha type, the pulse generator will be fitted on wheel No.2.
- Examine the front truck equalizers, helical springs and bogie frame for any crack or abnormality.
- Check the proper fixation of axle box covers and stay plates.
- Check the loco body bogie securing bolts and safety pins.
- Check the air bellows for any damage.
- Check the brake cylinder securing bolts, slack adjusters, brake shoes, brake riggings and safety brackets.
- Check the sand pipes alignment with rail and availability of sand in the sand boxes.
- Check the oil level in load bearer and center pivot oil cups.
- Check the condition of three unloader valves near wheel No.5.
- Check the condition of three safety valves after unloader valves (11.5 kg/cm^2)
- EP drain COC should be in closed condition.
- Check the centrifugal dirt collector with drain COC.
- Check C2A relay valve.
- Check the control reservoir drain COC and also SS2 on wheel No. 5.
- Check DJ oil separator drain COC.
- Check MR – 1 with drain COC.
- Check auto drain valve with cut out COC.
- Check panto pipe drain COC.

- Check the condition of battery boxes and their fixing brackets. Also observe for any smoke, smell or leakage of electrolyte.
- Check MR – 2 with drain COC.
- Check air intake cut out COC with NRV.
- Check SL – 2.
- Brake cylinder cut out COC.
- Check the item mentioned above from 2 to 8 on the rear truck also.
- Check the condition of side glasses and microfilters.
- Check the loco body and foot steps.

Loco Examination Front Side (Cab – 2 end) :

- Check the condition and position of cattle guard, rail guard and engine buffers.
- Check the condition of CBC and Transition coupling and locking pin. Secure the baby coupling in hook on leading side.
- Check the condition of marker lights, look out glasses and wind screen wipers.
- Check the condition of B, C, D couplers and their sockets.
- Check the condition of head light, flasher light and horns.
- Ensure that multiple unit cut out COCs are in closed condition (MR equalizing and BC apply).
- Check the condition of vacuum hose pipe and its proper fixation on dummy plug with IR washers.
- Check the condition of BP and FP hose pipes, their palm ends with rubber washers and properly secured on the hanger.
- BP and FP angle COCs should be in closed position.
- SA-9 apply and supply drain COCs should be in closed position.

Loco Examination Right Side :
(This examination to be started from cab - 2 end)

- Check the items mentioned for left side examination from 1 to 8 except pulse generator.
- Check the sander control valve with cut out COC for 9, 10, 11, 12, wheels above wheel No.10.

- Check the sander control valve with cut out COC for 7& 8 above wheel No.8.
- Check the feed valve 6 kg/ cm^2, feed pipe with cut out COC.
- Check the duplex valve for MR equalizing pipe.
- Check SL – 1.
- Check NRV, MR3 with drain COC, battery box No.1
- Check NRV, MR4 with drain COC, battery box No.2
- Check centrifugal dirt collector with drain COC.
- Check MR4 cut out COC.
- Check C2 relay valve (B) for independent brake.
- Check brake cylinder cut out COC.
- Check feed valve of 8 kg/ cm^2.
- Check air flow valve (in some locos provided in corridor 2).
- Check sander control valve with cut out COC for wheel No. 5& 6.
- Check sander control valve with cut out COC for wheel No. 1, 2, 3 & 4.
- Check centrifugal dirt accumulator drain COC above wheel No. 4.
- Check R1 cut out COC on wheel No. 2

Loco Examination Front side (Cab – 1 end) :

Check all the items mentioned for front side examination on cab-2 end except item 10 which should be between MR-3 and MR-4.

Under Gear Examination (Pit Examination) :

(This examination is to be conducted in shed or where examination pit is available)

- Check the CBC inner securing bolts and nuts.
- Check vacuum reservoir for any damage.
- Check the traction motor inspection covers for any cracks and proper fixation.
- Check the condition of traction motor fixing bolts on suspension bearing.

- Check the condition of six earthing bushes and their connections.
- Check the condition of gear case fixing bolts.
- Check the condition of traction motor cables and wooden cleats.
- Check the condition of resilient block, its bolts and safety pins.
- Check the oil level in suspension bearing lower and upper sumps and cardium compound level in gear case and proper fixing of the covers and dipsTICks.
- Check the condition of suspension bearings cover screws on either ends (four screws on each cover).
- Check the condition of MVRF (if RB is in service)
- Check the condition of air bellows.
- Check for any oil or grease splashes on inner wheel surface.
- Check for any oil and cardium compound leakage.
- Check the condition of brake shoes, brake riggings, safety brackets and sand pipes alignment, suspension bearings and grease case securing bolts and nuts.
- Check the condition of battery boxes.
- Check SL-1 and SL-2 covers any damage or slackness.
- Check for any oil leakage from transformer oil tank drain plug and check its wire seal.
- Check the condition of wheel tyres for any skidding mark.

Note: Items 3 to 10 to be checked on each traction motor.

Roof Examination :

This examination is to be conducted on arrival on loco examination pit after making the OHE dead by operating isolators and grounding the loco and placing earthing poles on either sides of the loco.

1. Pantograph Examination :

a. Check the condition of wearing strips for any breakage, grooving, globules, sharp edges and copper deposits.
b. Check the condition of grease on pantograph.
c. Check the proper flexibility of pantograph.

d. Check all springs, pins and flexible shunts.
e. Check the articulation tubes, actuating rod eyelet and raising springs for any abnormality.
f. Check HPT1 and HPT2 for proper fixation.
g. Check the panto base insulators, servomotor and pipe connection for any abnormality.

2. Roof Insulators Examination :
a. Check the cleanliness of the roof insulators and for any crack or for breakage.
b. Check the condition and position of roof bars.
c. Check the condition of HOM, ET1 and ET2.

3. DJ Assembly Examination:
a. Check the DI insulators for any abnormality.
b. Check the condition of DJ contacts and flexible shunts and also check for any oil leakage from roof bushing.

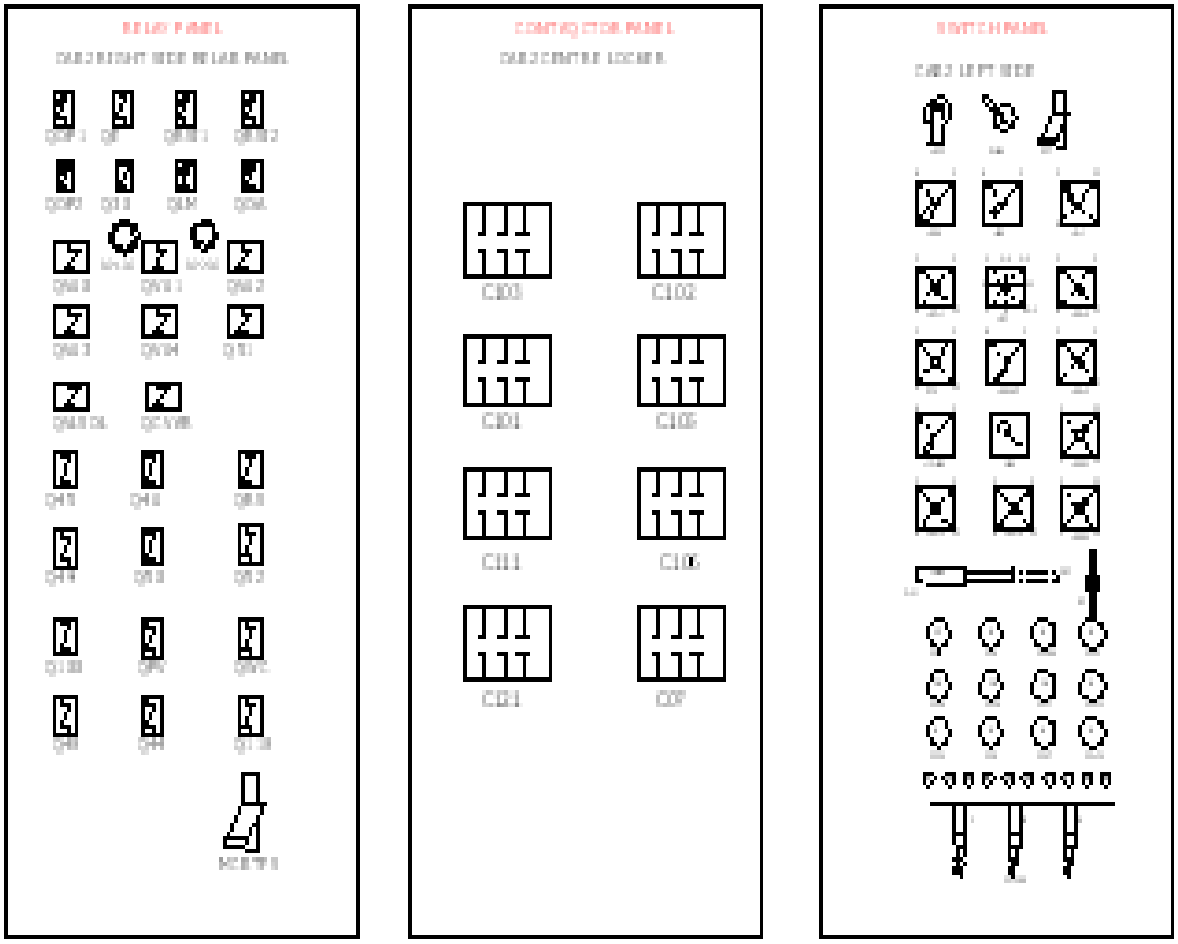
4. Head light, flasher light and horns examination:
a. Check the condition of head light and flasher light.
b. Check the condition of horns and its pipe line connections.
c. Check for any foreign body on loco roof.

CAB – 2 Examination :

Close HBA, switch `ON' entrance lamp and cab light.

a. Ensure A-9 and SA-9 handles on release position and RS is in closed position in non-working cab properly and SA-9 handle in application on working cab.
b. Keep A-9 inlet, outlet cut out COCs and SA-9 apply and supply cut out COCs open in working cab and closed in non-working cab. Also ensure horns LT, HT cut out COCs and wipers cut out COC are in open position.
c. Place MPJ, ZPT and BL keys in their respective positions.
d. Ensure ZUBA on position `1' and check the battery voltage.
e. Ensure all rotating switches on position `1' except ZPV and HCP.

f. Ensure ZRT is in `OFF' position and HOBA is in `ON' position.
g. Ensure that all fuses are tight in their sockets and spare fuses are intact. Test the spare fuses in EEC (35A-2Nos., 16A-4Nos. and 6A-4Nos.).
h. Ensure A, B, C conk connections at the bottom of switch panel are coupled up correctly and switch panel is secured properly.
i. Unlock BL and check that four pilot lamps LSDJ, LSCHBA, LSGR and LSB are glowing. Press BPT and check the lamps LSRSI and LSP. Also check the availability of LSBCR, LSOL, LSAFR, LSVGR and LSGRPT if provided.
j. Check the ammeters, voltmeters, notch repeater and speedometer needles are on `0'.
k. Open center locker door and check electromagnetic contactors for any abnormality and check that CCUA and CCTFS fuse caps are secured properly.
l. Open right side locker door and check that the safety relays are fixed properly and the relay targets are not dropped and all the relay seals are intact.
m. Ensure iron and glass shutters are intact.
n. Switch on BLFL or ZFL and check the working of flasher light.
o. Check that fire extinguisher is intact, sealed and not over due for testing.



Corridor – 1 Examination :

a. Enter from cab-2 to corridor-1 and check that the relays provided on cab-2 back panel are intact.
b. Check the colour of LTBA.
c. Check TFVT and R-118 for any abnormality. On some locos C-118 is provided above R-118.
d. Ensure CHBA ammeter needle is on `0'.
e. Check VMT-2, QVMT-2 and ARNO visually for any abnormality and ensure earthing shunts on roof and auxiliaries are intact.
f. Check RSI blocks and isolating switches HVSI-2 and HVSI-1 on `1' position and trigger fuses should not be in projected condition.

g. Check visually HT-1, HT-2 and HT-3 for any abnormality and ensure in HT-1 earthing poles 2 sets with cables are intact.
h. Check the HOM and ensure four fitchet keys are intact.
i. In motor chest No.1 check MVMT-1, MCP-1, MCP-2, MCP-3, MPV-1 and MPV-2 for any abnormality and vacuum equipments are not having any abnormality.
j. Check C3W distributor valve isolating handle and VTP (Vacuum train pipe) cut out COCs are in open position.
k. Ensure PT-1 cut out COC is in open position.
l. Check VEAD and its cut out COC is open and ladder is provided with its locking arrangement.

CAB-1 Examination :

a. In cab-1 left side locker check limiting valve 4 kg/cm2, electrical VEF, mechanical VEF, HS4 with feed valve and its gauge, H5 with cut out COC, HB5 with cut out COC, SWC, MU2B in lead position and F1 selector valve.
b. In cab-1 centre locker check MCPA, ZCPA, RGCP with cut out COC, VESA-1 and VESA-2 with cut out COCs, VEPT-1, RS drain COC, CPA drain COC, RS reservoir and RS pressure gauge and also RAL COC.
c. Switch on ZCPA and ensure proper working of MCPA.
d. In cab-1 right side locker check the hand brake is fully applied, portable telephone box and tool box are intact, and fire extinguishers are intact.
e. Ensure A-9 and SA-9 handles are on release position and RS is closed properly.
f. Ensure A-9 inlet and outlet cut out COCs and SA-9 apply and supply cut out COCs in open position, if it is working cab or else close them.
g. Keep A-8 cut out COC in open position.
h. Ensure that four pilot lamps LSDJ, LSCHBA, LSGR and LSB are glowing. Press BPT and check the lamps LSRSI and LSP. Also check the availability of LSBCR, LSOL, LSAFR, LSVGR and LSGRPT if provided.
i. Ensure ammeters, voltmeters, notch repeater and speedometer needles are on `0'.

Corridor –2 Examination :

a. Check the oil level in MPV-1, MPV-2, MCP-3. Secure the dip sTICks and filling caps properly. Check oil pump working on SLM type exhauster.
b. Check that the transformer oil level is above 15°C.
c. Ensure ZSMGR handle is at 6`O clock position, ZSMS is on position `1', RDJ drain COC is closed and SMGR drum is on `0'.
d. Check the relays QE, QF-1 and QF-2 and the red targets.
e. Check and ensure that there is no abnormality in C-118 if provided (in HT compartment).
f. Ensure that MVMT-2, RTPR and ARNO for any abnormality.
g. Ensure PT-2 cut out COC is opened on cab-2 back panel.
h. Check and ensure air flow assembly is intact (for some locos it is available under the loco).

High Tension Compartment Examination:

Remove ZPT key on `0' position, ensure that both pantographs are lowered. Insert ZPT key in BV box. Turn it clockwise from 5'O clock to 7'O clock position, operate HOM handle upwards and take out two fitchet keys. Keep one key in your personal custody and use other key to open HT compartment door lock.

A. HT-1 Compartment :

1. Open the door on corridor side.
2. Ensure that two sets of earthing poles with insulators and cables are intact and secured properly.
3. Ensure EP-1 cut out COC is opened.
4. Ensure shunting contactors arc-chutes are intact and there is no abnormality.
5. Ensure that reversor J-1 and CTF-1 is not locked and no abnormality.
6. Check for any abnormality in ATFEX and QD-1.

B. HT-2 COMPARTMENT :

1. Check for any abnormality in RF resistance unit if Rheostat brake is in service and cables are intact.
2. Check for any abnormality in MPH, QPH, radiator and its pipe line.
3. Check the cowl joint for any abnormality.

4. Ensure MPH inlet and outlet valves are open and securing bolts are intact.
5. Check the terminals of RSI, TFWA and TFWR are intact.

C. HT-3 COMPARTMENT :

1. check MVSL-1, MVSL-2. QVSL-1, QVSL-2, tap changer, CGR 1-2-3 with arc-chutes, RGR, RPGR, SMGR and roof bushing bar for any abnormality.
2. Check GR oil level in the gauge and it should be between +20 and –20°C.
3. Ensure that there is no abnormality in PHGR, its pipe line, silica gel, DJ assembly and QPDJ.
4. Ensure HQOP-1 and HQOP-2 in `ON' position, HQPDJ is on position `1' and EP2 cut out COC is opened.
5. Ensure C-145, line and shunting contactors, with their arc-Chutes are intact and there is no abnormality in QD-2, Q20, shunting contactors 1 to 6, reversor J-2, CTF-2, CTF-3, RSI-2, RSI-1 and RCC panel.

RNG : 7.2

QUICK EXAMINATION DURING SHORT STOPPAGE ENROUTE

a. Stop the train and apply SA-9 and keep the blowers working.
b. Check the temperature of axle boxes.
c. Check the condition of helical springs, equalizers, tie-rods, stay plates, sand pipes, brake riggings, speedometer gear case fittings.
d. Check for any oil or cardium compound leakage or air flow from under gearing and also check the condition of traction motor inspection covers.
e. Check the air flow from VSLs and for any oil leakage from transformer oil tank and drain plug.
f. Check the condition of air bellows for any leakage.
g. Check the condition of battery boxes and SL covers.
h. Drain out moisture from main reservoirs, centrifugal dirt collector, DJ oil separator, control reservoir, EP and graduator control board.
i. Check the cattle guard, rail guard, buffers for any abnormality.
j. Ensure front coupling is secured in the hook and rear coupling is tight and safety bracket is intact.

RNG : 7.3

STABLING OF THE LOCO IN STATION YARD

a. Berth the loco at a convenient place (ensure OHE while moving towards sidings).
b. Apply SA-9 and hand brake.
c. Build up air pressure upto 8 kg/cm^2 in RS and close RAL COC.
d. Ensure MP is in `0' and open BLDJ, check the glowing of LSDJ.
e. Lower the panto and ensure that it is fully lowered.
f. Remove ZPT, MPJ and BL keys from the sockets.
g. Check the battery voltage and make necessary remarks in loco log book
h. Close window shutters, cab and corridor doors.
i. Switch `OFF' all the lights and fans and open HBA.
j. Drain out moisture and air pressure duly securing the loco with skids and consult TIC for the disposal of loco.

Rng : 7.4

READING OFLOCO LOG BOOK AND MAKING ENTRIES

A. How to write the log book :
Give the following parTICulars in the loco log book.
Date,

a. Loco No.,
b. Train No.,
c. Load,
d. From & To,
e. Loco Pilot's Name,
f. Assistant Loco Pilot's Name,
g. Speedometer KM starting & ending, wherever Energy cum speed monitor system provided, KWH starting, ending & total consumption for the trip.
h. Do not write as refer previous booking in the loco log book,
i. The Loco Pilot must write all the repairs or failure particulars in the loco log book. Assistant Loco Pilot should not be utilized to write the above mentioned in the log book.
j. Any previous repair unattended for the last 48 hrs., to be informed to TIC.
k. While working MU or double headed locos mention the above items in the loco log book. Also mention as to which loco is leading and which is trailing. In case of single loco mention which cab is leading.

B. How to write the case of failure or defect in the loco log book :

In case of a failure or defect of the loco on line the Loco Pilot should enter the following parTICulars in the loco log book and report the same to TIC on duty.

a. Tripping at KM No.
b. Between stations
c. Time
d. Driving cab
e. Speed
f. Notch No.
g. UA reading
h. Voltmeter reading
i. Ammeter reading

j. Notches of MPS if any

k. MPJ position, mention abnormal sign and page No. referred for tripping.

Step – 1:

Name of the relay which is showing red indication, (target dropped), TSD page No. referred.

Step – 2, 3 and 4:

1. Mention the name of operation in which tripping took place.
2. Referred page No.
3. Apparatus handled or isolated.
4. Time resumed traction.
5. Informed TIC from station at: Dt:
6. Private No.
7. Total time lost

(While informing TIC furnish loco No., train No., load of the train, Loco Pilot's and Assistant Loco Pilot's name).

Traction Failure :

1. Nature of defect (total loss or partial loss of tractive effort or slipped pinion or locked axle or smoke emission or unusual noise from traction motors).
2. Place of occurrence
3. KM No.
4. Time
5. Driving cab
6. Traction motor
7. Referred TSD pages and chapter
8. Apparatus handled or isolated
9. Observed any smoke emission or unusual sound
10. Informed TIC from station
11. Total time loss

If relief is asked for (give details of relief loco arrival and the time when the block section is cleared).

Miscellaneous Failures :

1. Nature of defect
2. Between stations and KM No.

3. Time
4. Notch No.
5. Cab No.
6. Speed
7. MPJ position
8. Referred TSD page No.
9. Apparatus handled
10. Informed TIC from
11. Total time lost
12. Private No.

Note: Preferably give the break-up on the total time occupied in the block section or at station.

1. Time taken for TROUBLESHOOTING.
2. Time taken to inform TIC at a station or in block section.
3. Extra time occupied on run if any due to isolation of equipment on the loco (RSI or Traction Motors, MPH etc.)

RNG : 7.5

WORKING THE TRAIN BY ENERGISING THE LOCO FROM REAR CAB

1. Follow the instructions given in SR 17.09 in G & SR book for the method of driving the loco from rear cab.
2. In rear cab:
   a. Place ZPT on position '2' and raise the panto.
   b. Close DJ, switch on BLPV, BLCP and BLVMT. Keep A-9 in running position and close inlet and outlet cut out COCs.
   c. Close SA-9 supply and apply cut out COCs.
3. In leading cab:
   a. Keep A-9 handle in running position and open inlet and outlet cut out COCs.
   b. Keep SA-9 supply and apply cut out COCs open to apply loco brakes when required.
   c. The loco shall be operated by the Assistant Loco Pilot from rear cab. The Loco Pilot will remain in leading cab to control the train as required.
   d. If necessary, the Loco Pilot can operate A-9 to emergency position to regress GR to '0'.
   e. The loco shall be operated by exchange of signals between the Loco Pilot and assistant Loco Pilot.
   f. At neutral section, the assistant Loco Pilot shall trip DJ and lower panto if necessary.
4. The speed of the train shall not exceed 40 Kmph as per SR 17.09 (12) (6) if the Loco Pilot is in leading cab.
5. If the Loco Pilot is in trailing cab and the assistant Loco Pilot is in the leading cab, the speed is restricted to 15 Kmph.
6. The Loco Pilot shall request for assistance at the first opportunity as per SR 17.09 (12) (e).
7. Enter in the loco logbook stating the place from where TIC has been informed.

APPENDIX

STATIC CONVERTER

Static Converter is provided in place of ARNO to give constant 3Ø AC 415 Volts 50 Hz supply to all auxiliary motors, to charge the batteries and to give 1Ø AC 415 volts to non-motor loads (static devices). At present static converters are designed by SIEMENS and AUTOMETERS ALLIANCE LIMITED. These static converters are provided in some AC locos.

ADVANTAGES:

1. To give constant 415 V, 3Ø AC supply to all Aux. motors.
2. To detect single phasing
3. To detect earth fault.
4. Minimum Maintenance.
5. To avoid failure of Auxiliary motors.
6. High Efficiency.
7. To give the 3 Ø AC supply to MVRF.
8. Life of 3Ø E.M. contactors increases since operated on 'off' load.
9. More reliable.
10. Noise less smooth operation.

EQUIPMENT REMOVED:

ARNO, C118, R118, QCVAR, HQCVAR, QOA, HQOA, QLA, Q100, QTD 105 & 106.

NEW EQUIPMENT PROVIDED:

1. STATIC CONVERTER
   a. Rectifier (Motor chest No.2 towards Corridor No.2)
   b. Inverter (Motor chest No.2 towards Corridor No.1)
   c. Sine Filter (below the battery charger for battery charging & non-motor loads) only in SIEMENS.
2. a7, a8 bushings in TFWA are used to get 830 V
3. QTD 101 time delay relay of 5 sec (cab-2 back panel)
   For delayed starting of compressors.
4. Contactor C-108 (on contactor panel)
   For 3 Ø AC supply to MVRF.
5. QCON (on relay panel).
   For checking the functioning of static converter.
6. QSIT (on relay panel).
   For tripping of DJ whenever static converter trips.
7. CCINV fuse 6 amps (on switch panel)
   For inverter.

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9. LSSIT (on Loco Pilots desk):Indication lamp for static converter tripping.

SIEMENS MAKE

Procedure for energisation:

1. After examination of the locomotive, by keeping 'HBA' on '1' position, 110V DC supply given to static converter. This 110 V DC supply will step down 24 V DC supply to inverter electronics.
2. Start MCPA to build up RS pressure to 8 kg/cm2. Unlock BL key. Keep ZPT in 1 or 2 position to raise pantograph.
3. Close BLVMT. Close BLCP/BLCPD. (Also close BLPV if required in dual brake locos). Close BLDJ, press BLRDJ. Immediately LSDJ extinguishes. OHE voltage indicates in UA meter. Release BLRDJ immediately. Don't wait for extinguishing of LSCHBA and auxiliaries sound.
4. Close BLSI/ZSI with in 5 seconds after closing DJ. Otherwise DJ trips(In modified locos BLSI switch is dispensed with QV60 N/C interlock).
5. Static converter starts functioning approximately 6 to 10 sec after closing of BLSI/ZSI switch.
6. Converter on sensor will close on QCON branch after static converter starts functioning. Whenever QCON energized, LSCHBA lamp will extinguish.
7. Static converter takes 830 V 1 Ø AC supply from TFWA to convert in to 415 V 3 Ø AC supply and gives to all auxiliary motors.

PROCEDURE FOR MAKING LOCO DEAD:

1. Open BLSI/ZSI to switch off static converter
2. Open BLDJ to open DJ. Open BLPV, BLCP/BLCPD & BLVMT.
3. Control electronics of Static Converter will take 2 minutes (approx.) for switching OFF. So, wait for two minutes.
4. Then keep HBA in '0' position.

SEQUENCE OF STARTING AUXILIARIES:

1. After closing DJ and switching 'ON' BLSI, static converter ramps up with all the loads except compressors (And exhausters in dual brake locos).
2. After static converter fully ramps up, QCON relay will energise and its N/O I/L closes on compressors and exhausters control circuit.
3. Through BLCP & RGCP contact, QTD-101 time delay relay will energise. After 5 sec. its chronometric interlock will close on C-101, C-102 & C-103 to start MCPs according to

HCP position but MCP3 will start with 5 sec. delay through Q119 N/C chronometric interlock as usual like conventional loco.

4. In dual brake locos, if BLPV is closed, according to ZPV position MPV1/MPV2 will start.
5. During RB working MVRF will work on 3Ø AC supply along with other loads instead of MVRH.

Note:

a. On TKD based locos, BLVMT switch is made direct. Hence, blowers cannot be stopped for longer time detention. For that keep HVRH, HVMT1&2 on '0'.

b. In MGS based locos, QTD 103 time delay (5 sec) relay is provided for delayed starting of MCP3. QTD 101 relay is not available in this loco.

INSTRUCTIONS

1. Whenever static converter unit trips, SI TRIP contact will close on QSIT branch to energise relay QSIT to trip DJ by opening its N/C I/L on MTDJ branch and LSSIT lamp will glow.

   Note: On AJNI based locos, whenever QSIT relay energises, a red target will drop. Loco Pilot should troubleshoot as same as QOA relay dropping and make necessary remarks in loco logbook.
2. Whenever SI unit trips, it will try to restart automatically after 20 seconds for 2 times. (3 trippings) before going to shutdown mode.
3. After closing BLDJ and pressing BLRDJ, ensure UA meter needle deviation. If there is no OHE, UA meter needle will not deviate and DJ trips after releasing BLRDJ, which indicates NO TENSION.
4. Do not wedge any electro magnetic contactor.
5. Don't operate any Programme switches while static converter is functioning. If necessary operate the switch only after opening of DJ.
6. Whenever LSDJ glows first, before LSCHBA, trouble may be with loco. Troubleshoot accordingly.
7. Whenever LSCHBA glows before LSDJ, it indicates static converter has initiated the tripping.

   1 IN CASE, FAULT IN STATIC CONVERTER

   Static converter will restart within 20 sec. for 2 times before going to permanent shutdown mode. (For 3 trippings). Ensure availability of input voltage to static converter during restart attempts. If the converter doesn't start, then –

   a) Momentarily switch 'off' and 'on' of HBA.

b) Check healthiness of CCINV fuse.

c) Isolate all the auxiliary loads and close the DJ again. If the converter starts, then one by one switch 'on' the loads. If the converter trips for particular load, then isolate the defective load and restart the converter.

8. Whenever converter is not started due to permanent shutdown, battery resetting is necessary.

a) Remove CCINV and put it back again – Repeat the switching on sequence.

b) Battery reset can also be given by temporary switch 'off' of HBA and switch 'on' again

9. During static converter fault, LSCHBA will glow and auxiliaries will stop working along with one of the following indications. (Provided on inverter panel and Asst. Loco Pilot side in both the cabs).

d. Static converter 'ON' lamp

This lamp glows when static converter is giving output. This lamp will be 'off' when static converter is not giving output.

e. Static converter internal fault lamp

This lamp glows when static converter itself defective. In this condition, put 'OFF' HBA for 10 sec. and again put HBA 'ON'. Close DJ. Put on BLCP & BLVMT. Then put on BLSI. If unsuccessful then contact TIC.

f.OHE out of range lamp

This lamp glows when OHE voltage is less than 17 KV or above 31 KV

g. Outside fault lamp

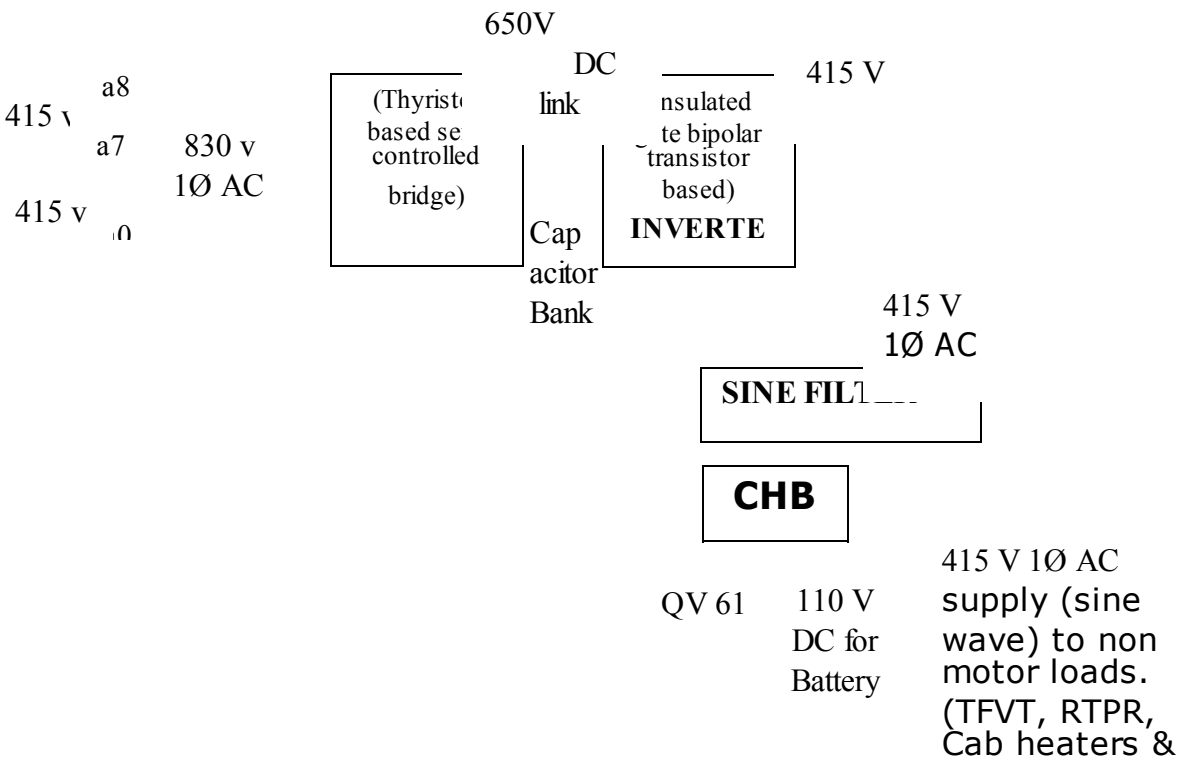
This lamp glows when there is any fault in auxiliary circuit. Troubleshoot according to TSD & isolate auxiliaries one by one.

Note: In AJNI based locos, HTFVT & HRT Programme switches provided in secondary side of TFVT & RTPR on switch panel. In case of any fault, same can be isolated.

e. LSSIT is provided on Loco Pilot's desk. It also glows along with internal fault lamp. Then put HBA 'OFF' for ten seconds and again try to close DJ.

10. Sine filter is not provided in AAL make static converter since inverter output is 3 phase, 415V AC, as sine wave mode.

POWER CIRCUIT (SIEMENS MAKE)



SEQUENCE OPERATION OF SWITCHES(SIEMENS SOFT START)

Energisation of Locos	Approaching N/S	Change over TR to BR
Switch on HBA	Switch off BLSI	Bring MP to '0'
Switch on BLVMT	Switch off BLDJ	Ensure GR '0'
Switch on BLCP/ BLCPD	After passing N/S	Open BLSI/ZSI
Switch on BLPV	Switch on BLDJ	Keep MP on 'p'
Switch on BLDJ	Switch on BLRDJ	Close BLSI/ZSI
Switch on BLRDJ	Switch on BLSI	Take notches on BR
Switch on BLSI / ZSI		
	Detention at Stn./Yard	Change over BR to TR
Loco tripping online	To stop blowers	Bring MP to 'P'
Switch off BLSI/ZSI		Ensure G '0'
Switch off BLDJ	Switch off BLSI	Open BLSI/ZSI
Switch off BLVMT	Switch off BLVMT	Bring MP to '0'
Switch off BLCP/BLCPD	Switch on BLSI	Close BLSI/ZSI
Switch off BLPV	To start blowers	Take notches on TR
	Switch off BLSI	
	Switch on BLVMT	
	Switch on BLSI	

In modified locos, if Loco Pilot operates the BL switches wrongly, then the DJ will not trip, only the StaTIC Converter will trip and re-start after two seconds, which will avoid tripping of DJ and latching of Inverter.

AAL MAKE

Procedure for loco energisation:

1. Switch 'ON' HBA. The following indications will show:

a. RXD (AMBER) and TXD (GREEN) LEDs will start blinking on DISPLAY PANEL provided on INVERTER.

b. VFD panel will display "LOCO STATIC CONVERTER" and the present "date and time"

c. EM contactors C105, C106 and C107 will close without closing of BLVMT as the BLVMT switch has been made direct, but those blowers i.e., MVMT1, MVMT2 and MVRH will start only after closing of BLSI.

2. Raise pantograph after building up RS pressure.
3. Close DJ through BLDJ and BLRDJ.
4. Close BLSI switch (BLSI is an additional switch to start the blowers).

The following indications will come on display panel:

a. In addition to RXD & TXD, 3 LEDs (Amber): AC Input ON, Rectifier ON, Inverter ON will also start blinking

b. Blowers MVSI 1&2, MVSL 1&2, MPH, MVMT1&2 and MVRH will start.

c. LSCHBA LED will extinguish after 6-10 seconds.

5. Close BLCP, CP1, CP2 & CP3 will start working with 5sec. delay each.
6. To isolate any blower, first switch 'OFF' BLSI and then isolate faulty blower through HVMT1, HVMT2 & HVRH.
7. Record battery charger voltage and current after every five hours approx. in the logbook. CHBA AMMETER is provided either on CHBA or near QTD relays.
8. When ever loco detained at station/yard to stop blowers switch 'OFF' BLSI and place HVRH, HVMT1&2 on '0' then switch 'ON' BLSI. To restart blowers switch 'OFF' BLSI, normalise the switches then switch 'ON' BLSI.

TROUBLE SHOOTING PROCEDURE

The SIV has been designed for automatic restarting after a fault in SI unit is detected. The restarting can take place for two times (i.e. Max. 3 trippings on fault are permitted by the SIV) Even after automatic re-start operation for two times if the SIV cannot restart, the DJ will trip.

DJ can trip during energising of loco or during run with:

a. Without any fault LEDs glowing on the front panel of SIV or,
b. With any of the fault LED/LEDs glowing on the front panel of the SIV.

1. In case of DJ tripping Without fault LEDs on SIV panel glowing:

Do the trouble shooting as per the abnormal signs observed and corresponding guidelines given in the TSD.

2. In case of DJ tripping with fault LED/LEDs on SIV panel glowing:

1.1 Switch OFF HBA for 5 minutes and then switch ON HBA & close DJ. If DJ does not hold, repeat the same procedure once again.

1.2 If the DJ does not hold and fault LEDs do not extinguish even after two times resetting with HBA switch, look for the following fault indication on the SIV panel.

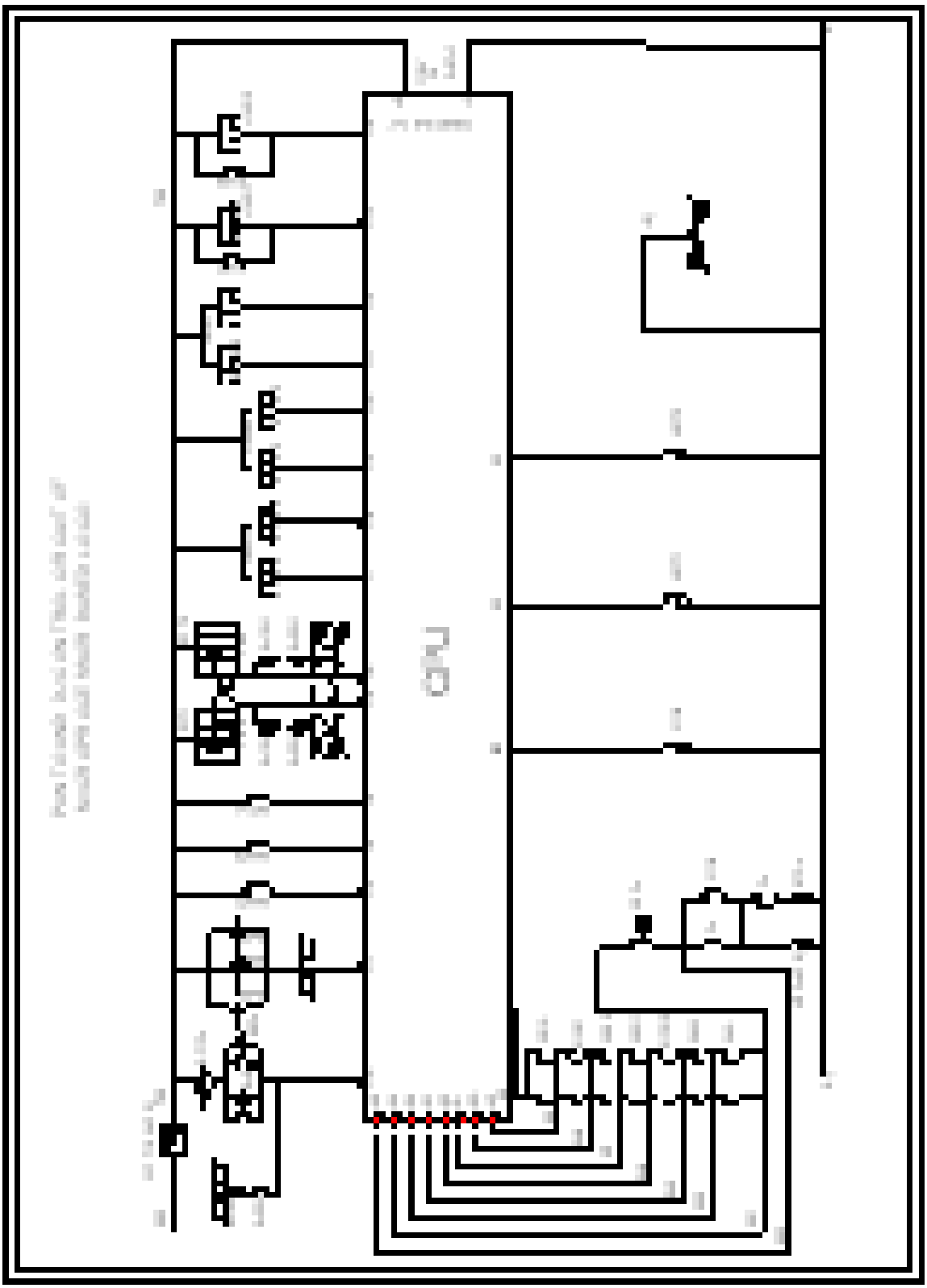
a) If Input over current LED or Output over current LED with Rectifier fault LED or Inverter fault LED is glowing.

- If the tripping of SIV is observed during blower starting with BLCP OFF, try by isolating the blowers one by one (MVMT1 or MVMT2 or MVRH)
- If the tripping of SIV is observed during starting of compressors, try using only two compressors i.e, CP1& CP3 or CP1& CP2 or CP2 & CP3 through HCP switch.

b) Earth fault LED indication:

- Trouble shoot same as in case of QOA relay target dropping, as per TSD. (Auxiliary earth fault indication comes through "Earth Fault LED")

Note: In locos provided with MEDHA make microprocessor along with static converter BLSI switch is dispensed with.



MICRO PROCESSOR BASED CONTROL AND FAULT DIAGNOSTIC SYSTEM

Microprocessors are used in Electric locomotives for the purpose of controlling and fault diagnostic. This fault diagnostic and control system ADCFDS 02 is designed by "Advanced Digital Controls", MCS 654 is designed by "Medha" and "Stesalit" company is also designing the system. This system is suitable for all types of Electric locomotives, including Static converter provided locos.

ADVANTAGES:

1. Microprocessor will monitor all the control circuit interlocking system. Hence, the control circuit with their interlocking system has been eliminated by removing all the functional/ Operational relays of conventional locos.
2. In each cab, one display unit is provided through which fault is displayed. This feature is useful for Loco Pilots troubleshooting during online failures, quickly. The stress on Loco Pilot is reduced enormously.
3. Due to less number of relays and interlocks means higher reliability of this locomotive and trouble free. In these locos, online failures are recorded. So, this record is useful for maintenance staff to know the faults occurred in the locomotive and helps them in rectifying the same.

The system comprises of the following sub-assemblies:

1) MAIN UNIT:

Main unit is mounted near the ARNO converter or in relay panel. This unit performs the main task of fault diagnostics and control and comprises of the following:

1) Power Supply Module
2) CPU module – 2Nos
3) System controller/Communications module
4) Digital Input modules 4 Nos. (5Nos in MEDHA make)
5) Digital Out put modules: 3 Nos.
6) Analog/Digital converter module (Available in all MEDHA make and some of ADC make)

SIGNAL CONDITIONING UNIT: It is mounted above the main unit. It accepts locomotive HV input of auxiliary supply, ARNO/SI output & TM armature voltage (of only one TM) through a terminal block. It out put isolated low voltage signals for control unit.

1) DISPLAY UNITS:

There are two display units in the system, one for each cab. These are housed in a robust iron cabinet. These intelligent display units, each with a built in microprocessor and communicate with the main units on a serial port. The broad features of these display Units are:

LCD DISPLAY	DIGITAL NOTCH INDICATOR
5 KEYS KEY BOARD	BUZZER

Fault Display Format

Fault Message			
Fault Time	**Fault Date**	**Current Time**	**Current Date**

Once a fault occurs, it will automatically appear on screen and remains there until another fault occurs or user clears the fault.

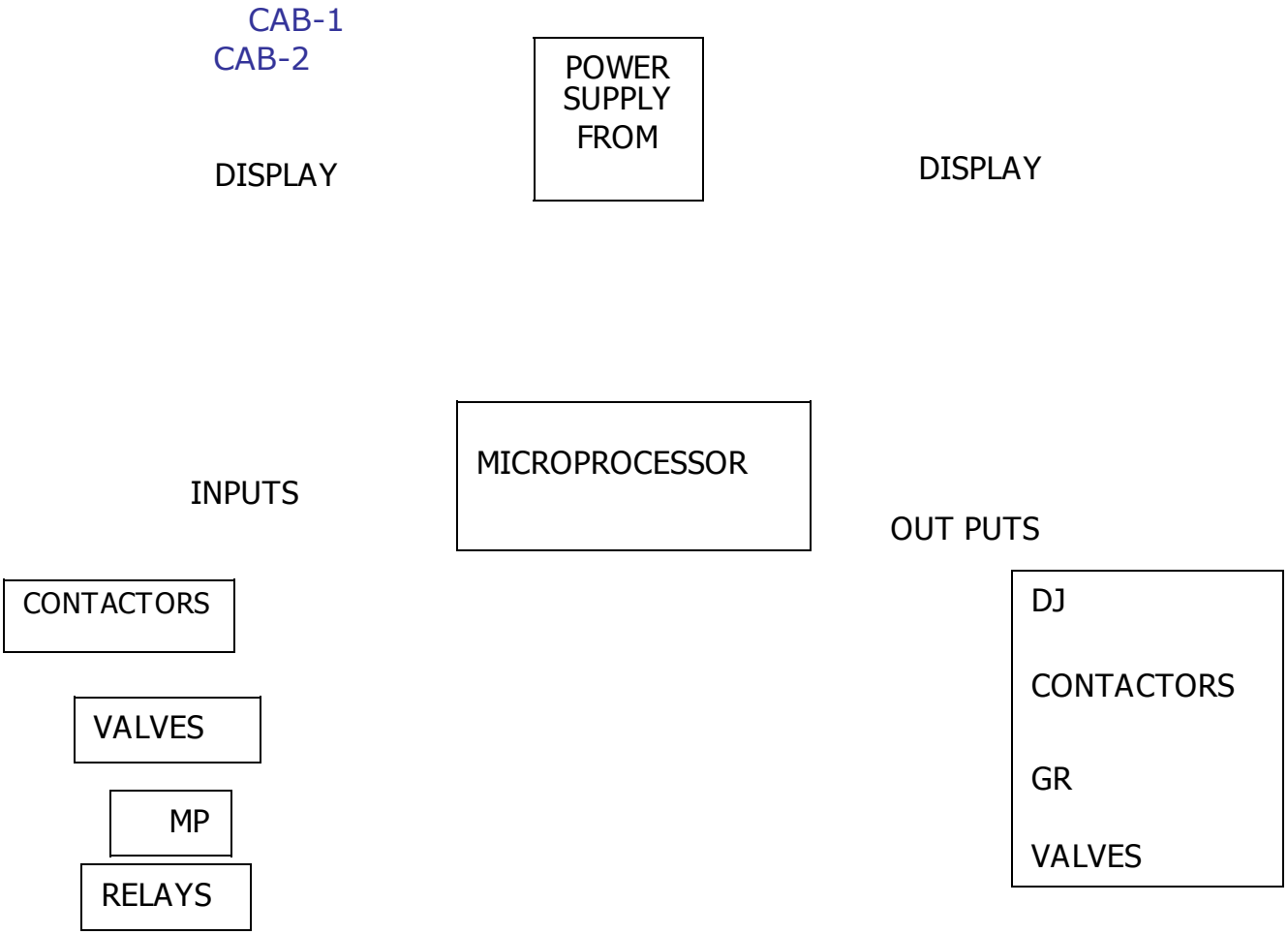
Fault MEMORY: The system is provided with non-volatile memory. The fault memory stores the fault, date and time of occurrence of fault in a sequential manner. The fault memory has capacity to store about 400 faults in ADC & 380 faults in MEDHA.

In addition to detection of faults, the system has following:

a) Real time clock,
b) A/D converter for measurement of: 1. TM voltage, 2. TM current, 3. MR pressure, 4. CHBA/BA voltage, 5. OHE voltage, 6. ARNO/SI out put.
c) KEY BOARD: The system is provided with 24 / 5 keys keyboard on the display units of each cab. The keyboard of either cab is operational. The following keys are used in the fault diagnostic system.

KEY	PURPOSE
ACK	This key is used for acknowledgement of the fault displayed on the screen.
MENU	This key is used for selection of various operations.
CURS UP	This permits one to view the next cursor fault in memory when in cursor fault display mode.
C U R S DN	This permits one to view the previous cursor fault in memory when in cursory fault display mode.
ENTR	This is the command terminator

BLOCK DIAGRAM



MEDHA MENU CHARECTERS

EXIT

Display will go to normal mode

Isolation | VEHICLE | Fault | PROCESS

Information About Isolated Equipment

Displays stored Faulty Information With date and Time

Input / Output

Display Digital Input

Display Digital Output

Display

965-966 Voltage ARNO / SI

SELFTEST

Loco Pilot need not to check

a0-a1 CH:OK,

ARNO / SI CH:OK,

TMV CH:OK, COM.DSP1 : OK, COM.DSP2 : OK,

EEPROM : OK, RTC : OK,

NO of CPU:2,CPU sts: OK.

Note: To see self test,GR should be on '0' and DJ open.

ELIMINATED RELAY STATUS
Q20,Q30,Q44,Q45,Q46,Q48,Q49,Q50,Q51,Q52
,
Q100,Q118,Q119, Q120,QCVAR / QCON,
'0' means the relay branch is not getting feed

RELAYS REMOVED:

Q20	Q30	Q44	Q45	Q46	Q48
Q49	Q50	Q51	Q52	Q100	Q118
Q119	QV60	QV61	QV62	QV63	QV64
QCVAR	QWC	QRS2	QTD105	QTD106	PR1

PR2 QSIT & QCON (in Static converter provided locos)

RELAYS AVAILABLE:

QOA	QOP1	QOP2	QRSI1	QRSI2	QLA
QLM	Q30	QCVAR	QV61	QD 1	QD2
Q20	QPH	QVMT1	QVMT2	QVRH	QVSL1
QVSL2	QVSI1	QVSI2	RGCP	RGEB	RGAF
QPDJ	QVRF	QFL			

Fuse provided newly: CCCPU (6A–ADC & 2A - MEDHA) some locos only

Fuses removed: CCDJ, CCA, CCLS & CCLSA

Modification to existing Equipment:

1. Auxiliary contacts/ Interlocks of MP, SMGR, ZSMS, CTF1, 2, 3, J 1, J 2, EM contactors.
2. Notch repeater and TFS are removed in MEDHA make locos.
3. BPQD switch provided in both cabs on Loco Pilot's desk.

MESSAGES DISPLAYED DURING VARIOUS OPERATIONS (ADC MAKE)

OPERATION	MESSAGE ON DISPLAY
HBA "ON"	ATTEMPTING SYNCHRONIZATION For few seconds and disappears. WAITING FOR COMMAND will appears
Unlocking BL	BLDJ BLDJ OPEN
Closing BLDJ	ZPT/ BV OPEN
ZPT 1 or 2	BLRDJ OPEN
Closing BLRDJ	DJ CLOSURE ATTEMPTED for few seconds and disappears REVERSER ON '0' will appear (After closing DJ)
Moving MPJ to 'F' or 'R'	MP ON '0'
Moving MP to 'N' Tr	MP on Traction
Moving MP to 'P' Br	MP on Braking
Taking notches	POSITION OF NOTCH (0-32) Indicated by Digital Notch indicator & NR

MESSAGES DISPLAYED IN THE DISPLAY UNIT WHEN DJ TRIPPED

When DJ tripped on run, the reason for tripping will be displayed on the screen of the display unit.

1	DJ tripping via QVRH	10	DJ tripping via QRSI 1
2	DJ tripping via QVMT1	11	DJ tripping via QRSI 2
3	DJ tripping via QVMT2	12	DJ tripping via QOP 1
4	DJ tripping via QVSL1	13	DJ tripping via QOP 2
5	DJ tripping via QVSL2	14	DJ tripping via QLM
6	DJ tripping via QPH	15	DJ tripping via QOA
7	DJ tripping via QVSI1	16	DJ tripping via QLA
8	DJ tripping via QVSI2	17	DJ tripping via Q30
9	DJ tripping via GR stuck up in between notches	18	Auto regression via wheel slip

PROCEDURE FOR ENERGISATION(MEDHA MAKE):

Energisation of this loco is similar to conventional loco.

The following messages will be displayed on display unit of each cab.

1. After general checkup, Put HBA on '1', observe LCD display panel for – Welcome note by MCS – 654.
2. Start MCPA and build up pressure up to 8 kg/cm^2, Unlock BL key and observe LCD display panel for – BL key ON.
3. Close BLDJ and observe LCD display panel for -BLDJ CLOSED.
4. Keep ZPT on 1 or 2 and check for panto to raise and observe LCD display panel for – CAB 1 / CAB 2 PANTO RAISED (According to cab and ZPT positions message will appear).
5. Press BLRDJ and observe C-118 contactor, DJ for closing and observe LCD display panel for -DJ CLOSED. (Provided DJ closed).
6. SI ON appears after starting of static converter till QCON energisation and disappears after extinguishing of LSCHBA (Static converter provided locos).
7. MPJ 'F' or 'R'-No message displays.
8. MP on 'N' (Tr / Br) - No message displays.
9. Taking notches – Position of notch (0 to 32) indicates by digital notch indicator only.

MESSAGES DISPLAYED IN THE DISPLAY UNIT OF MEDHA MAKE MICROPROCESSOR

No	DISPLAY MESSAGE	ACTION TO BE DONE BY THE LOCO PILOT
1	There is NO OHE at the time of DJ closing (BLRDJ is ON)	No Tension, Wait for OHE Voltage Retry to close DJ If OHE present SC Unit or its connection may be bad. Inform TIC
		OHE Power fail while Running, Apply Emergency brake
2	OHE Low/No Tension	And Conform really OHE there or not If OHE present SC Unit or its connection may be bad. Inform TIC
3	DJ Tripping due to QOP1 (Earth Fault)	Reset QOP1, Isolate faulty TM by HMCS1 Follow TSD, Inform TIC

4	DJ Tripping due to QOP2 (Earth Fault)	Reset QOP2, Isolate faulty TM by HMCS2 Follow TSD, Inform TIC
5	DJ Tripping due to QOA (Earth Fault)	Put HQOA at 0 Check all Auxiliaries / Heater, Follow TSD
6	DJ Tripping due to QRSI 1 (Over Current in RSI 1)	Reset QRSI1, Isolate faulty TM by HMCS1 Follow TSD, Inform TIC
7	DJ Tripping due to QRSI 2 (Over Current in RSI 2)	Reset QRSI2, Isolate faulty TM by HMCS2 Follow TSD, Inform TIC
8	DJ Tripping due to QLM (TFWR Over Current)	Check Transformer / GR Oil splashing Follow TSD and Inform TIC
9	DJ Tripping due to QVSL1 (SL1 Blower)	Check MVSL1, If normal put HVSL1 on 3 Resume Traction
10	DJ Tripping due to QVSL2 (SL2 Blower)	Check MVSL2, If normal put HVSL2 on 3 Resume Traction
11	DJ Tripping due to QVMT1 (MT1 Blower)	Check MVMT1, If normal put HVMT1 on 3 Resume Traction
12	DJ Tripping due to QVMT2 (MT2 Blower)	Check MVMT2, If normal put HVMT2 on 3 Resume Traction
13	DJ Tripping due to QVRH (RH Blower)	Check MVRH, If normal put HVRH on 3 Resume Traction
14	DJ Tripping due to QVSI1 (RSI 1 Blower)	Check MVSI1, If normal put HVSI1 on 3 Resume Traction
15	DJ Tripping due to QVSI2 (RSI 2 Blower)	Check MVSI2, If normal put HVSI2 on 3 Resume Traction
16	DJ Tripping due to QPH	Put HPH on 0 & clear block section Check TFP OIL level Frequently
17	DJ Tripping due to GR Stuck up on notches	Bring GR to 0 manually Clear the block section manually if necessary
18	DJ Tripping due to QLA (Over current in Auxiliary Circuit)	Isolate faulty auxiliary machine, If Fault exists make loco dead inform TIC.
19	DJ Tripping due to QPDJ	Check RS pressure, if less air pressure, start CPA, to build up pressure
20	QVRF not working	Insufficient air flow for DBR Do not use Dynamic Braking

21	Unable to close DJ due to QOP1	Put HQOP1 OFF On running condition watch HTC
22	Unable to close DJ due to QOP2	Put HQOP2 OFF On running condition watch HTC
23	Unable to close DJ due to QLM	Check HT Compartment for Oil splashing, Inform TIC
24	Unable to close DJ due to QRSI1	Watch HTC, Inform TIC
25	Unable to close DJ due to QRSI2	Watch HTC, Inform TIC
26	Unable to close DJ due to QLA	Check ARNO, Inform TIC

27	Unable to close DJ due to QPDJ	Check RS pressure, if less air pressure Start CPA to build up pressure
28	Reversers are neither in "F" nor "R"	Set the Reversers manually Resume Traction
29	CTFs are neither in "Tr" nor "Br"	Set the CTFs manually on "Tr" side only Resume Traction
30	GR not in Zero	Put GR to 0 manually, close DJ
31	Brake applied through IP	IP coil deenergises during Dynamic Braking Do not use DBR
32	Auto Regression via RGEB	If not brake applied check for leakage
33	Auto Regression via QD	Press BPQD / Resume Traction
34	Auto Regression via TM over voltage	Check TM voltage, Bring notch down if Auto regression not come
35	Braking Fault SWC operated	Braking fault SWC operated Do not use loco brake during DBR
36	Working with one CPU	One CPU failure. Note in log book and resume traction & inform to TIC
37	EEPROM failure working with Default parameters	No action by the Loco Pilot
38	Display Communication fail with other CAB	No action by the Loco Pilot
39	BLRDJ closed but DJ could not close	Press BLDJ, Select panto, Press BLRDJ

40	HVMT1 is in position 0	L1 L2 L3 Cut off, Half power available Clear the section and inform TIC
41	HVMT2 is in position 0	L4 L5 L6 cut off, Half power available Clear the section and inform TIC
42	HVSI1 is in position 0	L1 L2 L3 Cut off, Half power available Clear the section and inform TIC
43	HVSI2 is in position 0	L4 L5 L6 cut off, Half power available Clear the section and inform TIC
44	C145 Open HMCS 1/2 not in 1	C145 open in DB mode due to HMCS 1/2 not in 1 Do not use DBR
45	DBR overheated or QF/ QE Operated	C145 open in DB mode DBR Overheated Do not use DBR

No	DISPLAY MESSAGE	ACTION TO BE DONE BY THE LOCO PILOT
46	DJ Tripped via DJ Feed back Fail	Check if DJ is getting closed, If not Inform TIC
47	Battery Charger Output Fail	If not Inform TIC If not Check CHBA, note down in log book Clear the section and inform TIC
48	ICDJ through C106 Feedback Fail	Unable to close DJ due toC106 Feedback Fail Put HVMT2 on 0 Clear the section and inform TIC
49	ICDJ through C105 Feedback Fail	Unable to close DJ due toC105 Feedback Fail Put HVMT1 on 0 Clear the section and inform TIC
50	GR stuck on Notches	GR stuck up on notches. Put GR on 0 manually
51	V965 Channel Fail	965-966 Voltage Measurement channel Failed De energise the loco & Inform TIC,

52	Auto - Regression via ACP	Auto regression via ACP (Alarm Chain pulling / Train parting)
53	BPAR put in bypass	BPAR put in bypass mode
54	BPAR restored	BPAR restored
55	ICDJ through QSIT Dropped	Unable to close DJ due to QSIT high, Follow SI Display
56	OHE Voltage out of Range	OHE Voltage out of range, SI unit shut down. PUT OFF HBA for 10sec. and try again

Note:

1.The above mentioned messages are related to ARNO /STATIC CONVERTER provided Locos.

2. Loco Pilot should follow TSD / Recent instructions on various trouble shootings along with above actions.

IMPORTANT INSTRUCTIONS

1. If there is any fault in loco, the fault message will come on display unit along with buzzer sound. Based on the fault message, troubleshoot according to TSD. After troubleshooting, press ACK/CLR FLT button provided on display unit. Message will clear from the screen and it will be recorded in memory, buzzer sound stops.
   - If message not cleared keep HOBA in OFF and try.
   - If still unsuccessful, keep HBA on '0', wait for 3 min., again energise the loco and try.
   - If there is a message working with one 'CPU' Then press 'ACK' button and work the train and inform TIC at appropriate place.
2. BPQD is provided on Loco Pilot desk of each cab. This switch should be pressed (up to 10th notch only) if Loco Pilot experiences auto regression via wheel slipping. After releasing BPQD, If still auto-regression experiences, it may be due to any Traction Motor defect, troubleshoot according to TSD
3. In case of any safety relay acted, troubleshoot according to TSD.
4. In case of any E.M contactor not closing, troubleshoot according to TSD, If unsuccessful keep HOBA in OFF and try. Still unsuccessful in case of ARNO provided locos wedge the contactor and work onwards.
5. In case of tripping through Airflow relays, Loco Pilot can isolate relay/Blower through Programme switch like conventional loco.

6. It is not necessary change the position of ZSMS, during EEC operation.

7. Do not change the position of any switch while the loco is in energised condition.

8. If any one display unit not working:
   - By observing other cab display unit messages work onwards duly making necessary remarks in logbook.

9. If both display units not working
   - Keep HBA on `O' and keep in `1' after 10 sec. If still not displays.
   - If Loco is in energised condition work up to destination, duly informing to TIC and make necessary remarks in log book.
   - If any fault occurs, identify the same with the help of pilot lamps and troubleshoot as per TSD

10. If main unit not working, pilot lamps will not work and no message will be displayed.
   - Ensure battery voltage is above 90 V.
   - Check Add. CCBA, CCBA, CCPT and CCCPU. If any fuse melted, renew the same. If again melts keep HOBA in OFF and renew the fuse.
   - If still unsuccessful, keep HBA on '0' and wait for 3 minutes and again try to close DJ.
   - If still unsuccessful, contact TIC.

   Note: - While attending any trouble, before checking any equipment ensure BLDJ is in open condition.

TROUBLE SHOOTING

ICDJ:

1. Check Add. CCBA, CCBA, CCPT & CCCPU. If any fuse melts, renew the same. If again fuse melts, keep HOBA in OFF and renew the fuse

2. Ensure MR/RS pressure is above 8Kg/cm^2.
3. Check safety relay target, if any relay energised, act according to TSD.
4. Ensure BA voltage is above 90 Volts.
5. Ensure GR on '0'
6. Try to close DJ with BP2DJ.
7. Keep HQOP 1 in OFF, HQOP 2 in OFF, and HOBA in OFF and try.
8. Try from rear cab.
9. Keep HBA on '0', wait for 3 minutes and try to energise the locomotive.
10. In ARNO provided locos check C118 contactor closing or not.

TLTE:

1. If LSB glowing ensure J1, J2 and CTFs are in proper position.
2. Ensure SMGR pressure is between 2.5 to 3.5Kg/cm ^{2}.
3. Ensure RGEB 2 COC is in open condition.
4. Try with EEC operation.
5. Try from rear cab.
6. Keep HOBA in OFF and try.
7. Try to clear the section by manual operation of GR.

- At times, the fault diagnostic systems are giving erratic information leading to wrong guidance since they are not stabilized fully. Hence Loco Pilots should follow the normal procedure of troubleshooting.

IMPORTANT LOCATIONS OF CREW FRIENDLY LOCOS

1	ATFEX transformer	Motor chest No-2
2	C-118	Beside the C-145 in BA-3 panel in HT-3 compartment
3	R-118	On top of BA-3 panel in HT-3 compartment
4	CTF-1	BA-1 panel in HT-1 compartment
5	CTF-2	BA-2 panel in HT-3 compartment
6	CTF-3	BA-3 panel in HT-3 compartment
7	C-145	BA-3 panel in HT-3 compartment
8	RB unit (RF resistances, MVRF etc)	HT-1 compartment towards corridor No-2
9	HQOP-1	BA-1 panel
10	HQOP-2	BA-2 panel
11	MCPA, RS, their drain COCs, R-1 COC, RAL COC, SS-1	Motor chest No-1
12	ZCPA	In switch panel (cab-2 panel)
13	RGCP and its COC	CAB-1 back panel
14	QFL	CAB-2 relay panel
15	Hand brake, wooden wedges, spare hoses, etc.	CAB-1 floor panel
16	Almost all pneumatic equipments are provided in pneumatic cubical.	Motor chest No-1

MU OPERATION

MULTIPLE UNIT OPERATION

Introduction

For MU operation, 3 electrical jumpers (One set) are connected between two Locos besides connecting the pneumatic & Vacuum hosepipes. Due to connection of electrical jumpers, the control circuit feed of one Loco reaches to another Loco therefore same control circuit operation takes place in both the Locos, though operation is done from leading Loco. In MU operation, almost all the feed of control circuits of the leading Loco reaches to the trailing Loco but Q118, Q44 and Q100 get the control supply from its own Loco. Therefore for closing DJ, HBA should be on '1' position in both Locos. A switch BLSN is provided on the BL box, which controls the feed to VEPT and MTDJ of trailing Loco. Its normal position is 'up' (close). On pressing it down, the supply to trailing Loco VEPT and MTDJ cuts off and the DJ of trailing Loco gets opened and Panto also lowers. It is important to know that from leading Loco closing of DJ can be done for both Locos together or separately. Similarly tripping of DJ can be done for both Locos together or of the rear Loco only. However, DJ of the leading Loco alone cannot be tripped from leading Loco. It should be kept in mind that if required, DJ can be closed of trailing Loco by pressing BP2DJ of trailing Loco, but cannot be opened by BP1DJ of the trailing Loco. In case of emergency the DJ of trailing Loco can be opened by removing CCPT fuse of trailing Loco, but normally it is to be avoided.

Preparing of MU Locos

Checking of Locos

1. Examine the Locos separately and prepare them individually.
2. After complete checking de-energise the Locos. Attach them one to the other, preferably with cab 2 on either ends with CBC & pin.
3. Keep HBA of both Locos in '0' position.
4. On one side attach B C D couplers of one Loco to other. On other Loco side Loco B C D couplers will be kept as spare.
5. Couple up MR and BC equalising hose pipes and open their angular COCs.
6. Couple BP &FP air hoses and open their angle COCs. If necessary connect vacuum hose pipe also.
7. Keep A9 I/L & O/L COCs of working cab open condition and remaining cabs should be in closed position.
8. Keep SA9 supply & apply COCs of working cab open condition and remaining cabs should be in closed position.
9. Keep A8 COC Open in leading Loco Close in Trailing Loco.
10. MU2B of leading Loco in LEAD position and in Trailing Loco should be kept in TRAIL/DEAD position.
11. Keep ZPT, MPJ & BL keys of trailing Loco in the side locker.
12. HBA should be kept on '1' in both the Locos.

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13. Start MCPA of both the Locos and ensure RS pressure raises up to 6.5 kg/cm^2.

Note: If CPA of any Loco is defective, then first energise the MU Locos from the Loco in which CPA is working.

Energising Of MU Locos

1. Unlock the BL in working cab of leading Loco and ensure four pilot lamps LSDJ, LSCHBA, LSGR, & LSB glowing.
2. Place ZPT ON '1' and ensure rear pantos of both the Locos are raised and touched to OHE.
3. Place BLSN switch at 'ON' position and ensure trailing Loco panto is lowered.
4. Close BLDJ and press BLRDJ. After UA needle is deviated release BLRDJ exactly after 4 seconds. LSDJ, LSCHBA, LSGR & LSB will not extinguish.
5. Normalise the switch BLSN (i.e., 'OFF' position) and ensure trailing Loco rear panto is raised and touching to OHE.
6. Now press BLRDJ again and release it after LSDJ & LSCHBA lamps extinguishes.
7. Close BLCP and ensure CPs working according to HCP switch position of each Loco.
8. Close BLVMT and ensure three blower motors are working in both Locos.
9. Keep MPJ on 'F' or 'R' as required and ensure LSB is extinguished.
10. Move MP from 'N' to '+' and ensure LSGR is extinguished. NR shows one notch and ammeters are deviating. Then bring back mp to '0'.

** * Now MU Locos are ready to work a train.***

Procedure to locate defective Loco:

While working in MU operation, when DJ trips in 'Leading' or 'Trailing' Loco or certain faults occurs, it can be detected by LSGROUP lamp provided on cab roof and LSOL on the Loco Pilot's desk as given below.

- In defective Loco - LSGROUP glows and LSOL remains extinguished.
- In healthy Loco - LSOL glows and LSGROUP remains extinguishes.

The concerned pilot lamp indicating the fault will also glow in both the Locos along with LSGROUP/LSOL. Until the fault is rectified, the pilot lamp will continue to glow in both the Locos.

Therefore, on seeing LSGROUP (along with pilot lamps), we can locate the defective Loco. If LSGROUP is glowing in leading Loco, then leading Loco is defective and if LSOL glows in leading Loco then it means that defect is in trailing Loco (ensure LSGROUP is in working order).

LSGROUP glows under following 4 circumstances in the Locomotive.

- When DJ trips.
- CHBA is defective.
- Q50 de-energised.
- When tell tale fuse melted in RSI block.

The above defects can be rectified/trouble shooted in concerned Loco.

Note: In case of Loco trouble in leading or trailing Loco, the Loco Pilot should first try to clear the section & then do the trouble shooting of defective Loco. Switch ZLS is provided in switch panel. When ZLS is switched OFF, signaling lamps will not glow. This switch should be kept in OFF position in healthy Loco while trouble shooting in defective Loco.

Signaling lamp indications in MU Locos

S. No	TYPE OF INDICATION	LEADING LOCO	TRAILING LOCO
1	Leading Loco energised and trailing Loco de-energised.	LSDJ, LSCHBA, LSGR, LSB & LSOL glows.	LSDJ, LSCHBA, LSGR, LSB & LSGROUP glows.
2	Leading Loco de-energised and trailing Loco energised.	LSDJ, LSCHBA, LSGR, LSB & LSGROUP glows.	LSDJ, LSCHBA, LSGR, LSB & LSOL glows.
3	Both Locos de-energised	LSDJ, LSCHBA, LSGR, LSB & LSGROUP glows.	LSDJ, LSCHBA, LSGR, LSB & LSGROUP glows.
4	CHBA failed in leading Loco	LSCHBA & LSGROUP glows.	LSCHBA & LSOL glows.
5	CHBA failed in trailing Loco	LSCHBA & LSOL glows.	LSCHBA & LSGROUP glows.
6	Reversers not correctly set in leading Loco	LSB & LSGROUP glows.	LSB & LSOL glows.
7	Reversers not correctly set in trailing Loco	LSB & LSOL glows.	LSB & LSGROUP glows.
8	Tell tale fuse projected in leading Loco	LSRSI & LSGROUP glows	LSRSI & LSOL glows
9	Tell tale fuse projected in trailing Loco	LSRSI & LSOL glows	LSRSI & LSGROUP glows

PASSING NEUTRAL SECTION

At 500 Board:

1. Check pressure in MR Gauge, if less, close BLCPD and build up maximum pressure.
2. Try to accelerate the train speed before reaching Neutral Section, keeping in view the caution order in force and maximum speed of the train.

At 250 Board:

1. Bring MP to '0' and Ensure GR has come to '0' by seeing LSGR glowing.
2. Close (down) BLSN switch. Observe LSDJ, LSCHBA& LSB lamp glows in leading Loco but UA meter needle will not come to '0' and Panto of trailing Loco lowers. Signaling lamp LSOL glows on Loco Pilot's desk.

At DJ open board:

1. Open BLDJ one mast before of DJ open board and ensure DJ of leading Loco is tripped by watching UA needle comes to '0'. If not come to '0', lower Panto by keeping ZPT on '0'.
2. After tripping DJ ensure LSGROUP lamp glows and LSOL lamp extinguishes in cab.

At DJ close board:

1. At DJ close board Loco Pilot shall close DJ through BLDJ & BLRDJ. Release BLRDJ after Waiting 4 seconds after UA needle deviation or after glowing of LSOL.
2. After passing one mast distance, place BLSN in 'ON' (UP) position and wait for 10 seconds.
3. Press BLRDJ again and when LSDJ, LSCHBA& LSB have extinguished release.
4. Observe signaling lamp LSOL also extinguishes.

Note: While passing Neutral Section Assistant Loco Pilot should check the leading Loco as per procedure.

MU LOCO CAB CHANGING PROCEDURE

1. Driving cab (Which was leading Loco)

- Close BLCPD and build up MR pressure to maximum.
- Keep A9 in release and SA9 in application position.
- Ensure Brake Cylinder pressure is showing 3.5kg/cm^2 and pistons are projected out.
- Do not change any pneumaTIC cut out COC positions.
- Open DJ, switch OFF all auxiliaries, lower pantograph, put MPJ to '0', lock BL and remove all the keys.

- Proceed to another Loco.

NOTE: On gradient apply hand brakes of Loco if necessary.

2. In other Loco (which was trailing Loco)
   - Keep SA9 handle in application position and keep A9 in release position. Open A9 & SA9 inlet and outlet COCs.
   - Keep MU2B in lead position.
   - Open A8 COC.
   - Unlock BL box and raise the pantos close DJ and start auxiliaries.
   - Proceed to rear Loco change MU2B to TRAIL position, close A8 COC and close A9 & SA9 I/L & O/L COCs.
   - Close cab doors and windows.
   - Then return to the leading Loco and proceed further.

IMPORTANT POINTS ON MU

1. Do not wedge any EM contactor or relay (except Q100 and QRS) in trailing Loco. If necessary, make the trailing Loco dead. Wedging of Q50, Q44 & Q118 is strictly not permitted in trailing Loco.
2. If HOBA is required to be kept in 'OFF', keep HOBA in OFF position in both the Locos.
3. In case of EEC working, both ZSMS switches should be kept on '0' position.
4. If HQCVAR of the front Loco is on '0', never close DJ separately. In such a case, first open DJ of leading Loco and then press BLRDJ to close DJ together.
5. If CCPT melts in leading Loco, both Locos DJ trips and both Loco pantos lowers.
6. If CCPT melts in trailing Loco, only trailing Loco DJ trips but trailing panto will not lower.
7. If CCDJ melts in leading Loco, both Locos DJ trips.
8. If CCDJ melts in trailing Loco, DJ will not trip in any Loco thereby no indication.
9. Feed Loco Pilot's data in both Locos SPM(R) and ensure availability of chart.
10. Keep MP on '0' while coasting.
11. Before starting the train, ensure both Loco brakes are released.
12. If Additional CCBA or CCBA melts in any one Loco trouble shoot as single Loco.
13. Maximum four Locos only permitted to make as MU Consist.

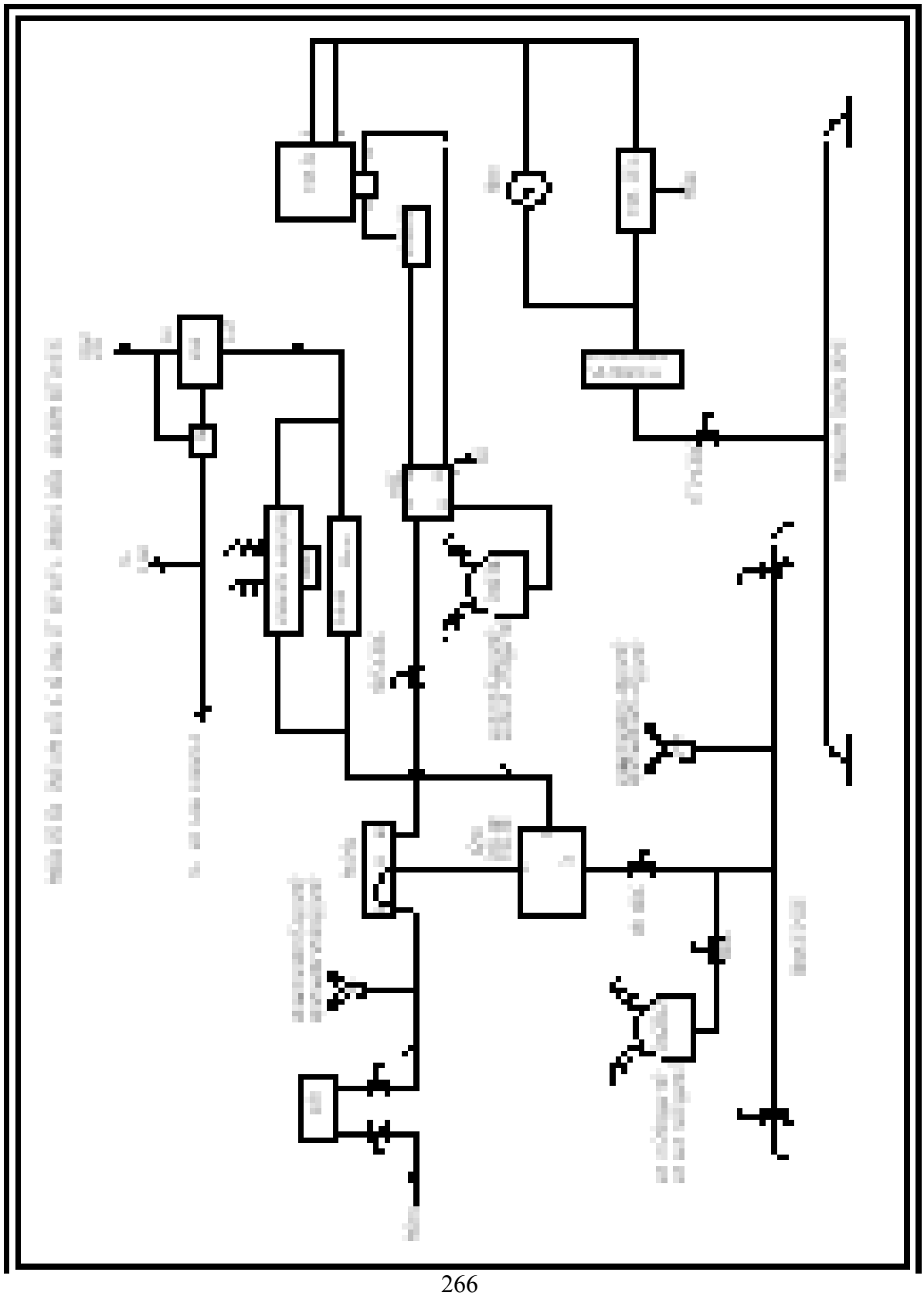
POSITION OF COCs IN MU LOCOS

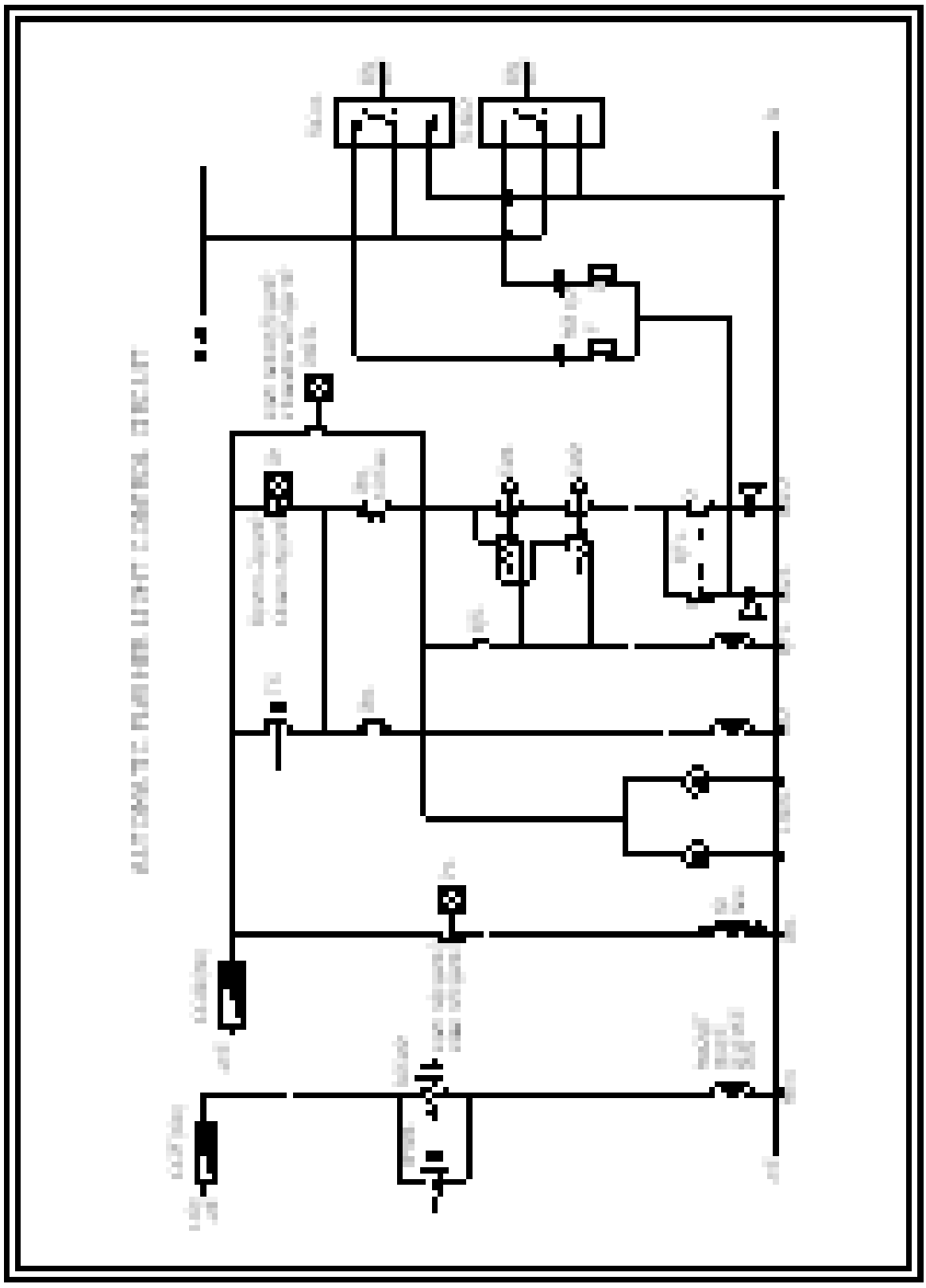
ITEM	LEADING LOCO	TRAILING LOCO
A9 I/L &O/L COCs	WORKING CAB : OPEN NON WORKING CAB : CLOSE	BOTH CABS CLOSE
SA9 SUPPLY & APPLY COCs	WORKING CAB : OPEN NON WORKING CAB : CLOSE	BOTH CABS CLOSE
MU2B	LEAD	TRAIL
A 8 COC	OPEN	CLOSE
VTP COC	OPEN	OPEN
HB 5 COC	OPEN	OPEN
A 1 DIFF COC	OPEN	OPEN
RGEB 2 COC	OPEN	OPEN

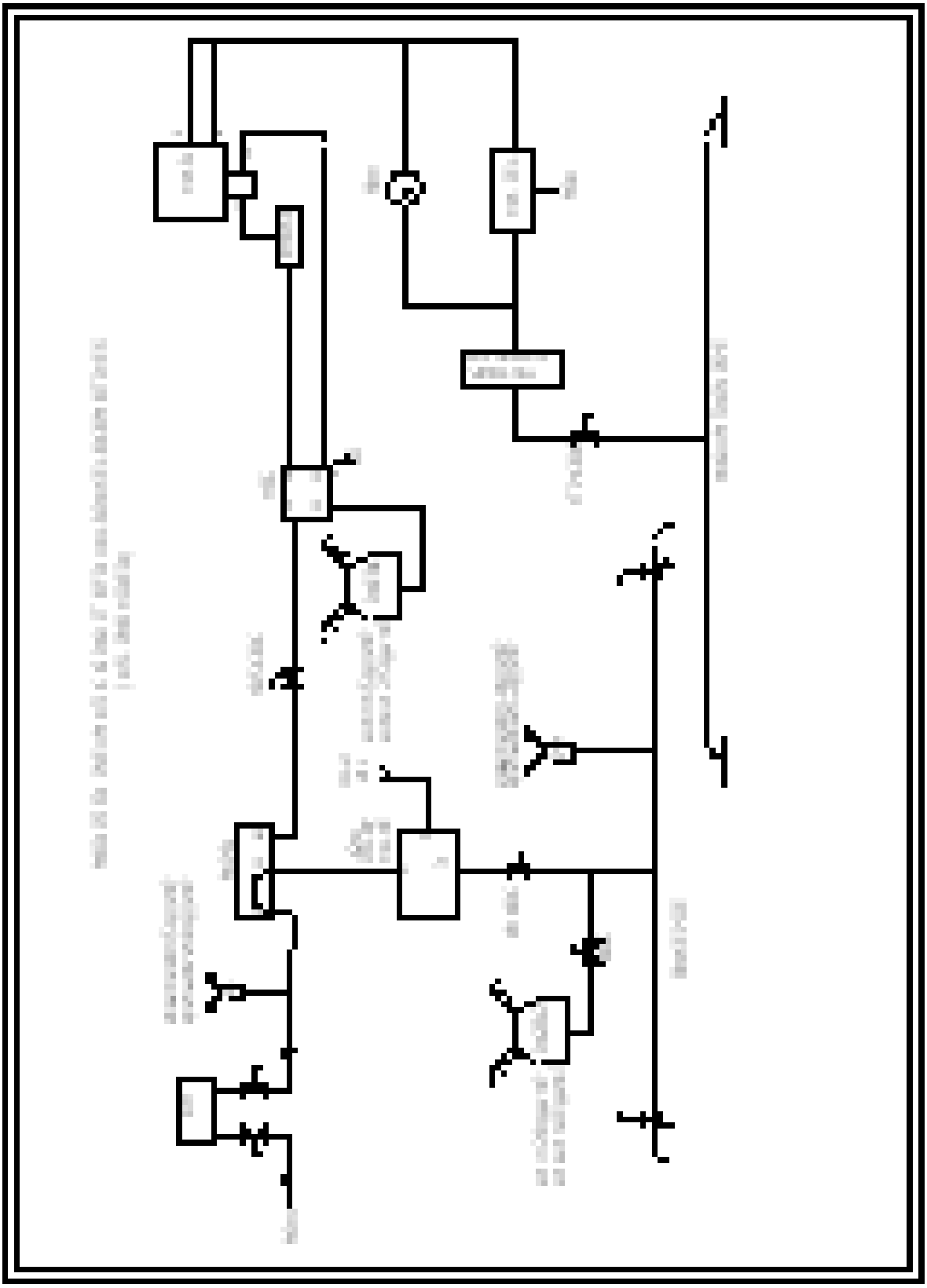
PRECAUTIONS TO AVOID LOCO WHEEL SKIDDING

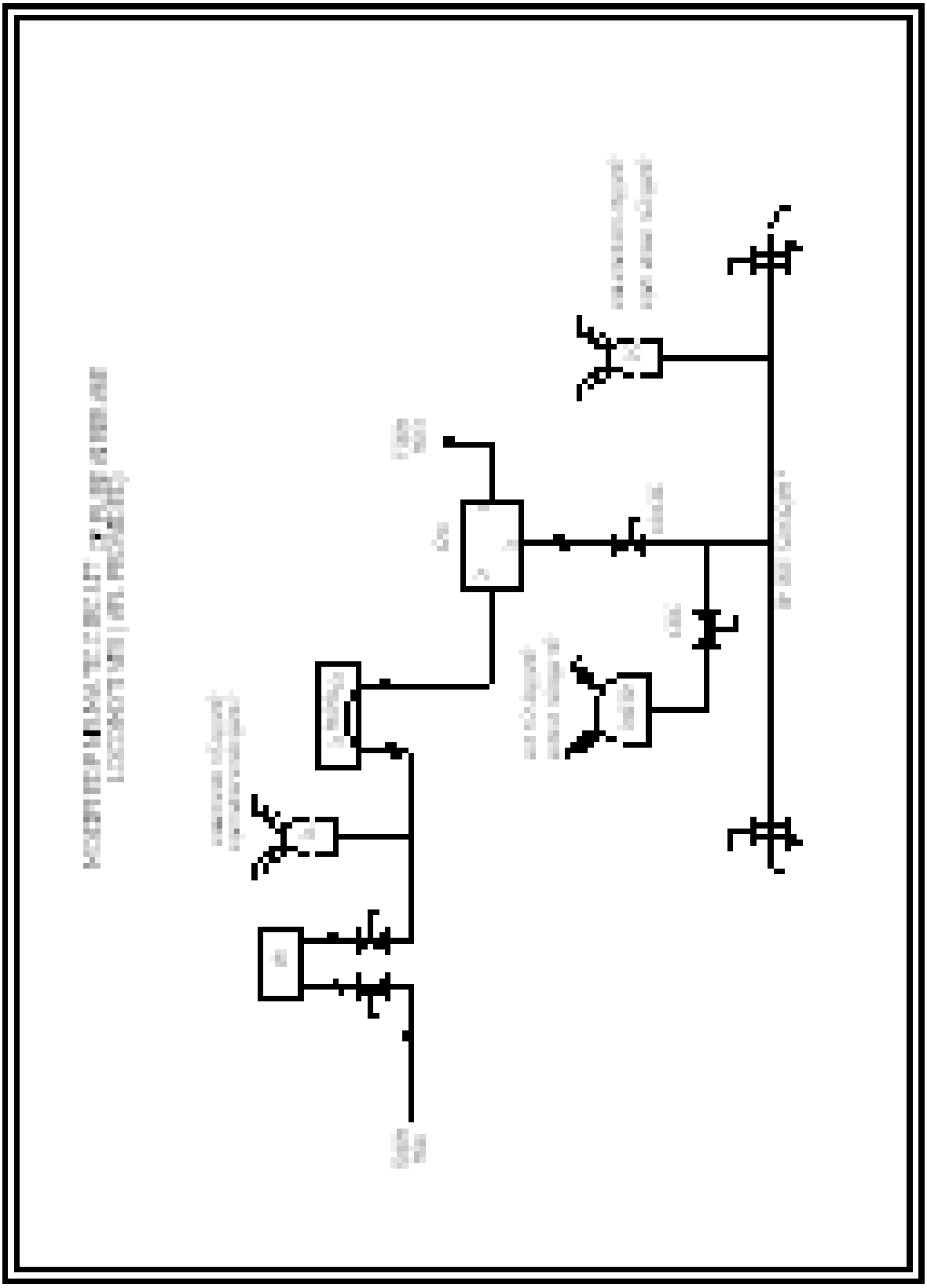
1. While taken over charge of loco, check the loco wheels for any skid marks.
2. Ensure all brake blocks are intact.
3. Ensure loco brake power is intact.
4. Before starting the train, release loco brakes.
5. After starting the train if wheel skidding is noticed, try to stop the train before the signal (starter) and inform to tic.
6. Check the brake power of the train at first opportunity and make judgment.
7. Advise the assistant loco pilot to check the wheels of rear truck for any wheel skidding sound. This should be done before reaching next block station. If wheel skidding observed, stop at station and inform to tic.
8. Do not apply sa9 for stopping the formation.
9. Apply sa9 only after complete stopping of the train.
10. While performing shunting, connect BP /VAC pipes to the formation and make use of formation brakes.
11. When dead loco is attached, isolate c3w valve in dead loco.
12. Check the wheels of dead loco also during stopping of the train.
13. After applying of brakes give sufficient time to release.
14. Before notching up ensure brakes are fully released. Ensure airflow indicator needle reads '0' in case of air brake stock.
15. If wheel skidding is experienced on run, work with restricted speed up to the next station and inform to TLC.
16. During RB don't use loco brakes.

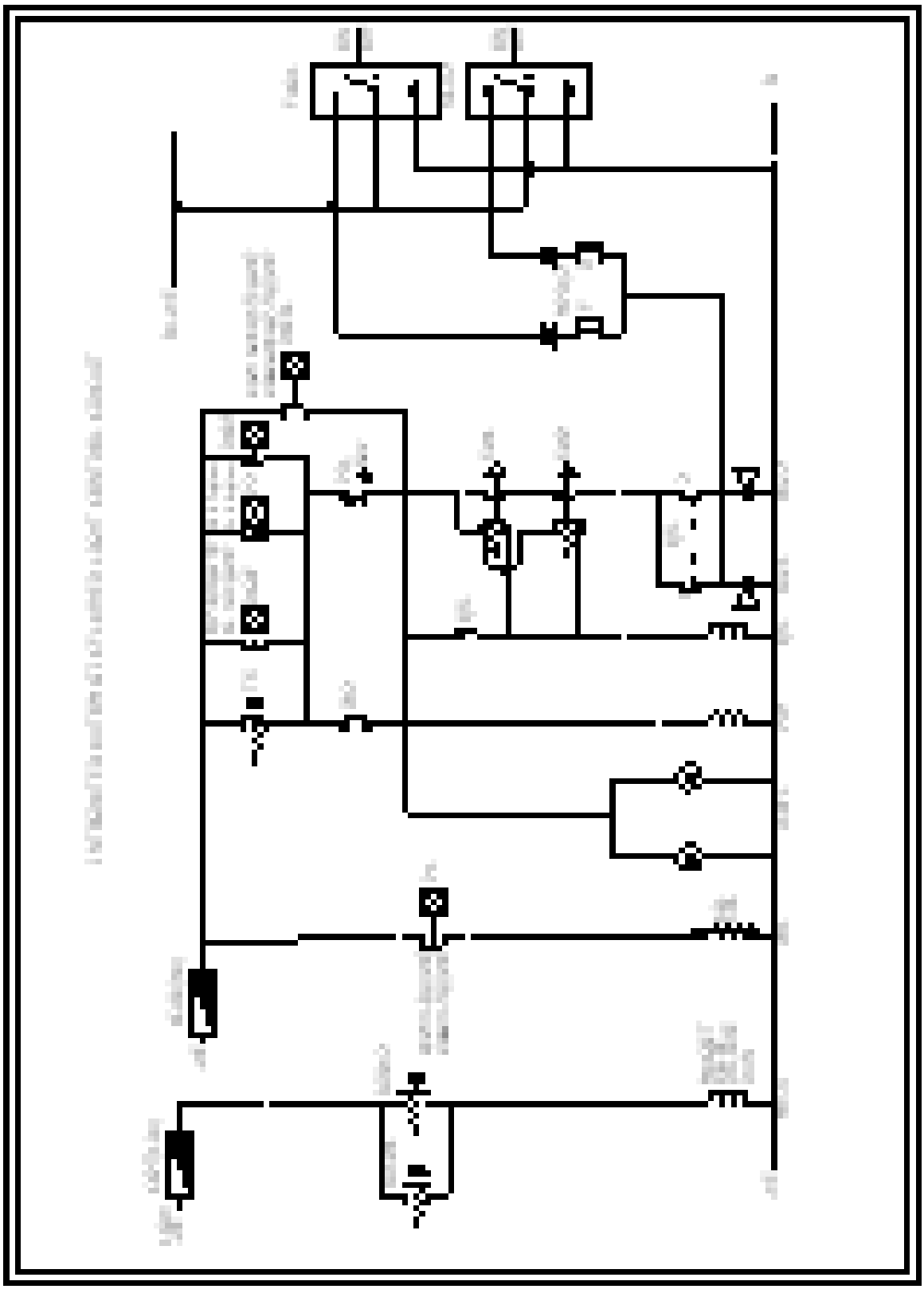
When the train is stalled on the gradient, do not try to restart repeatedly to safe guard wheels as well as rails also











AUTOMATIC SWITCHING ON FLASHER LIGHT:

This is provided for switching on Flasher light automatically during any emergency situation such as ACP, BP pressure/ Vacuum dropping or during derailment, etc,. It does not take any responsibility of Loco Pilot in abnormal situation like train parting, etc,. as given in G&SR. Loco Pilot should keep the manual push button switch BPSW 1/2 pressed during brake release/ initial charging.

When BP pressure drops below 4.4 kg/cm^2, automatically P2 I/L will close and Buzzer and Flasher light will work through P2, PR1, SW & QFL I/Ls. same time LED indication will also come in the cab. By energising PR2 relay, circuit will maintain through PR2 I/L and it's I/L will close on Q51 branch and auto regression of GR will takes place. If it is Vacuum stock, through HB5 valve RGEB1 will acted and it's I/L will close on AFL circuit and Flasher light will work.

Loco Pilot can isolate Flasher light and Buzzer by pressing SW1/2 provided in the cab, if required. LEDs will extinguish only after BP pressure recharged to 4.7 kg/cm^2.

Relay PR1 is provided for avoiding AFL when Loco Pilot applying brake through A9. When BP pressure drops through A9, P1 will actuate at 4.5 kg/cm^2 and PR1 Relay will energise and it's I/L will open on AFL branch and action of P2 will nullify. When Loco Pilot again keeping A9 in release position, control pipeline pressure will create immediately and PR1 will de energise after 60 seconds. Due time lag I/L of PR1, flasher light will not work even though BP pressure is not creating up to 4.7 kg/cm^2 within 60 seconds.

Loco Pilot shall stop the train immediately when Buzzer sounds with LED indication comes in the cab. If any abnormality noticed, Loco Pilot has to protect the train as per rules. Loco Pilot can switch off AFL by SW1/2 if every thing is normal only.

TESTING:

Preparation:

1. Keep SA 9 in application position.
2. Ensure BC gauge reads 3.5 Kg/cm^2
3. Personally ensure that all brake cylinders are applied and brake blocks are touching to the wheels.
4. Keep HVSI 1&2 and HVMT 1&2 on '0'

1. WITH TSAFL:
   a. Take few notches.
   b. By pressing TSAFL, Flasher light will glow, GR will come to ‘0’, Buzzer will sound and LEDs will glow.
2. WITH A9:
   a. Take few notches.
   b. Apply A9, there will not be any actions of AFL, other than dropping of BP pressure.

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c. When A9 brought to emergency, only GR will come to '0'.

3. WITH RS:
   a. Take few notches.
   b. Open RS. Flasher light will glow, GR will come to '0', Buzzer will sound, LEDs will glow (On opening of BP angle COC also same actions will come).
4. WITH VACUUM DROPPING:
   a. Take few notches.

Open RS to 45^{o} or open Vacuum hosepipe. Flasher light will glow, GR will come to '0', Buzzer will sound, LEDs will glow.

Control circuit of QRS2

QRS2 is an emergency relay, provided in relay panel. Whenever BP drops by any reason, it causes auto regression and stops functioning exhausters in DBC locos.

QRS2 will energise through CCLS,BL IL,RGEB2 contact closes when the BP pressure is more than 4.0 KG/CM^2, self I/L of QRS2. Hence while running the train, QRS2 will be in energised condition.

Whenever BP drops to 2.8 KG/CM^2 or below by any reason, QRS2 will de energise through RGEB2 contact. Then QRS2 I/L closes on Q51 branch causing auto regression of GR.

For a DBC loco,QRS2 I/L opens on exhausters control circuit causing C111 or C121 to de-energise and hence exhausters will stop functioning. At the same time QRS2 N/o I/L on VEF(E) will open causing loco brakes to apply though PVEF is pressed.

SANDERS CONTROL CIRCUIT

The sanders control circuit energises VESA1 & 2 or VESA3 & 4 according to the direction of train movement causing sand to apply in case of wheel slip.

When PSA1 is pressed, through CCLS, BL I/L PSA contact, J1F and J2F contacts, VESA1 & 2 will energise. When PSA2 is pressed, through CCLS, BL I/L PSA contact, J1R and J2R contacts, VESA 3 & 4 will energise. When these electro valves are energised, the pressure from MR2 acts on sand ejectors (provided below each sand box) and sand is dropped along with forced air in between wheels and rails for better grip. During cab-1 leading sand drops to axle No 1, 2 & 4. During cab-2 leading sand drops to axle No 6, 5 & 3.

When ever Q48 is energised by any means, automatically concerned electro valve energises according to the cab leading. But this Q48 I/L is chronometric I/L which allows dropage of sand even after de-energisation of Q48relay.

DUTIES OF CREW AFTER CATTLE RUN OVER:

1.If BP is dropped:

a) Put on Flasher Light and find out the reason for BP drop and arrest the same.
b) Stop the train and Check cattle guard, rail guard, sand pipes, battery boxes and their covers, SL's, leakage of air from any pipeline, TM inspection covers and rectify if any abnormality is found.
c) Clear the section and check the battery voltage.
d) Inform to TLC with all particulars even though there is no abnormality and work further.

2.If BP is not dropped:

a) Stop the train and Check cattle guard, rail guard, sand pipes, battery boxes and their covers, SL's, leakage of air from any pipeline TM inspection covers and rectify if any abnormality is found.
b) Clear the block section, check BA voltage and work further duly informing to TLC.

Make entry in the log book with all particulars.