Generally speaking, power supplies for signalling purposes can be grouped under three headings:

1) Primary Cells
2) Secondary Cells
3) Alternating Current Apparatus

The types of electrical supply that we have previously discussed on the E.P.1. Course were:

a) Direct Current - D.C.
b) Alternating Current - A.C. - As supplied by the Central Electricity Generating Board (C.E.G.B.)

It was stated that with a D.C. supply, the current always flows in one direction but in an A.C. circuit it constantly changes direction. This change of direction in the mains supply is at a rate of 50 times per second. The A.C. supply is thus called 50 Cycle Supply or 50 Hertz (Hz)

For signalling relays a direct current supply is required. When possible it will be obtained from the C.E.G.B. and then changed to D.C. at the correct voltage. There are, however, many areas where Primary Cells are used as the only source of D.C. power supply.

PRIMARY CELLS

Primary cells are generally constructed as follows:

1) Container or outer case.
2) Positive element.
3) Negative element.
4) Electrolyte.
5) Depolariser.

Requirements for primary cells:

1) The E.M.F. should be large and remain constant.
2) The internal resistance should be small and remain constant
3) The condition of the cell should be capable of being easily inspected and/or tested.
4) It should be easy to renew.
5) It should give off no offensive fumes.
6) It's initial cost should be relatively small.

The two main types of primary cell in use on this region are as follows:

"LECHLANCHE" TYPE DRY CELL

Zinc container covered with cardboard.
Carbon for Positive Element.
Zinc Container acts as Negative Element.
Salamoniac Paste for Electrolyte.
Manganese Dioxide as Depolarising Agent.
"On Load" voltage approx. 1.3 volts (when new)

INERT "AIR DEPOLARISED" CAUSTIC SODA CELLS

Fibre or Plastic Container.
Carbon for Positive Element.
Zinc for Negative Element.
Booster Zinc fitted for extra life.
Porous Carbon as Depolarising Agent.
"On Load" voltage 1.2 volts (when new)
Caustic Potash Solution as Electrolyte.
Instructions for servicing on container side.

There are two inert caustic cells in use. The 618A and the 608A. The former should be removed from service and replaced when the "on load" voltage reaches 1.1 volts. The 608A cell should be changed when the "on load" voltage drops to 1.0 volt. Dry cells do not have this sharp fall off characteristic and should be replaced when the overall battery voltage falls below the required value or when individual cell "on load" voltages drop to 0.3 volts, whichever occurs first.

Ventilation is important for all primary cells and a continuous supply of fresh air is essential across the top of each cell. Inert Caustic Cells will not operate satisfactorily if ventilation is not provided.

RECOMMENDED DISCHARGE RATES

Type of Cell	"Rated" Capacity Continuous	Weight lbs	Maximum Recommended Discharge Rates		
			Continuous	Intermittent	
				60x5 secs Daily	2x2 hrs Daily
D.S.3	2,000 hours	2	50 mA	375 mA	100 mA
D.S.1	2,600 hours	6	100 mA	500 mA	200 mA
A.D.513	850 Watt hrs	16	200 mA	5 Amps	600 mA
A.D.618A	1000 " "	10 *	400 mA	800 mA	800 mA
A.D.608A	2,000 " "	22 *	1 Amp	2.5 Amps	1.5 Amp

* Weight before filling with water.

PRIMARY CELLS : TYPES AND APPLICATIONS

Type of cell	Description	Applications
D.S.1	1.4V dry cell	Electric detection Track circuit repeating
D.S.3	1.4V dry cell	Telephones (Ringing & microphone) Signal repeating, Light repeating
D.S.7	1.4V dry cell	Portable Field Type Telephones
A.D.513	1.4V Air Depolarised Cell	Circuits requiring intermittent currents:- Lever locks, Signal motors, AWS Inductors.
A.D.608A	1.4V Air Depolarised Cell Inert type.	Continuous loads:- Track circuits and Semaphore signal lights requiring over 400mA.
A.D.618A	1.4V Air Depolarised Cell Inert type.	Continuous loads under 400mA.

NOTE.

1) As far as possible the type of cell chosen must be such that the continuous load is within the discharge rates shown in the table

2) A single cell or bank of cells of the appropriate size should be used in preference to parallel banks of smaller cells.

The use of primary cells does, however, place many constraints on the Signal Engineer in terms of equipment and circuitry limitations, and, of course, the relatively high labour cost of replacing the cells. It is B.R. policy therefore, to eliminate the use of primary cells wherever possible, eg; where main power is available.
It can also be appreciated that primary cells are completely unsuitable for providing the wide range of voltage and load requirements demanded by modern signalling installations, neither would they meet the important criteria of:- Maximum Reliability of Supply.

THE EFFECT OF CELLS CONNECTED IN SERIES AND PARALLEL

CELLS CONNECTED IN SERIES

The ordinary dry cell has an e.m.f. of about 1.5V. A 3V battery is simply two 1.5V cells connected in series, and a 4.5V battery contains three cells in series, and so on.
Fig.1a shows six dry cells connected in series, and the e.m.f. is 6 X 1.5 = 9 volts.

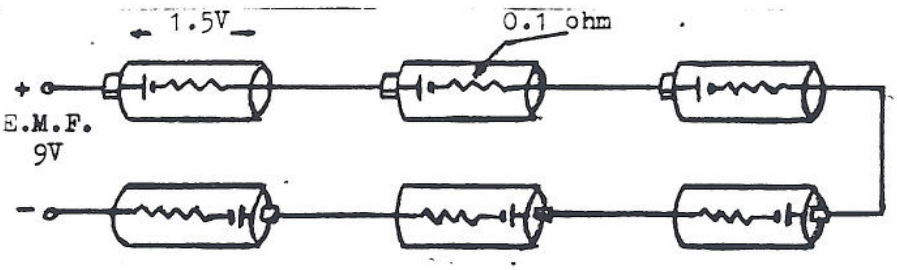

FIG.1a

The maximum current that can be drawn from this battery (Current Capacity) is determined by the voltage and the internal resistance of the cells When cells are connected in series, their individual internal resistances are also connected in series.
Fig.1a illustrates six cells, each with an internal resistance of 0.1 ohm connected in series. The total internal resistance being:-

$$0.1 \times 6 = 0.6 \text{ ohm.}$$

$$\text{Maximum Current} = \frac{\text{Total E.M.F.}}{\text{Total Resistance}} = \frac{9}{0.6} = 15 \text{ amps.}$$

CELLS CONNECTED IN PARALLEL

Fig.1b shows the same six cells connected in parallel with a total e.m.f. of 1.5V

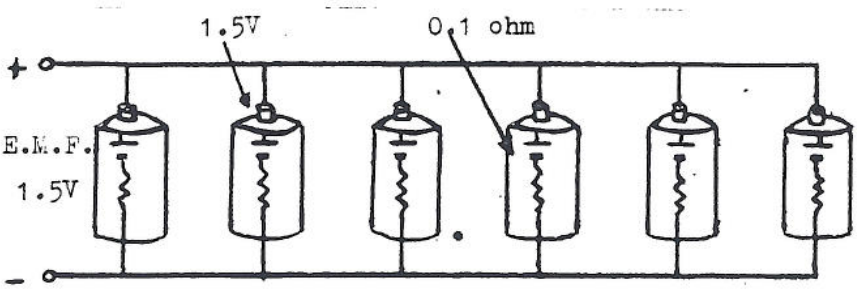

FIG.1b

With the cells connected in parallel, the internal resistances will also be connected in parallel, the total resistance being found by the formula:-

$$\frac{1}{Rt} = \frac{1}{0.1} + \frac{1}{0.1} + \frac{1}{0.1} + \frac{1}{0.1} + \frac{1}{0.1} + \frac{1}{0.1}$$

$$\frac{1}{Rt} = \frac{6}{0.1} = \frac{60}{1}$$

$$Rt = 1/60 \text{ ohm}$$

$$\text{Maximum Current} = \frac{\text{Total E.M.F.}}{\text{Total Resistance}} = \frac{1.5}{1/60} = 90 \text{ amps}$$

It can be seen that the six cells connected in parallel can deliver six times as much current as each individual cell (or for that matter, six times as much current as the same six cells connected in series).

INTERNAL RESISTANCE

All cells have a certain amount of internal resistance. We will now consider a method of calculating the internal resistance of an individual cell.

If we measure the 'off load' voltage of a cell, the only current that flows will be the 'meter current', which will be negligible, so the voltage drop across the internal resistance will also be extremely small. Thus the measured voltage is considered the e.m.f. of the cell. However, when the cell is 'on load', with a known current, the voltage measured is the e.m.f. of the cell minus the voltage drop across the internal resistance due to the load current.

The difference between the 'off load' and 'on load' voltages is the ... across the internal resistance. This voltage can now be used to find the value of the internal resistance of the cell by using the ohms law formula:- R = V/I

... where V is the P.D. across the internal resistance.

EXAMPLE

The 'off load' voltage of a cell is 1.4V

The 'on load' voltage when supplying a current of 200mA is 0.4V

Calculate the internal resistance of the cell.

Off Load Voltage - On Load Voltage = P.D. across the Internal Resistance.

1.4V - 0.4V = 1.0V

Internal Resistance = V/I = 1.0/0.2 = 5 ohms

The same methods used for finding the e.m.f., current capacity and internal resistance of dry cells can also be used to determine these values in secondary cells.

SECONDARY CELLS

Secondary cells used for railway signalling purposes are generally of two types:-

Lead Acid
Alkaline

LEAD ACID CELLS

The composition of lead acid cells have been discussed in detail on previous courses. We will now consider their application, maintenance and charging requirements so far as railway signalling is concerned.

The battery location should be clean, dry and have good ventilation. Cells are usually connected in series, with the positive of each cell connected to the negative of the cell adjacent to it. The connecting straps are usually made of lead. The positive terminal of the battery as a whole should be connected to the positive of the charging source, and the negative terminal of the battery should be connected to the negative of the charging source.

All points of contact should be thoroughly clean and coated with petroleum jelly. Bolted connections should be firmly tight.

Each cell should be checked with a voltmeter to ensure that polarity is correct.

The strength of the electrolyte is measured in terms of 'Specific Gravity', which is the ratio of the weight of a given volume of electrolyte to an equal volume of water. Concentrated sulphuric acid has a specific gravity of about 1.835, whilst the specific gravity of water (pure water) is 1.000. The sulphuric acid and water are mixed in the correct proportion to give the specific gravity required. For example, electrolyte of 1.220 specific gravity is about 20% concentrated acid and 80% water by volume.

Specific gravity readings are given by an Hydrometer. The specific gravity of a lead acid cell is normally 1.220 (or as recommended by the makers), whilst the 'on load voltage of a fully charged cell should not be less than 2.2 volts.

When it is necessary to mix sulphuric acid with water to the specific gravity desired for an electrolyte, "The Acid Must Always Be Added To The Water".

If water is poured into a container of concentrated acid, the heat so generated will cause spurts of acid solution to fly off in all directions, perhaps causing danger to persons and damage to equipment.

USE OF THE HYDROMETER AND SYRINGE

PROTECTIVE GOGGLES MUST BE WORN

Remove the cap from a battery cell, squeeze the suction bulb and insert the flexible tube into the cell. Slowly release all pressure in the suction bulb which will allow the maximum volume of electrolyte into the syphon jacket thus ensuring the hydrometer floats freely at any of the markings between 1.100-1.300 Specific Gravity.

Lift the instrument clear of the cell and make certain that the electrolyte in the syphon jacket is free from air bubbles as these can cause inaccurate readings.

Take Readings at Eye Level. If sighted below eye level an ellipse is observed around the stem of the hydrometer, lift the eyes until this ellipse disappears and then take the reading. Repeat to ensure accuracy.

Repeat for each cell.

Never Mix Acid & Alkaline - Always Use Clean Utensils

Syringes, hydrometers, filling bottles and other containers which have been used on one type of cell should be thoroughly rinsed in clean water before using on the other type.

INITIAL CHARGE

All types of batteries lose some of their charge during shipment, and while standing idle, therefore, upon installation it should be made certain that the battery is fully charged by giving it a freshening or booster charge. This initial charge should be given before the battery is connected to its ultimate load and should be given for as long as the specific gravity and voltage of any cell show any increase and then for some three hours after the last increase is observed. This charge should be carried out at the normal rate given by the manufacturer. If the charge rate is lower than that laid down then the three hour period should be lengthened proportionately. Any cell failing to achieve maximum specific gravity or charge voltage

should not be placed into service.
The specific gravity of lead acid cells is normally 1.220.
The voltage of a fully charged cell should not be less than 2.2V

MAINTENANCE

Regular voltage and hydrometer readings must be taken. The specific gravity of the electrolyte is a clear indication of the cells condition and whether or not it is receiving a satisfactory charge.

Voltage tests are indicative of the condition of the cell plates, establishing that a satisfactory electrical potential is existing between the positive and negative electrodes. This test should be carried out with the cell discharging into a load, therefore the charging current must be switched off previously and the cells should have ceased gassing. If it is impracticable to take voltage tests while 'on load' conditions exist then a 1 ohm shunt resistance connected across the cell will allow a voltage test to be made with the cell discharging quite heavily. The voltage should be steady for a 10 second period, at approx. 2 volts.

It is essential to keep the level of the electrolyte above the plates and topping up should be done with distilled water. To prevent leakage to earth, batteries should be stood on insulating material and location cupboard shelves kept dry and clean. Adequate ventilation is important as secondary cells of all types give off considerable amounts of explosive gases. Naked lights and smoking is prohibited in battery rooms and cells should not be disconnected while charging or discharging or while the cells are gassing as a spark may cause an explosion.

If cells, either when new or later, are to be put into storage for several months or longer, they should first be given a charge until all cells are gassing and the specific gravity has reached its normal full charge value. Cells should then be stored in a cool, dry place and must not be placed near a radiator or other source of heat. A thorough recharge is necessary before returning cells into service.

A lead acid cell should never be allowed to remain in a discharged condition for any appreciable time. If allowed to do so, the lead sulphate in the solution will grow on the plates in the form of hard white crystals. This is known as SULPHATION.

Abnormal sulphation closes the pores of the active material in the plates and in time will destroy them. When the battery is again placed on charge, after a period of standing in a discharged condition, some of the lead sulphate, instead of changing back into spongy lead or lead peroxide, is dislodged from the plates in small particles and drops to the container bottom as sediment. This active material is lost forever. In normal operation all lead acid cells shed a small amount of active material from the positive plates.

To properly maintain lead acid cells they should be periodically discharged and charged.

ALKALINE CELLS

Alkaline batteries are used for a large variety of purposes. They have almost every advantage over the lead acid type cell, except that of first cost which is higher, however, as an alkaline cell will outlast a lead acid cell, it is actually cheaper in the long run.

An alkaline cell has a specific gravity of 1.190. The specific gravity does not vary during discharge. The cell case is usually steel, on which the electrolyte has no action, but the outer surface of the cell is sometimes plated to prevent atmospheric corrosion. The voltage of a cell should not be less than 1.45V.

PREPARATION OF NICKEL CADMIUM CELLS FOR SERVICE

The cells are delivered with electrolyte but in a discharged condition.

Wearing Goggles remove the transit plugs from the top of the vent and discard.

Check the electrolyte level in all cells and correct where necessary by adding distilled water only, using the plastic filler bottle type PB4.

The cells should now be given a 'First Charge'. Details of charging Secondary Cells are given later in this lecture.

MAINTENANCE PROCEDURE

1) PUT ON GOGGLES (this is for your own protection.)
2) Switch off battery charger and allow air to circulate so that any accumulation of gas can disperse.(enforce air circulation by wafting or fanning where no motion of air is apparent).

3) Check the electrolyte level and top up with distilled water where necessary using Filler Bottle Type PB4 with Filler Tube and Probe. (For FA and FV cells with modified vent plugs, the insulated Probe No 3 (2¼" long) must be used).

METHOD OF USING THE FILLER BOTTLE

The bottle should be kept clean and contain pure distilled water. With the probe inserted through the filler vent the bottle should be raised in an inverted position above the cell. Gently squeezing the bottle will then force a little water into the cell. The bottle should then be held upright at a 'lower than cell' level and the finger pressure on the bottle relaxed. This will cause the probe to suck and extract electrolyte until the correct level is achieved. Care must be taken to ensure that whilst the sucking is taking place that some electrolyte is extracted initially, followed by the sucking of air. This indicates that the correct level is achieved even without a visible view of the cell interior.

4) At not less than yearly intervals test and record the specific gravity of cells. This should be between 1.160 and 1.200. This test should not be carried out on a cell which has been topped-up on the same day.

5) Ensure the exterior of the cells are clean and dry.

6) Ensure that all cell inter-connectors are secure, using an insulated box spanner to eliminate spark risk. Do not turn the bottom gland retaining nuts which lie beneath the connectors.

7) Terminals must be kept lightly greased with petroleum jelly.

8) Measure and record the total battery voltage. Measure and record individual cell voltage on a progressive basis as frequently as directed.

If a cell is found to be faulty, it must be replaced. The new cell must have its transit stopper removed and electrolyte level checked. Before installation at site, the cell must be given an initial bench charge in accordance with installation instructions for first charge rates.

9) Cases containing cells must always be well ventilated by top and bottom louvres. Check that ventilation louvres are not obstructed.

CHARGING OF SECONDARY CELLS

Storage batteries can be recharged after being partially or fully discharged by passing a direct current through them at the appropriate voltage. The usual source of direct current employed in railway signalling is via a rectifier which receives its power from an A.C. supply and delivers D.C. for use in the charging circuit.

TYPES OF CHARGERS

There are many types of chargers used for sinalling purposes, however, they generally fall under two main categories:-

a) Constant Potential
b) Manual Adjustment

CONSTANT POTENTIAL CHARGERS - Maintain a constant battery voltage irrespective of the rate of discharge (subject to a maximum value). It is very important that the correct number of cells are installed for the size of the charger. The voltage and charging current rating is predetermined to suit the battery operating conditions, and no adjustments are necessary once in service.

MANUAL ADJUSTMENT CHARGERS - The charging rate is set by the technician and must be adjusted to give the minimum charge necessary to keep the battery in a fully charged state. This would take into account intermittent peak loads plus a small amount for the batteries internal losses.

CHARGING RATES

EXCESSIVE CHARGING RATE - Results in heavy water consumption, ie; the electrolyte level drops by more than $\frac{1}{4}$" per month and excessive gassing is evident.

INSUFFICIENT CHARGING RATE - Results in little or no water consumption.

THE DESIRABLE CHARGING RATE - Is indicated by a consumption rate which gives a fall in water level of between $\frac{1}{8}$" and $\frac{1}{4}$" per month.

It is essential that the battery is not continually overcharged which produces excessive quantities of explosive gas.

APPLICATION AND CAPACITIES OF NICKEL CADMIUM CELLS

The following table shows the applications for different types of alkaline cells

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TABLE OF APPLICATIONS AND CAPACITIES OF NICKEL CADMIUM CELLS

TYPE	DESCRIPTION	CAPACITY	APPLICATIONS
RE 16	Single crated cell	16 amp.hrs. discharged at 1.6 amps over 10 hrs.	Track circuits, Line circuits, AWS, Electrically lit semaphore signals, Motor operated and Colour light signals, Internal S.Box circuits.
RE 16	Five crated cells	"	"
RE 44	Five crated cells	44 amp.hrs. discharged at 4.4 amps over 10 hrs.	"
DLS 4	Five crated cells	40 amp.hrs. discharged at 8 amps over 5 hrs.	Point Machines
RV 8	Five crated cells	80 amp.hrs. discharged at 6.7 amps over 12 hrs.	Barriers and other forms of crossings.

FIRST CHARGE RATES FOR NICKEL CADMIUM CELLS

Charge for 10 hours at the appropriate rate for the type of cell required. If lower charging currents are used the charging time should be increased proportionately.

RE 16	RE 44	DLS 4	RV 8
4 amps	11 amps	10 amps	20 amps

METHODS OF CHARGING

FRESHENING OR INSTALLATION CHARGE

All types of batteries lose some of their charge during shipment and while standing idle. Before the installation of a battery can be considered complete, the battery should receive a freshening charge.

The charge for lead acid cells, if the normal charge rate is used, should be continued until all cells show no further increase in specific gravity and then for three hours more. If the charge rate is lower than manufacturers recommended figure, then the three hour period should be lengthened in proportion.

The charge for alkaline cells requires to be continuous until the voltage of all the cells in the battery is constant on discharge through a two ohm shunt resistor for ten seconds.

At the end of the pre-installation charge, a record should be taken of specific gravity, voltage, temperature reading and electrolyte level for comparison with future readings.

TRICKLE CHARGING

Enables enough current to flow through the battery to maintain it in a fully charged condition, taking into account peak loads and also the current required to offset local action losses in each cell. The battery will not discharge appreciably except when a power failure occurs, then the battery will carry the entire load for a predetermined time.(Hopefully until the power is restored.)

The charging current required to compensate for local action losses of a secondary cell should be calculated at a minimum of 1mA per ampere-hour of the cells rated capacity, ie; a cell rated at 50AH would require a charging current of at least 50mA to compensate for local action losses. As the cells deteriorate over the years then it may be necessary to increase this figure.

Fig. 2 shows a typical manually adjusted battery charger and also illustrates the A.C. input and rectified D.C. output waveforms.

Fig. 3 shows a point power supply with 'Floating' battery where the point operating voltage is 110 volts D.C. (as at Kings Cross power signal box). Note also the duplication of switch gear and battery chargers.

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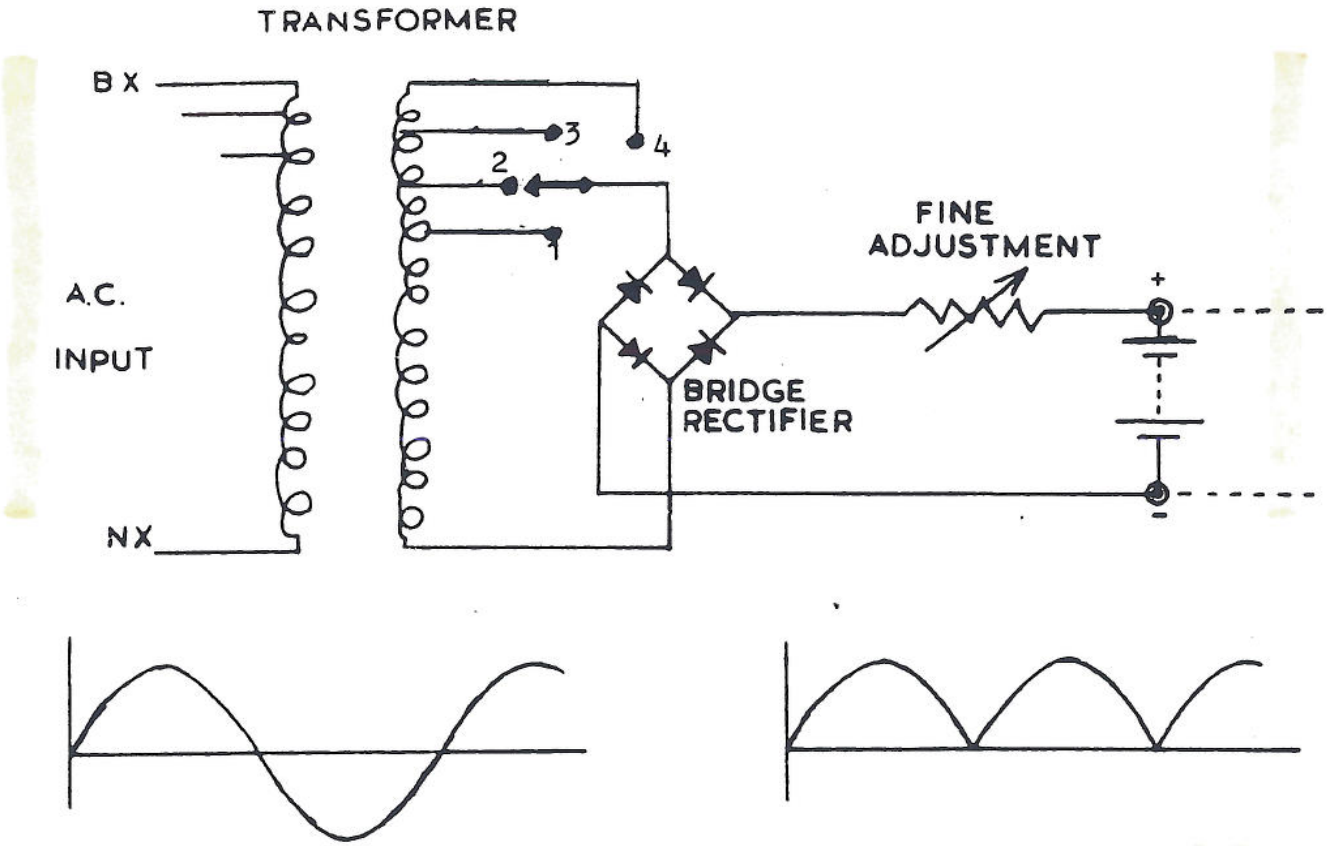
FIG. 2 TYPICAL BATTERY CHARGER



Both the transformer and rectifier are incorporated in the same unit. To enable adjustments to be made to the charging supply, the transformer windings are 'tapped', the tappings on the secondary side of the transformer being terminated on a 'Course Control Switch', usually having four positions.

The course control adjusts the input to the rectifier, but to adjust on a much finer scale an adjustable resistor is fitted in the output circuit together with an ammeter.

With a fluctuating load on the batteries being charged it may be necessary to re-adjust a few times before a satisfactory charge is obtained.

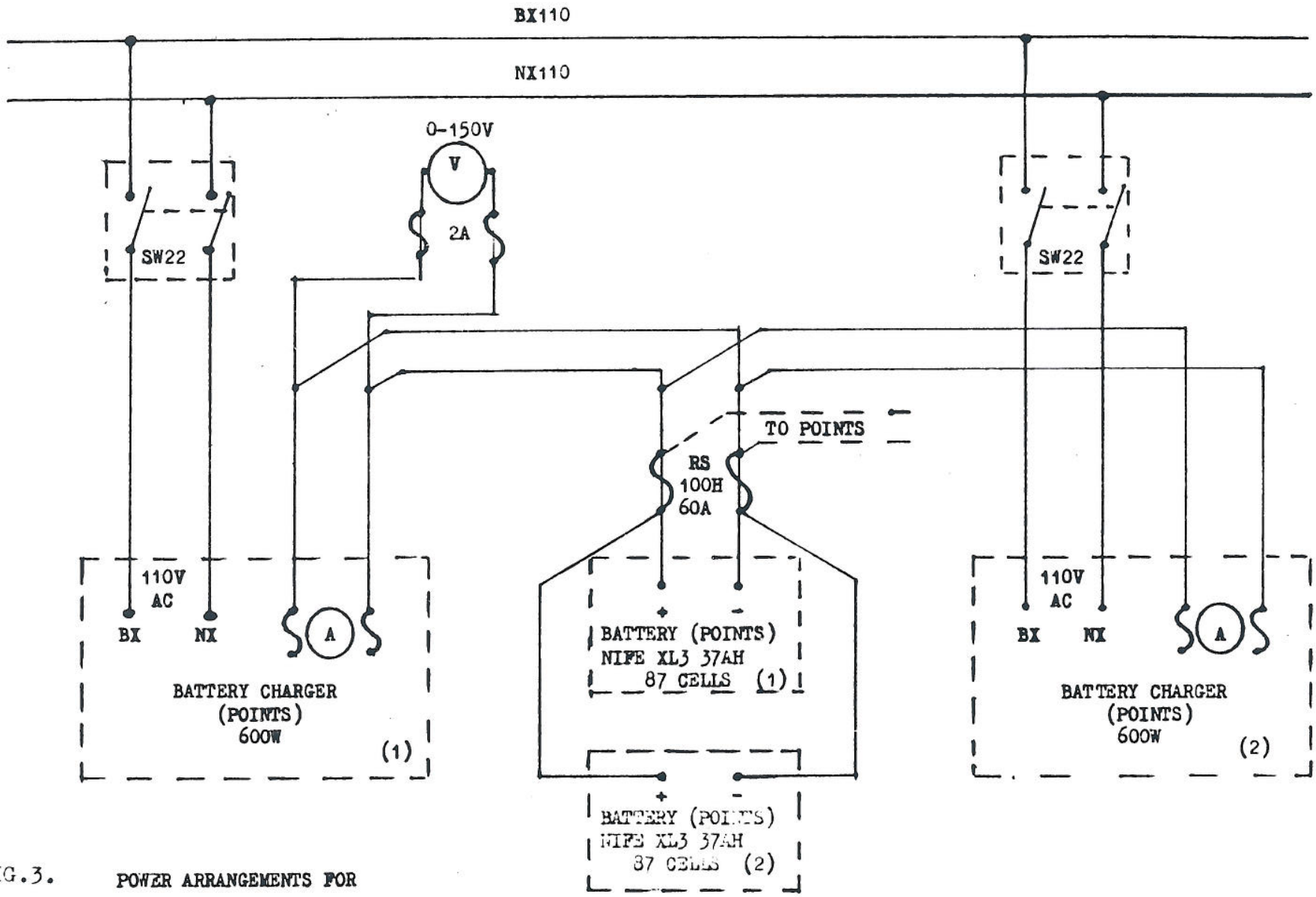


FIG.3. POWER ARRANGEMENTS FOR MOTOR POINTS

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DUPLICATED SUPPLIES AND STANDBY SUPPLIES

It would not be a practical proposition to supply individual batteries for all of the signals and apparatus at a large signalling installation and in addition it is often more convenient, or safer, to employ apparatus operated by alternating current. Also in some electric traction areas, it is essential to provide alternating current apparatus of a type which is immune from the effects of traction current.

In these cases, one mains supply to the signalling system would not be sufficient, as this would be liable to interruption for reasons outside the control of the raiway system. It is therefore essential for a second supply to be immediately available from an outside source or in the form of a local standby generating set, or both.In some areas, the second supply is derived from the overhead traction system at 25KV. and then transformed down to 650V.

Experience has shown that even alternative supplies from an outside source cannot be depended on to give 'absolute' reliability, because even if two supplies are obtained from different generating stations, it may happen that one of these stations will break down and, as the stations are interconnected through the grid, the second generating station may become overloaded and be forced to shed load. It is therefore preferable at any important signalling interlocking, to provide a standby diesel generator complete with automatic controls for bringing into use a few seconds after the mains failure.

Signalling Maintenance Instruction SM 24 defines the division of responsibility and maintenance requirements for Standby Generator Sets for Signalling Supplies.

DISTRIBUTION OF POWER SUPPLIES

Having now obtained a reliable supply, the next step is to distribute the power to relay rooms and lineside locations at the requisite voltage.

Signalling supplies at main installations are usually distributed at 650 V.A.C. This voltage enables the size of conductors in the power cable to be kept to a minimum and results in the best possible voltage regulation in the cable. This voltage is stepped down and rectified as necessary to suit local signalling requirements. Fig. 5 illustrates typical distribution networks for railway signalling power supplies.

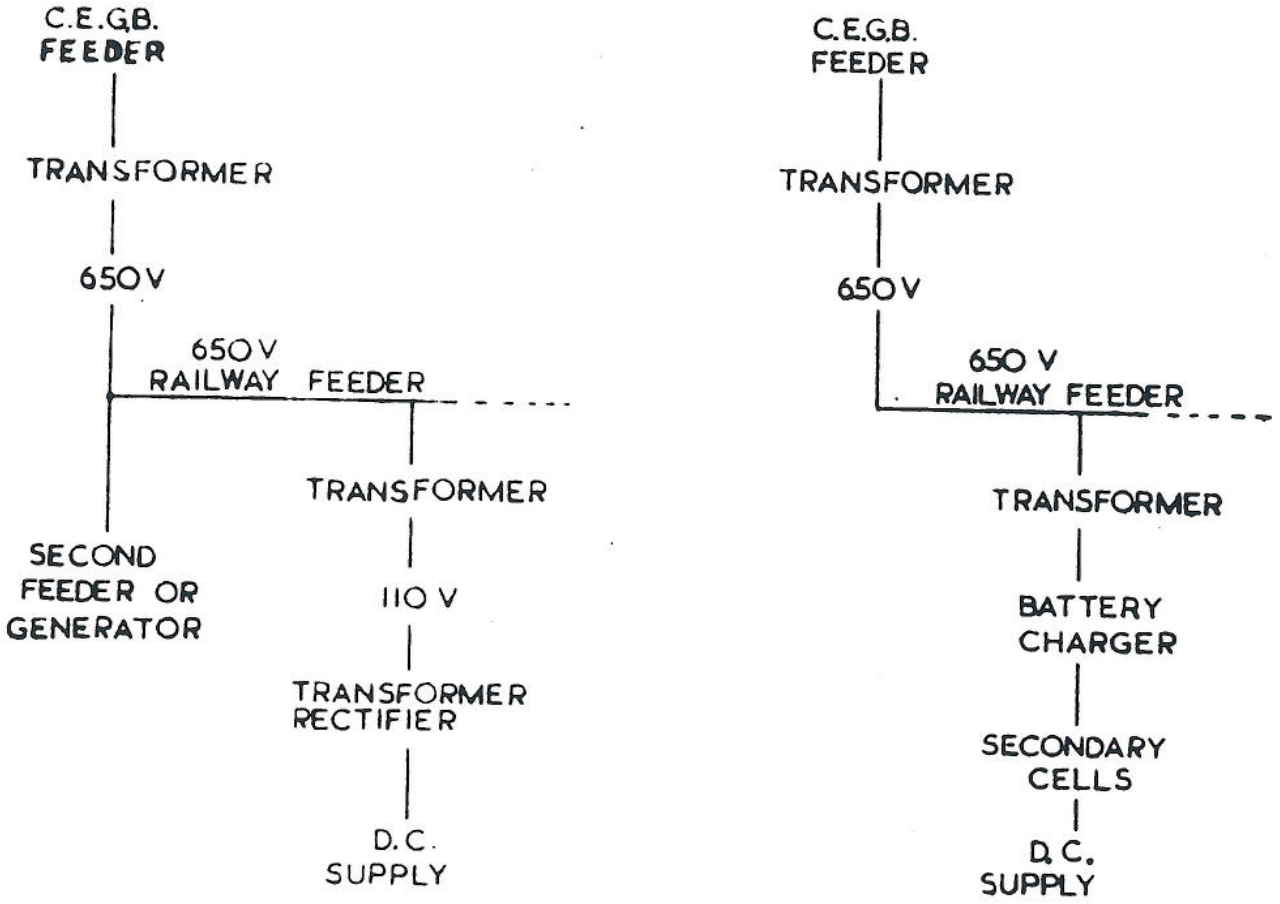

FIG. 5 TYPICAL DISTRIBUTION NETWORKS FOR SIGNALLING POWER SUPPLIES

At many important installations such as Power Signal Boxes and Remote Relay Rooms, it is usual to provide duplicate transformers. This avoids a complete shut down if a transformer should fail. The transformers are controlled through manually operated primary and secondary fuse switches so as to enable either transformer to be 'on load' leaving the other isolated or to enable both transformers to be connected in parallel.

TYPES OF DISTRIBUTION - RING AND LINEAR MAINS

Ring Mains have the advantage of maintaining supplies if a disconnection occurs in the circuit. Links are provided at every location so that any section of cable can be readily isolated if a fault arises, whilst any single disconnection in the cable will not cause a failure as the load is fed from either direction.

Fig. 6 shows a signalling load taken from a ring main. In this example, links are provided on either side of the load, thus enabling either section of cable to be disconnected, but a corresponding disconnection must be made at the next location before the section of cable is completely isolated.

A power ring main does, however, have one major disadvantage. A potentially dangerous situation could arise if a live wire becomes loose as this could remain undetected and may result in a fire or 'wrong side' failure if in contact with other circuitry.

On new signalling installations, ring mains are not gener generally installed.

Linear Mains are safer than ring mains, however, a fault condition can isolate numerous circuits, particularly if it is near the supply end.

Fig. 7 shows a load tapped from a single cable, one pair of links being provided to enable the section beyond the load to be isolated.

SPURES 650 and 110 VOLTS

Spures are provided where it is not economical or desirable to duplicate the 650 volt feeder from the source of supply.

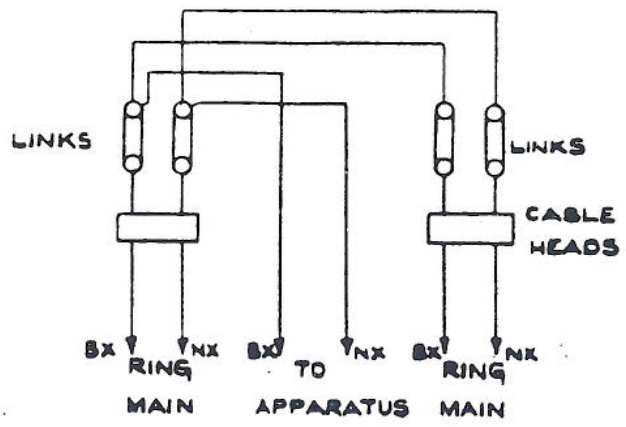

FIG. 6 LOAD TAPPED FROM RING MAIN.

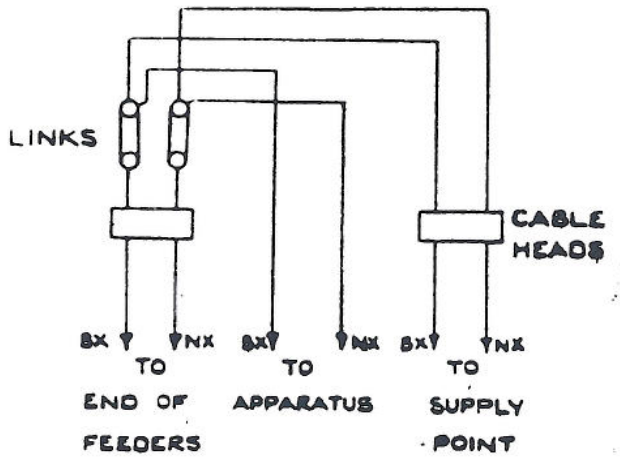

FIG. 7 LOAD TAPPED FROM SINGLE CABLE

CABLE

Power cable is generally to BR Spec. 872 Type MD2 PCP 600/1000V. Every cable has a definite current rating and the size of the conductor used should be such that it will carry the necessary current without any undue temperature rise or voltage drop, allowance always being made for any future possible loads. Typical sizes of power cable (as used at Kings Cross) are 19/1.53 and 7/1.53mm.

An illustration of the effects of the relationship between current flow and resistance of cable is shown below.

NOTE - For accurate calculations to be made in the example, arithmetical functions would be necessary, however, for practical purposes assumptions can be made which allow simple ohms law to be used. The results obtained are sufficiently accurate for general practical purposes.

EXAMPLE

A location has a load of 0.6KVA. The power supply for the location is derived from the 240 volt supply at a wayside signalbox 3.3 kilometers away.

The power cable used is 7/1.35 which has a total (go and return) resistance of 12 ohms.

What would be the input voltage to the location transformer primary?

TOTAL RESISTANCE OF CABLE 12 OHMS

LOAD AT LOCATION 600 VA

VOLTAGE (EMF) AT SIGNALBOX 240 VOLTS

CURRENT FLOW THROUGH CABLE - I = VA/V = 600/250 = 2.5 AMP

VOLTAGE DROPPED OVER CABLE LENGTH - V = I.R. = 2.5 X 12
= 30 VOLTS

VOLTS AT LOCATION TRANSFORMER PRIMARY:-
240 - 30 = 210 VOLTS

The size and length of the cable in the above example serves to illustrate the effects of the magnitude of current flow related to the size (resistance) of the cable.

It does not indicate the size of the cable that should be used.

FUSES

Throughout the distribution, from the point of supply, down to the signalling circuits fed from the signalbox or location bus-bars, particular attention must be paid to fuse discrimination. By this is meant that the fuse ratings must be such that a short circuit, wherever it occurs, will take the nearest fuse in the circuit and thus result in the isolation of that portion of the circuit only, leaving the remaining circuits functioning normally.

Fuse ratings are calculated when the installation is planned and replacement fuses must be of the same value - Never of a Higher Rating.

Overload circuit - breakers are in common use, and are designed to break the circuit at a suitable pre-determined overload.

Spare fuses of the correct size and type should be kept adjacent to the equipment ready for use in event of a fuse 'blowing'. (See also - EXTRACT from I.R.S.E. BOOKLET No 11).

ROUTINE TESTS

1) Standby generator and changeover apparatus must be operated and tested at laid down frequencies.
2) Voltage and load readings to be checked and recorded.
3) Earth Leakage Indicators must be checked for correct operation.

POWER SUPPLY DIAGRAMS

Power supply diagrams should be kept up to date, with any amendments that may have been carried out.

Remember - Power equipment failure can cause serious disruption to traffic operation.

WORKING ON LIVE EQUIPMENT

If it becomes necessary to work on live equipment it is essential that Rubber Gloves suitable for High Voltages are used in conjunction with a Rubber Mat and that any tools used are Insulated.

Rubber Gloves and Mats can be found in Relay Rooms etc. where power supply cubicles are installed. The rubber gloves are marked on the cuff with the year of manufacture, month and size and that they are to be tested in accordance with BS697.
Replacement tested gloves are provided on a regular basis.

Instruction SM 12 states :-

Switch off the battery charger and allow air to circulate so that any accumulation of gas can disperse. (Ensure air circulation by wafting or fanning where no motion of air is apparent).

The instruction requires the battery charger switched off for two reasons :-

1) From a safety angle, gassing will be reduced whilst maintenance work is carried out.
2) The bank of cells will supply the load current and any faulty cell will be detected when the cells are tested.

It must be realised of course that the battery charger must be switched on again to check the charging current and before leaving the Location/Battery Room.

SAFETY PRECAUTIONS TO BE OBSERVED WHEN WORKING WITH PRIMARY CELLS.

Both the 618 and 608 type Inert cells use Caustic Soda as the electrolyte so the following precautions need to be taken :-

1) Always ensure the cell is kept upright when being transported, stored or is in service. Cells in service must be well ventilated.
2) Caustic Soda and its solutions coming in contact with the skin or eyes can cause serious burns. Goggles Must Be Worn.
3) If caustic soda comes into contact with skin or eyes wash thoroughly with clean water.

Remember Batteries are no more dangerous than many other types of equipment as long as they are handled correctly.

SAFETY PRECAUTIONS TO BE OBSERVED WHEN WORKING ON POWER SUPPLIES

Railway signalling uses power supplies at various voltages, a typical voltage being 650V which is used extensively for power distribution to power cubicles and apparatus cases located alongside the track.

Power supply cubicles, disconnection links etc. connected to a 650V supply should have prominent lables displayed stating or indicating that the equipment is connected to a High Voltage Source. Transformers and other equipment having exposed terminals should be fitted with insulated protective covers. Individual terminals can be fitted with insulated sleeves and insulated nuts to give the required protection.

EARTH LEAKAGE DETECTION

PURPOSE

Railway signalling circuits operate from a fully floating power supply i.e. both the positive and negative legs of the supply are earth free.

Leakage to earth from either bus bar must successfully be detected so that the earth fault can be traced and eliminated before subsequent earth faults develope which could falsely operate or hold a vital relay, producing a wrong side failure

Generally in industry, equipment is protected by fusing, where an earth fault results in the equipment being shut down.

In railway signalling it is preferred that the system should be kept operational, but the fault indicated so that remedial action can be taken.

IMPORTANCE OF EARTH PREVENTION

The importance of earth prevention can be simply demonstrated by looking at Fig I. Where it will be noted that although the earth fault X I in 'A'R circuit would not in itself cause a failure, another earth fault arising at X 2 in 'B'R circuit at the same time would create a stray link and could cause 'A'R to operate , Perhaps depending on the circuit involved with serious results

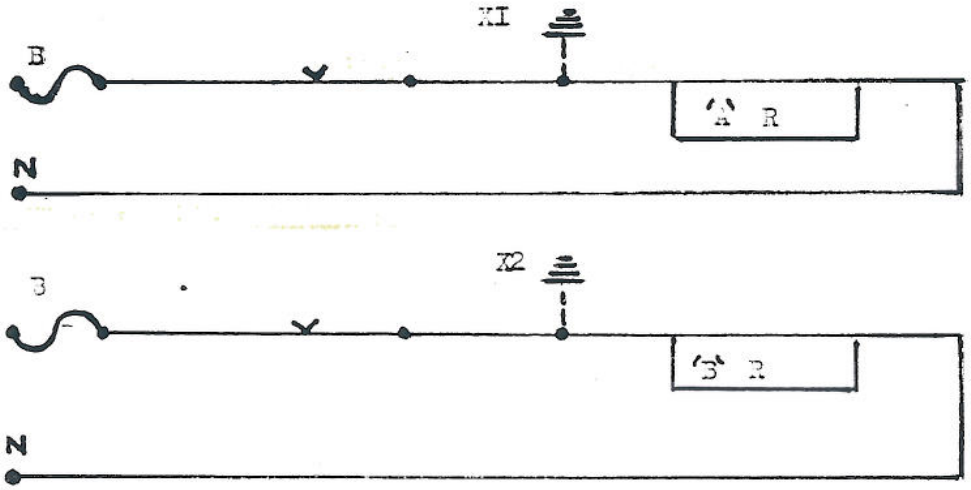

FIG. 1

Providing additional control contacts in the N leads to double cut the circuits considerably improves the position, but can be seen that it is obviously dangerous to allow earth faults to persist and accumulate and therefore permit such link conditions to arise.

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METHODS OF E.L.D.

Essentially there are two categories of detection.

INTERMITTENT METHOD
Visual type indicator connected to positive and negative legs via push button, checked by technician on each maintenance visit.
Directly measure each leg to earth using AVO meter, again done by the technician on maintenance visits.
Megger testing of cables at pre determined intervals.
The detection of earth leakage is not continuous.

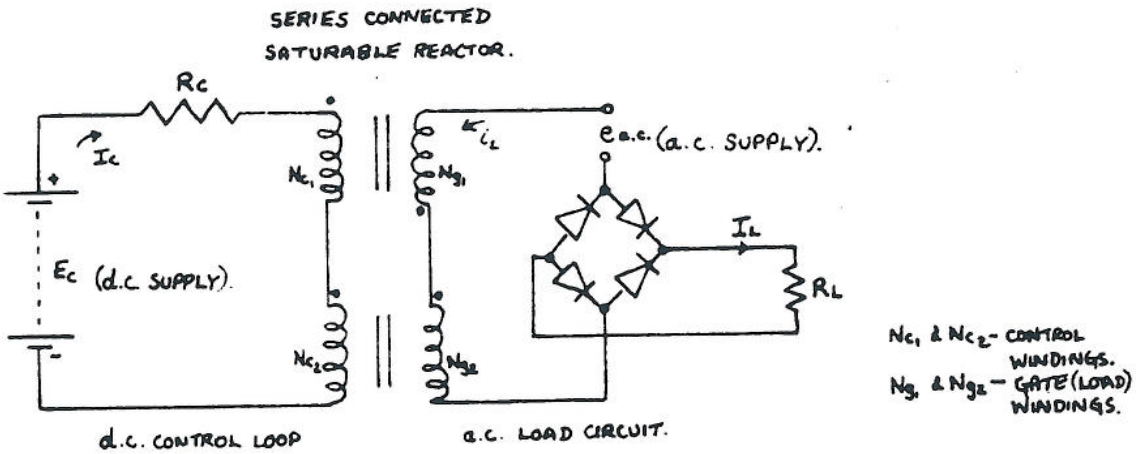
CONTINUOUS METHODS
This type of detection is performed by an automatic earth leakage detector, which is permanently connected across the bus bars, and upon detection of an earth fault or low resistance to earth an indication of earth leakage is given.

DESIRED FEATURES OF AN EARTH LEAKAGE DETECTOR

To respond to both direct earths and gradual increase in earth leakage due to slow degrading of cable insulation.
The unit should provide a high impedance to the supply should it fail.
The unit should have the ability to detect simultaneous balanced earth faults.
Provision of test, indication of fault and reset facilities both locally and remote.
Loss of supply should give fault indication and remote indication to be via a front contact.
Adjustable sensitivity between 10 and 50 KΩ with the capability of being sealed.
The device should be capable of being tested whilst in operation without influencing the state of the safety of the signalling system.
The unit should have a slight delay (about 0·5 secs) to overcome power transients and surges but still be able to detect earth faults only visible for a few seconds eg. an earth fault on a point machine motor circuit.
.. means of checking the integrity of the earthing circuits.

STYLE PED1 EARTH LEAKAGE DETECTOR

This detector uses a series connected saturable reactor (or transductor) with a bridge to rectify the load current. This combination is sometimes called a 'D.C. Transformer'. Consider the following basic circuit:-



If the control resistance Rc is large compared to the load resistance R_L, multiplied by the square of the turns ratio $(Nc/Ng)^2$, and provided the other parameters are correct, rectified load current I_L will be proportional to the D.C. Control Current Ic. It will also be independant of the direction of Ic and the frequency of the A.C. Load Feed. From the circuit diagram for the PED1 it can be seen that it essentially consists of the above, the operation is as follows:

With supply lines connected to 1 and 4 and no earth fault on either line, no current flows through the control winding of the transductor (which is connected between the centre tapped resistor bridging the supply lines, and earth connection 44). Under this condition only a small current is flowing in the gate winding of the transductor and hence the output of the series rectifier to the relay is very small, the relay is deenergised and the green lamp is lit over a back contact showing the lines to be clear.

Assume that a fault occurs on the 'B' line, there will now be a current flowing from 'B' to 'N' through earth, the control winding of the transductor, the 20K resistor and the test 'B' button. The effect of this current through the control winding is to allow the current through the gate winding and the series rectifier to increase and pick the relay. At some value of leakage current, determined by the constants of the circuit, sufficient rectified current will be available to operate the relay, thus extinguishing the green lamp and lighting the red lamp over the front contact. The relay 'Hold-up' winding is also now energised from the D.C. Supply Lines via the front contact of the relay.

Similarly, if the fault occurs on the 'N' line, the leakage current flows through the 'transductor control winding' in the opposite direction to that occasioned by fault on the 'B' line.

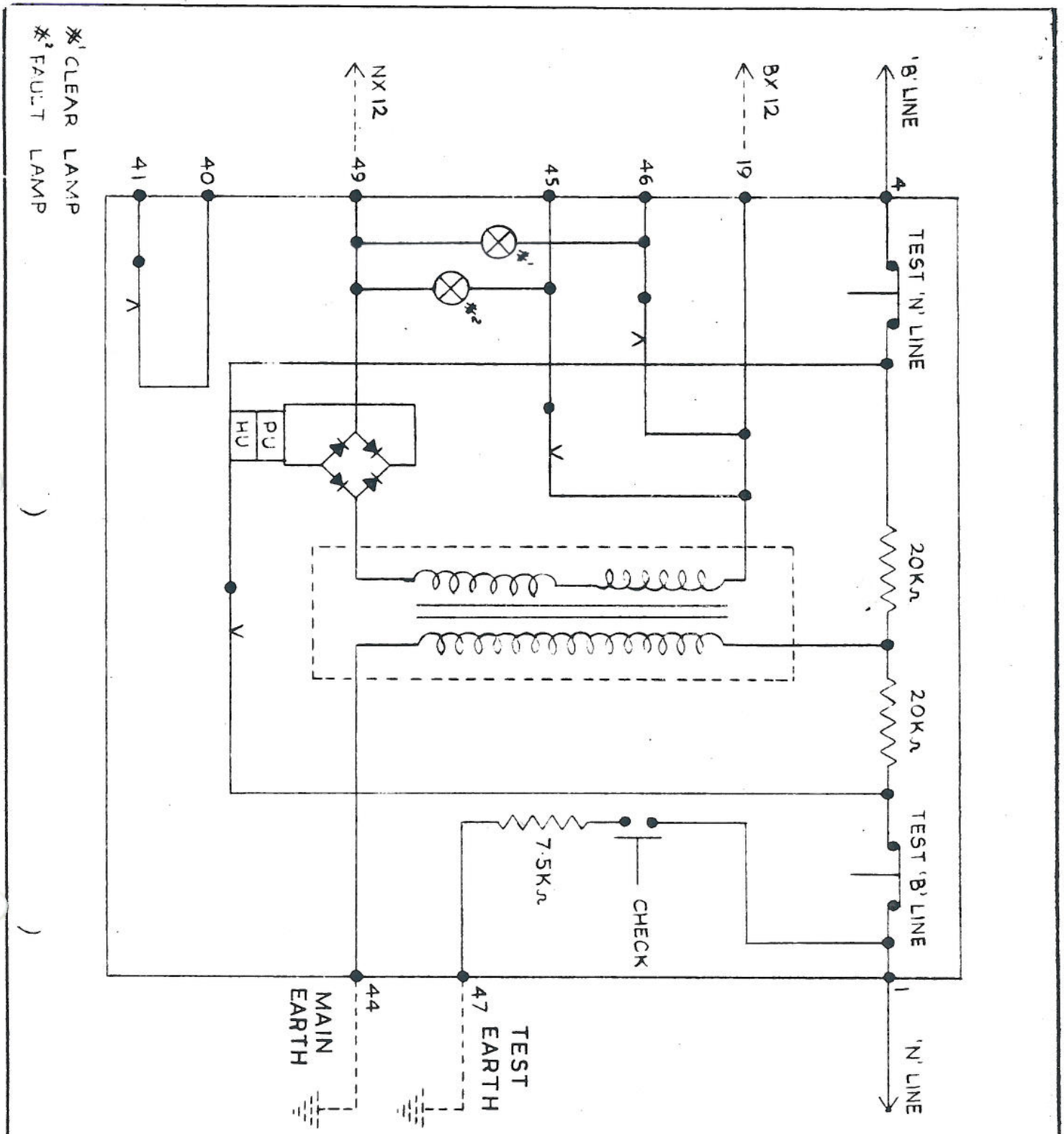
This reversal of current flow through the control winding (depending upon which line is faulty) does not affect the gate output which increases in the same proportion regardless of control current polarity. It is, however, essential that the two 20K OHM resistors used to bridge the two supply lines are equal in value to close tolerances, otherwise different transductor outputs will result from the same fault resistance depending upon which line it occurs.

Since there is only one set of indications to cover faults on both the 'N' and 'B' lines of the D.C. supply, two push-buttons are provided to determine on which line the fault is actually present. The operation of these push-buttons is as follows:-

The device is operated and is indicating a fault. The user presses the button marked 'N', thus disconnecting 'B' line to relay 'Hold-up' winding. Should the fault actually be on the 'N' line, there is now no return circuit for the fault current. Since the relay hold-up winding is disconnected, the device indicates clear. When the button is released the fault current circuit is again connected and the fault indication will return.

Should, however, the fault be on the 'B' line, the fault current circuit is still complete when 'N' button is pressed, and the device will remain at fault. By releasing the 'N' button and pressing the 'B' button (when the device should clear) the tester can confirm the fault is on the 'B' line. If the fault is intermittent and is not present at the time of tests, then the device will clear when either button is pressed and remain 'clear' when the button is released.

A means of checking the operation of the device during periodic inspection is provided by means of a 'check' button which connects the resistance of 7.5K OHMS between the 'N' line and a test earth to simulate a fault.



Issue		App.	Co-mp	Eastern Region Chief Signal and Telecommunications Engineer	British Rail
1	–	–	–	W.B.& S. Co. E.L.D STYLE PED1	Chief S & T Engineer
					Date: MARCH '78
				Scale: / Drawn: JLT Checked: RG	No.: 1
				Corres Ref: ST589 Authority:	

WESTINGHOUSE TYPE AD1 EARTH LEAKAGE DETECTOR.

GENERAL.
The WB & S type AD1 earth leakage detector is a control unit that monitors 110 volt a.c supplies for earth leakage. It requires no external power supply for the unit itself, but it has to be used in conjunction with a WB & S WT2 detector relay.
The AD1 control unit has adjustable sensitivity to earth leakage and as there is only 'earth clear' indication then lamp failure or loss of power results in 'earth fault' indication.

OPERATION IN RESPONSE TO AN EARTH FAULT.
(Refer to fig 2)
In the normal condition the WT2 earth leakage detector relay (which has a coil resistance of 7·4 kΩ) stands energised from the d.c. supply derived from the half wave rectifier and smoothing capacitor in the AD1 control unit. The earth clear lamp will be illuminated and the earth leakage detector indication relay (ELD WR) will be energised over separate front contacts of the detector relay.

EARTH FAULT ON THE WX LINE.
The WX line developing an earth fault puts contact 64 to WX potential. The d.c supply which holds the WT2 detector relay up, now has an alternative path, i.e. contact 33 (d.c. supply positive), contact 63, earth path, contact 64 (d.c. supply negative). With the current being diverted away from the detector relay it will drop, extinguishing the 'earth clear' lamp and dropping the ELD WR.

EARTH FAULT ON THE BX LINE.
The BX line developing an earth fault puts contact 64 to BX potential. The d.c. supply now flows from contact 33 (d.c. supply positive), contact 63, through transformer primary winding to contact 64, earth path, contact 64 (d.c. supply negative). The detector relay drops, extinguishing the 'earth clear' lamp and dropping the ELD WR.

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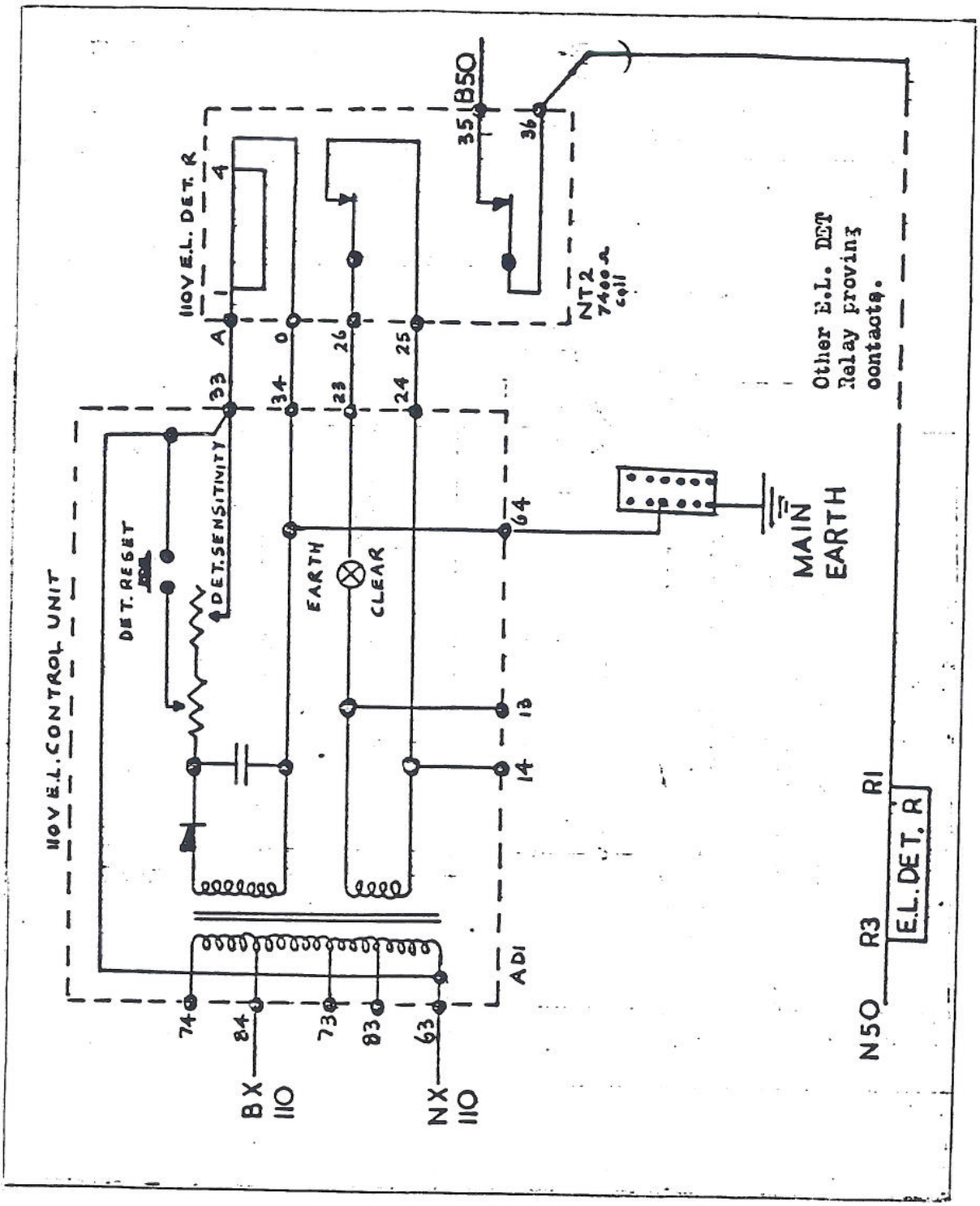
Fig. 2.

WESTINGHOUSE TYPE A.D.1. EARTH LEAKAGE DETECTOR



BS 2	1	30

BRITISH RAILWAYS
EASTERN REGION
C.S. & T.E. DEPT

SPECIFICATION	M.S.33/2
ISSUE	1
DATE	25.2.81
CORRS. REF.	ST.1289

PERIODIC MAINTENANCE SPECIFICATION

SECONDARY CELLS

This specification is designed to cover the maintenance requirements of both Lead Acid and Alkaline Nickel Cadmium Secondary Cells.

Materials used :-

Battery Syringe	54/42955
Battery Terminal Compound	27/27000
Filler Bottle	54/40140
Filler Bottle Nozzle	54/42442
Distilled Water	

Battery Charging Precautions to be observed before carrying out Maintenance.

1.0 PERSONAL SAFETY & PREVENTION OF EXPLOSIONS

1.1 Before charging cells and bringing them into service ensure that Stoppers have been removed, vent caps are free to open and electrolyte level is correct.

1.2 When cells are housed in locations, doors are to be left open and correctly fastened back to disperse any build up of gases before battery maintenance is commenced. Check that all ventilation grills, cowls and the location base are free from obstruction which would prevent a continuous air circulation.

When cells are housed in Battery rooms before maintenance is commenced check -

(a) If forced ventilation is provided, it is working correctly.

(b) If ventilation is by air bricks or grills, that these are unrestricted and allow a continuous air circulation.

During maintenance the Battery Room door should be left open and correctly fastened back.

1.3 Never smoke, use naked flames or create sparks in Battery rooms or near battery locations. Never tighten or loosen connections while cells are on charge or gassing.

Keep all connections tight using an insulated spanner. (These can be obtained from the Supplies and Materials Assistant York).

Do not allow any metal objects to rest on, or fall across the battery terminals. Extra care to be taken when wearing rings or metal watch straps.

1.4 Maintenance or cell inspection must not be undertaken without wearing approved protective clothing and eye protection.

1.4 (Cont'd)

The following protective equipment is available

Goggles Stockhead Code 44/116120
Gloves " " 44/21800, 21801, 21802, 21803
for sizes 8, 9, 10, 11.
as appropriate
Aprons " " 44/3170 40 inch long 44/3195 48 inch long
Eyewash Battery Rooms Stockhead Code 34/1342
Eyewash Personal Issue " " 34/1347

The following action must be taken if affected by Electrolyte splashes

1.5 EYES - Immediately wash them with water using the eye bottle if necessary then seek immediate medical attention.

Ensure the eyewash bottles provided are in a clean and serviceable condition. Instructions for using the eyewash bottles must be adhered to.

1.6 SKIN - Rinse liberally with water and seek medical attention.

1.7 CLOTHING - Remove contaminated clothing as soon as possible.

1.8 Should Electrolyte be accidentally spilled on floors etc. swill down the spillage with water as soon as possible.

Note: never do this in substations where there is high tension electrical equipment : report the situation to the Supervisor.

1.9 Never use the same utensils for Alkaline and Lead acid cells, as alkaline will destroy lead acid cells and acid will destroy alkaline cells. Utensils must be suitably marked.

1.10 Ensure that the Battery Precaution Notices are correctly displayed including "No Smoking" or naked lights and treatment of electric shock.

2.0 CHARGING OF SECONDARY CELLS

2.1 The amount of distilled water used 4 weekly gives an indication of the battery charging rate i.e. if the electrolyte drops by more than ½" per 4 weekly period, then the charging rate is excessive. Insufficient charging rate results in little or no water consumption.

The desirable charging rate is indicated by a consumption rate which gives a fall in electrolyte level of ⅛" to ¼" per 4 week period.

2.2 Where the charger is of the Constant Potential type it is normally set to give the correct voltage per cell. The voltage and current charging rate being pre-set to suit operating conditions and no adjustment should be necessary once in service.

It is essential for this type of charger that the battery consist of a total number of cells equal to the number quoted on the charger specification plate.

2.3 When the charger is not as 2.2 the charging rate must be set to give the minimum trickle charge to keep the battery in a fully charged state as indicated in 2.1.

3.0 DISPOSAL OF BATTERY MATERIAL

3.1 It is illegal to dispose of batteries except at approved Local Authority Sites or to an Authorised Waste Disposal Agency. All spent batteries must be returned to the departmental collection point indicated by the Divisional Signal and Telecommunications Engineer and arrangements made for their disposal. Batteries must not be emptied of electrolyte on site, disposal again being left to an authorised waste disposal agency.

Recovered cells which are considered re-usable should be, by arrangement with the Material and Resources Engineer, returned to York Central Signal and Telecommunications Stores.

LEAD ACID CELLS

4.0 4 WEEKLY

4.1 Switch off battery charger.

4.2 Using a hydrometer check the specific gravity is not below 1.220. If this cannot be obtained inform the Supervisor. Record results and date of test. Appendix "B".

4.3 With battery on load check individual cell voltage is approximately 2.2 volts. Intermittent loaded cells should be tested by the use of a 1 ohm shunt resister for a period of ten seconds; the voltage should not be less than 2.0 volts. If this cannot be obtained inform the Supervisor. Record results and date of test. Appendix "C".

4.4 Check full battery voltage which should be approximately the number of cells multiplied by 2.2. Record results and date of test. Appendix "C".

4.5 Check the level of electrolyte and ensure it is to the correct level by the addition of distilled water.

4.6 Clean and examine battery terminations and cases. Protect terminals by applying Battery Terminal Compound Stockhead code 27/27000.

4.7 Ensure that battery racks and location shelves carrying secondary cells are clean and dry.

4.8 Connect voltmeter across the terminals of one cell, switch on battery charger and note that the reading gradually increases. This indicates the charger is working.

ALKALINE CELLS (NICKEL CADMIUM)

5.0 4 WEEKLY

5.1 Switch off battery charger.

5.2 Check electrolyte levels in cells. There should be slight consumption of water and, according to the duty, the battery will need topping-up at three, six, nine or twelve monthly intervals. Only pure distilled water must be used for topping-up and the electrolyte level must never be allowed to fall below the top of the plates. Do not fill above the correct level as this may result in subsequent loss of solution.

5.3 Level checking and topping-up may be achieved by using the Plastic Bottle type Stockhead code 54/40140. (See appendix"A")

For cells of the types RE, RV8, DLS4, PA and PV, the bottle should be fitted with the special insulated nozzle No.3 supplied. Stockhead code 54/42442.

Fill the bottle with pure distilled water to about 2" below the mouth. Hold the bottle as in position A compress it gently and then insert the nozzle to the full extent through the hole in the vent.

Note: For older type cells fitted with screw-in type vents, the probe will pass through gas release holes and there is no need to remove the vent from the cell.

Now release the pressure and if liquid is withdrawn into the plastic tube it indicates that no topping-up is required. Return the extracted liquid into the cell by gently compressing the bottle.

If, however, no liquid is withdrawn the cell requires topping-up as follows:-

Hold the bottle in position B, as close to the level of the cell tops as possible, and compress gently in order to inject a little water into the cell. Release the pressure to allow withdrawal of air. Continue to compress and release gently until a solid column of liquid appears in the tube. The cell is now topped-up to the correct level. Return the bottle to position A and compress to empty tube.

5.4 With Battery on Load check each individual cell voltage. The voltage can vary between 1.5 and 1.2 volts depending whether there is a constant or intermittent load. Record results and date of test. Appendix "C".

5.5 Check full battery voltage which should be number of cells multiplied by 1.8 volts unless the load is exceptional. Record result and date of test. Appendix "C".

5.6 Clean and examine all exteriors and terminations using insulated box spanner and protect terminals by applying Battery Terminal Compound Stockhead code 27/27000.

5.7 Ensure that battery racks, location shelves carrying secondary cells are clean and dry.

5.8 Connect meter across terminal of one cell switch on battery charger and check that the cell voltage gradually increases indicating the charger is working.

6.0 8 WEEKLY (ADDITION TO 4 WEEKLY ALKALINE CELLS ONLY)

6.1 Using a hydrometer check the specific gravity of each individual cell. This should be in the range 1.160 to 1.200. If the range cannot be obtained, inform the Supervisor. Record results and date of test. (Appendix "B").

Note: This test should be carried out before cells are topped-up. See items 5.2 and 5.3.

POWER SUPPLIES - SAFETY PRECAUTIONS.

Safety Precautions to be observed at all times when working with Secondary Cells.

1) Goggles Must be Worn when dealing with cells.
2) Keep Batteries Upright.
3) Ensure there is a good circulation of air to disperse any accumulation of gas before starting work.
4) Do not allow metal objects to rest on the battery or fall across the terminals.
5) Do not smoke or permit naked lights near batteries or do anything likely to cause sparks near a battery.
6) When mixing or handling electrolyte, goggles and rubber gloves must be worn. Do not spill electrolyte on the skin or clothing

ACCIDENTAL SKIN BURN OR ELECTROLYTE IN THE EYES.

SKIN BURNS - Wash liberally with clean water.

ELECTROLYTE IN THE EYES - Immediately use the eyewash bottle or wash out thoroughly with clean water. The filler bottle should not be used for this purpose.

ELECTROLYTE ON CLOTHING - Immediately remove the contaminated clothing.

All the above instructions are contained in a safety notice as shown below and a copy of the notice must be prominently displayed in battery rooms.

CABLES AND WIRES.

The majority of cables and wires used in railway signalling are manufactured to B.R. specification No. 872.

They have a voltage rating of 600/1000 volts thisisexpressed in the form Eo/E, where Eo is the power frequency voltage of conductors to earth and E is the power frequency voltage between conductors.

CONDUCTORS.

Conductors are circular tinned annealed high conductivity copper wire. Either single stranded or multi - strand.

INSULATION.

Core insulation is flame retardant. It consists of an inner layer of rubber compound coloured blue and an outer layer of polychloroprene compound coloured black. Some wires are covered by a closely woven tape which is rubber proofed on one side and coloured as required.

Wire can also be braided, the braiding being of a textile material applied over a taped core and thoroughly coated with a flame retardent cellulose acetate lacquer, coloured as ordered.

CORE IDENTIFICATION.

The cores may be identified by one of the following methods :-

TWIN CABLES.

Coloured Proofed Tape - 1 core red 1 core black.

Untaped Core - Outer layer of insulation coloured 1 core red 1 core black.

Untaped Core - Both cores black outer layer and numbered 1 and 2 or with words corresponding to the figures.

MULTI-CORE CABLES.

Proofed Tape - Each core numbered with black figures on a white ground.

Untaped Cores - Outer surface of insulation printed with figures or figures and words.
Confusion of similar figures avoided by interspacing letters e.g. S for 6. N for 9.

METHOD OF NUMBERING.

The numbering of all cores in all layers of the cable increase consecutively in a clockwise direction at the same end beginning with one at the centre of the cable. This end of the cable is the A end and the other the Z end.

CONDUCTOR RESISTANCE.

The resistance of a conductor is dependant on the following :-

Type of Material.

Cross Sectional Area.

Length of Conductor.

The resistance of a conductor is directly proportional to its length and inversely proportional to its cross sectional area.

CONDUCTOR SIZES.

Wire sizes are identified bythe number of strands per core and nominal diameter of each strand.

e.g. 1/0.85 mm means single strand 0.85 mm nominal diameter.

16/0.30 mm means core made up of 16 strands of wire each having a nominal diameter of 0.30 mm.

WIRE TYPES AND USES.

Two types of wire are in general use MC 1 and MC 2.

MC 1. - Single core, plain black insulation used for internal wiring of Locations, Relay Rooms and Signal Boxes.

MC 1 is available in the following sizes :-

9/0.30 mm Used for general circuit wiring.

16/0.30 mm Used for heavy current circuits. Two wires in parallel to be used for Clamplock and Point Machine Motor Circuits.

1/1.13 mm Used where connections to tag blocks are required.

MC 2. - Single core with taped, braided and lacquered insulation.
Used in place of MC 1 where extra mechanical strength is needed.

e.g. In lower rooms of signal boxes on lever locks and circuit breakers.

MC 2 is available in the following sizes :-

9/0.30 mm, 16/0.30 mm, 1/1.53 mm and is used as for MC 1 above.

MC TYPE WIRE MUST NOT BE USED EXTERNALLY TO A RELAY ROOM, APPARATUS CASE OR A SIGNAL BOX.

CABLES TYPES AND USES.

Only one type of cable is in general use within the R.S.& T.E. Dept. and that is type MD.

All MD cables have a heavy duty P.C.P. outer sheath.

MD 1. - Single insulated core - sizes 1/1.53 mm, 7/1.35 mm and 19/2.14 mm - used for external single wires and internal power supply connections.

MD 2. - Multicore cable available in a varying number of core sizes and different core sizes.

2 core - 7/.67 mm 7/1.35 mm 19/1.53 mm 19/2.52mm

3 core - 1/1.53 mm 7/0.67 mm

5 core - 1/1.53 mm 7/0.67 mm

10, 12, 19, 27, 37, and 48 core - 1/0.85 mm
1/1.53 mm

Used for lineside and power cables.

All lineside main cables should be 1/0.85 mm size except where the cable carries signal lamp circuits or where excessive volts drop is experienced.

All lineside power cables should be 2 core and of a conductor size dependant on the current to be carried or the volt drop between load points.

Volts drop over complete length of a power feeder must not exceed 10%.

MD 4. - Single insulated flexible core - sizes 50/0.25 mm

Used for single wire connections to trackside equipment.

e.g. Track Circuit Connections.

MD 5. - Multicore flexible core - sizes 50/0.25 mm

2, 4, 7, 10, or 12 core.

Used for on track equipment.

e.g. Points, Signals, A.W.S. and Detectors.

SPECIALISED CABLES.

Certain types of equipment require special types of cable.

Audio frequency circuits require twisted pair cable core -size 1/0.85 mm - 6 pair and 3 pair.

Aster track circuits - Connections between rails and lineside units - Single core P.V.C. insulated - 19/1.53 mm.

H.A.B.D. - C.C.T.V. Have their own recognised types of cable.

INSTRUCTION	SI 19
ISSUE	3
DATE	1.11.82
CORR.REF.	S T.5234
DISTRIBUTION	
A* A(s) B(s) C(s)	

British Rail

CHIEF SIGNAL & TELECOMMUNICATIONS ENGINEERING DEPT., E.R., YORK

SIGNALLING INSTALLATION INSTRUCTION

CRIMP CONNECTORS FOR TERMINAL POSTS

1.0 GENERAL

This instruction covers the use of crimp connectors for the termination of signalling cables and wires on to O.BA.(M6) 3.BA(M4) 2.BA(M5), M8 and M10 terminal posts only.

2.0 CRIMP CONNECTORS

2.1 The crimp terminal connectors covered by this instruction are coloured according to the wire size for which they are suitable (see Appendix A).

2.2 All the crimp connectors are constructed as shown in Fig.3 and must only be used in conjunction with stranded cables.

2.3 When crimped the crimp connectors are clamped on to both the conductor and the insulation, the latter gives a measure of physical support to the cable.

3.0 CRIMPING HANDTOOLS

3.1 Crimping handtools are stamped with the wire size range on which they can be used and the tool handle is coloured for ease of identification (See Appendix B).

3.2 All handtools are fitted with a ratchet mechanism which prevents release of a crimp connector after commencement of the crimping cycle until the latter has been completed. This ensures that the assembly has been correctly compressed to give a satisfactory joint every time.

4.0 CRIMPING PROCEDURE

4.1 Before crimping is commenced the correct size crimp connectors must be selected for the wire to be terminated and subsequently the crimping handtool with the corresponding coloured handle must be used.

4.2 Cut to length the cable or wire to be terminated.

4.3 Strip the wire 6mm; this will ensure that the conductor will be correctly crimped and the insulation will be crimped into the sleeve only. For wires of type MC2 having a braided and lacquered outer sheath it is necessary to remove an additional 6mm of the sheath to expose the insulation.

This allows the inner insulation to be fitted correctly into the sleeve of the red crimp connectors.

Black connectors should not be employed for type MC2 cable.

4.4 Place the correct crimp connector in the jaws of the crimping handtool so that the terminal tongue and barrel rest against the locator (See Fig.2).

4.5 Squeeze the handles until the crimp connector is firmly held in place.

4.6 Insert the wire into the crimp connector barrel, the wire will just protrude beyond the barrel if it has been correctly stripped.

4.7 Compress the handtool until the ratchet is released, the crimped connection can then be removed from the tool.

5.0 INSULATION ADJUSTMENT (SEE APPENDIX A)

The handtools have three adjustments to facilitate correct crimping of the wire insulation, the correct adjustment is determined as follows:

5.1 Place both insulation adjustment pins (Fig.1) in No.3 position.

5.2 Place a crimp connector in the handtool as in 4.4.

5.3 Squeeze the handles until the crimp connector is held firmly.

5.4 Insert a length of unstripped wire into the insulation grip portion of the crimp connector.

5.5 Crimp the connector in the usual manner.

5.6 Remove the connector from the handtool and check the insulation support by flexing the wire backwards and forwards once whilst holding the connector. The connector sleeve should retain its grip on the insulation.

5.7 If the insulation pulls from the sleeve, set both pins in No.2 position.

5.8 Repeat the test. If the insulation grip is again unsatisfactory repeat with the pins in No.1 position.

6.0 TESTING OF COMPRESSION TOOLS

In order to maintain the satisfactory operation of the tools it is imperative that they are maintained in good condition and that any wear or maladjustment which may occur is promptly detected. When compression tools are used continuously the terminations produced should be checked daily before normal use. Checks should be made by producing at least three trial terminations on short lengths of cable (approximately twelve inches)and subjecting each to a pull of about 20 lbs to ensure the strength of the bond. If the handtool is used only occasionally then, before use, three trial terminations should be made and checked as previously stated. Any tool which is thought to be suspect in this respect should be returned immediately to the Chief S&T Engineer's Workshops, York, but in any case all tools must be returned annually for inspection.

7.0 FLEXIBLE CABLES

It is mandatory to use crimped connectors on all flexible cables terminated on terminal posts.

CHIEF SIGNAL & TELECOMMUNICATIONS ENGINEER

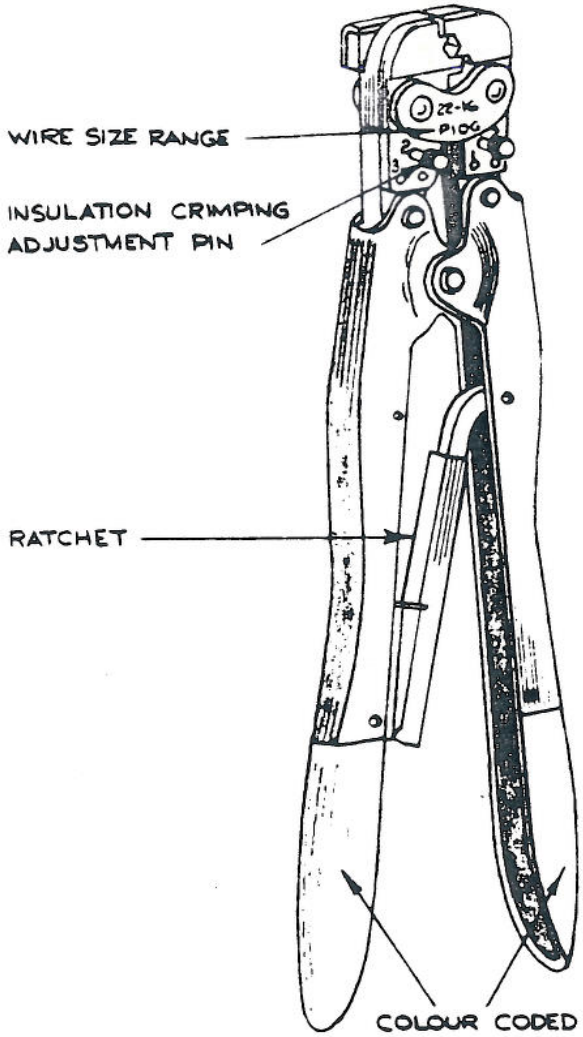


FIG 1.

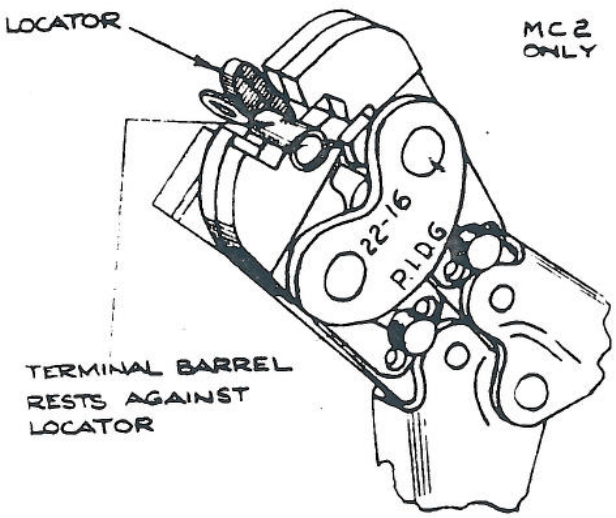
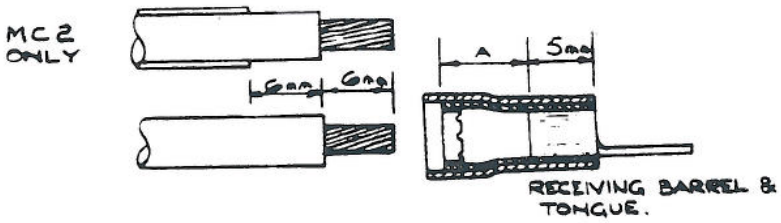


FIG 2.



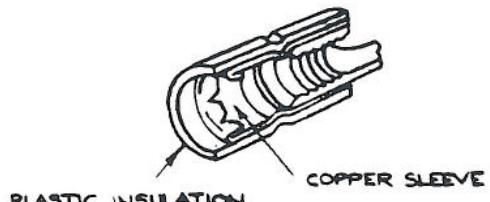


FIG 3.

CRIMP CONNECTORS. AMPLIVERSAL TYPE P.I.D.G.

BR CATALOGUE Nº	COLOUR CODE	STUD (TERMINAL) SIZE	APPROVED WIRE SIZE BR 872	BS 972A	BS 2004	BS 6231 T6	AMP PART NO	AMP SIZE	HAND TOOL COLOUR
54/119368	RED	2BA (M5)	9/0.30 16/0.30	9/.012 16/.012		30/0.25	151730 RING TONGUE	22-16	RED
54/119370	RED	OBA (M6)	9/0.30 16/0.30	9/.012 16/.012		30/0.25	31894 RING TONGUE	22-16	RED
54/119070	BLUE	3BA (M4)	16/0.30 7/0.67	16/.012		30/0.25	160212 FLANGED SPADE	16-14	BLUE/GREEN
54/119364	BLUE	2BA (M5)	16/0.30 7/0.67	16/.012		30/0.25	30094 RING TONGUE	16-14	BLUE/GREEN
54/119369	BLUE	OBA (M6)	16/0.30 7/0.67	16/.012		30/0.25	31906 RING TONGUE	16-14	BLUE/GREEN
54/119567	BLACK	2BA (M5)	16/0.30 7/0.67 50/0.25	16/.012			342062 RING TONGUE	16-14 HD	* YELLOW/ BLACK
54/119568	BLACK	OBA (M6)	16/0.30 7/0.67 50/0.25	16/.012			342063 RING TONGUE	16-14 HD	* YELLOW/ BLACK
54/119493	BLACK	M8	16/0.30 7/0.67 50/0.25	16/.012			153199 RING TONGUE	16-14 HD	* YELLOW/ BLACK
54/119495	BLACK	M10	16/0.30 7/0.67 50/0.25	16/.012			153149 RING TONGUE	16-4 HD	* YELLOW/ BLACK
54/119457	YELLOW	2BA (M5)	7/1.04	7/.029	110/.0076	56/0.30	130167 RING TONGUE	12-10	YELLOW/ BLACK
54/119462	YELLOW	OBA (M6)	7/1.04	7/.029	110/.0076	56/0.30	35273 RING TONGUE	12-10	YELLOW/ BLACK
54/119433	YELLOW	M8	7/1.04	7/.029	110/.0076	56/0.30	153431 RING TONGUE	12-10	YELLOW/ BLACK
54/119437	YELLOW	M10	7/1.04	7/.029	110/.0076	56/0.30	153151 RING TONGUE	12-10	YELLOW/ BLACK

* HAND TOOL USED ON PIN SETTING Nº1.

HAND TOOLS CERTI-CRIMP

BR. CATALOGUE Nº	COLOUR CODE	AMP PART Nº	AMP SIZE
39/9126	RED	47386	22-16
39/8123	BLUE/GREEN	47387	16-14
39/8127	YELLOW/BLACK	59239	16-14 AND 12-10

CABLE TESTING.

The testing proceedure laid down here is applicable to all signalling cables, be they tail cables, main cables, power cables, or indoor cables.

For multicore cables and power cables the insulation and continuity tests will be made after the new cable installation and termination has been completed. In the case of new tail cables the cable may be tested with only the location end of the cable terminated if difficulty is experienced with earthy apparatus.

Continuity tests are only required on new cables, here we are looking for resistance values that agree with the laid down value for the type and length of cable in question (see appendix to MT 4, attached).

Megger insulation tests are to be made with a 500 volt test instrument for multicore cables, or a 1000 volt instrument for power cables.

New cables will have insulation resistance values near infinity, core to core and core to earth; in service cables shall show at least 10 Meg. ohms in the case of indooor and Main lineside cables, or, at least 2 Megohms in the case of Tail cables. Failure to reach these figures must, in most cases be treated as a failure condition (exceptions to these basic rules may occur, as mentioned in MT 4).

New cables shall have all cores tested but routine tests of in service cables only require: 2 cores tested if 10 core or smaller cable,
3 cores tested if 10-21 cores,
4 cores tested if over 21 cores.

Spare conductors will be used as far as possible, if these are insufficient some working cores will have to be removed for the test.

Test Proceedure for New Cables.

1. Verify correct type and size of cable conductor has been installed.
2. Prove integrity of Test Earth Spike.

3. Test insulation resistance between each conductor and all other conductors in the cable.
4. Test insulation resistance between each conductor and earth.
5. Test continuity of each conductor.
6. Check correct polarity of power cables, both A.C. and D.C.

Tests 3. and 4. will usually be conducted together by testing each core to all the other cores bunched together and connected to earth.

When continuity tests are made the tester must ensure that the results obtained are directly proportional to the length of conductor under test, and also ensure that each cable core is correctly terminated by connecting core No.1. sequentially to every other core in the cable at one end while continuity testing in the same sequence at the other end.

Record weather at the time of the test and enter on test sheet.

Visual checks will also be made to ensure that conductors and insulation have not been damaged during stripping.

Check that conductors are held firmly on terminals and in crimps and that terminals and links are properly secured.

CABLE CHARACTERISTICS.

Resistance of Conductors. Metric. TABLE 1.			
Conductor (Annealed Copper to B.S.6360) tinned.			
No. & Diameter of Wires	Max. Resistance for 1Km of Cable		
	Single Core	Multi-core	Multi-core Go & Return
No/mm.	Ohm.	Ohm.	Ohm.
1/0.85	30.7	31.2	62.4
1/1.13	17.9	18.2	36.4
1/1.53	9.76	9.96	19.12
7/0.67	7.41	7.56	15.2
1/1.78	7.21.	7.35	14.7
7/0.85	4.6	4.7	9.4
7/1.04	3.05	3.11	6.22
7/1.35	1.81	1.84	3.68
7/1.70	1.14	1.16	2.32
7/2.14	0.719	0.734	1.468
19/1.53	0.519	0.529	1.058
19/1.78	0.383	0.391	0.782
19/2.14	0.265	0.270	0.54
19/2.52	0.191	0.195	0.39
37/2.03	0.151	0.154	0.308
37/2.25	0.123	0.126	0.252
9/0.30	30.2	31.7	-
16/0.30	17.0	17.8	-
50/0.25	7.82	8.21	16.42

Resistance of Conductors. Imperial. TABLE 2.			
Conductor (Annealed Copper) tinned.			
No. & Diameter of Wires	Max. Resistance for 1,000yds of cable		
	Single Core	Multi-core	Multi-core Go & Return
No/ins.	Ohm	Ohm	Ohm
9/.012	25.72	26.23	52.46
1/.036	24.37	25.47	50.94
1/.044	16.71	17.04	34.08
16/.012	14.47	14.76	29.56
3/.029	13.08	13.34	26.68
3/.036	8.408	8.576	17.512
1/.064	7.900	8.058	16.116
7/.029	5.591	5.704	11.408
1/.083	4.698	4.792	9.584
7/.036	3.594	3.666	7.332
7/.103	3.050	3.111	6.222
7/.044	2.405	2.453	4.906
7/.052	1.722	1.756	3.512
7/.064	1.137	1.160	2.320
19/.044	0.8877	0.9055	1.811
19/.052	0.6358	0.6485	1.296
19/.064	0.4196	0.428	0.856
19/.083	0.2495	0.2545	0.508
37/.072	0.1704	0.1738	0.3476
37/.083	0.1281	0.1307	0.2614
37/.103	0.08322	0.08488	0.16976

1.0 SCOPE

The various types of elastomer insulated tinned annealed copper cables included in this Specification are listed below. They have a voltage rating of 600/1000 volts.

Type A

Flame retardant halogen free compound insulated cables :-

A1 Single plain.

A2 Single as A1 with flame retardant, halogen free sheath.

A3 Flexible light duty circular twin and multicore, cores as A1 with flame retardant, halogen free sheath.

Type B

Insulated with Ethylene Propylene Rubber (EPR) compound which meets the requirements of this specification, heavy duty polychloroprene sheathed, plain finish :-

B1 Single.

B2 Circular twin and multicore.

Type C

Flexible conductors insulated with Ethylene Propylene Rubber (EPR) compound which meets the requirements of this Specification, Heavy Duty Polychloroprene (HDPCP) sheathed, plain finish :-

C1 Flexible single.

C2 Flexible circular twin and multicore.

2.0 DEFINITIONS AND DESIGNATION OF CABLES

For the purpose of this Specification the definitions relating to electric cables in BS 4727 Part 2 Group 08 "Power Cable Terminology" shall apply.

Cables in this Specification are designated by the rated voltages expressed in the form Uo/U, where Uo is the power-frequency voltage to earth and U is the power-frequency voltage between conductors for which the cable is designed, i.e. 600/1000 V.

3.0 CONDUCTORS

The conductors shall consist of circular tinned annealed high conductivity copper wire in accordance with Table 1 of this Specification and BS 6360 and be capable of withstanding all the relevant tests therein.

Stranded conductors shall be approximately circular in section. The nominal sizes of solid and stranded circular conductors are given in Table 1.

No joint shall be made in a solid (single wire) conductor.

A separator of polyethylene terephthalate film may be applied to stranded conductors at the option of the manufacturer.

4.0 INSULATION

4.1 Composition and Properties

The insulation material shall be flame retardant, halogen free for Type A and EPR for other types. These materials shall be cross linked and comply with the performance requirements of this Specification.

5.0 TAPE

Proofed textile used for lapping individual cores of twin cables shall be of high quality without selvedge, rubber proofed on one side and coloured as required.

A suitable binder tape of polyethylene terephthalate or proofed textile may be applied over laid up cores at the option of the manufacturer.

Tapes shall be applied with an overlap suitable to the situation in the cable unless particularly otherwise specified.

Tapes may be applied between layers of cores. These may be either overlapped or open spiralled.

6.0 SHEATHS

6.1 Composition and Properties

For all types except A2 and A3 the sheaths shall be black Heavy Duty Polychloroprene Type RS2 compound in accordance with BS 6899 and be capable of withstanding the tests for physical properties therein.

The requirements for the cross linked halogen free flame retardant sheath of Types A2 and A3 cables shall be :-

The sheath shall be continuous and close fitting and shall be applied uniformly and symmetrically, free from flaws and defects of any kind, and shall fill the interstices between the cores of the outer layer of the cable completely if no binder tape is used.

The sheath shall be readily removable from the cable without damage to the insulation of the cores.

6.2 Colour of Sheath on A2 and A3 Types

The sheath shall be coloured as ordered and the colours normally ordered shall be black, red (No. 537), yellow (No. 355), green (No. 218) or blue (No. 166) to reasonably match with BS 381C - "Colours for identification, coding and special purposes".

8.0 CORE IDENTIFICATION

8.1 Single Core

The insulation shall be coloured black.

8.2 Circular Twin Cables

The cores may be identified by one of the following methods :-

(a) Insulation coloured, 1 core red, 1 core black.

(b) Both cores black insulation with printed numbers 1 and 2, or with interspersed words corresponding to the figures (see Clause 8.3).

8.3 Multicore Cables

The insulation shall be black the outer surface of which shall be printed as in Clause 8.3.

8.4 Method of Numbering

When the outer surface of a core is numbered it shall be printed in a contrasting colour distinctly and permanently with figures alone or with interspersed words corresponding to the figures.

The number of the cores in all layers of the cable shall increase consecutively in a clockwise direction at the same end beginning with one at the centre of the cable. This end of the cable shall be known as the A end and the other as the Z end.

10.0 DIRECTION OF LAY

10.1 For multicore cables the direction of lay of the cores shall alternate for successive layers. The direction of lay of successive layers is at the discretion of the manufacturer.

10.2 By agreement between the purchaser and the manufacturer unidirectional lay of cores may be specified as an alternative to the above.

12.0 SEALING AND LABELLING OF ENDS

Immediately after completion of the electrical tests the ends of cables shall be sealed.

The ends of each factory length of multicore cable shall be plainly labelled A and Z in accordance with Clause 8.0.

Cables supplied on drums shall have the Z end inside unless otherwise specified.

13.0 DELIVERY

13.1 Single cable Type A1 and A2 shall be supplied on drums or non-returnable reels in 100, 200 or 400 metre lengths as may be ordered.

13.2 Cable Types A3, B and C, shall be supplied on drums in lengths as may be ordered.

13.3 Where special requirements for drum sizes apply these shall be specified on the order.

13.4 Cable drums shall be lagged with stout cross battens to ensure adequate protection against damage to the cable during transit and storage.

14.0 DRUM MARKING

Drums shall be marked with :-

(a) An arrow to indicate the direction in which the drum may be safely rolled.

(b) Description and length of cable in a sealed plastic envelope securely fixed to the inner and outer flange of the drum.

(c) Gross weight (cable and drum).

(d) Letter A (or Z) to indicate the leading end of cable.

15.0 TYPE A - FLAME RETARDANT HALOGEN FREE COMPOUND INSULATED CABLES

Type A cables shall consist of a core of tinned copper conductor in accordance with Clause 3.0, insulated with flame retardant compound in accordance with Clause 4.0.

They shall have the following finishes as ordered by the purchaser :-

Type A1 — Single Plain (Table 2)
The core insulation shall comply with Clause 4.0 and shall be identified in accordance with Clause 8.0. The surface of the core shall have a smooth finish and be thoroughly coated with chalk so that the cable may be readily pulled in between other cables.

Type A2 — Single with Sheath (Table 2)
The core insulation shall be as for Type A1 with a protective cover complying with the requirements of Clause 6.0.

Type A3 — Light Duty, Flame Retardant Halogen Free Flexible Cables (Table 3)
Type A3 shall consist of the required number of 9/0.30 mm tinned copper conductors insulated in accordance with Clause 4.0, and identified in accordance with Clause 8.0 laid up (Table 8) and sheathed with flame retardant halogen free material complying with Clause 6.0.

16.0 TYPE B AND C - HEAVY DUTY SHEATHED CABLES

Type B cables shall consists of a core or cores of tinned copper conductor insulated with EPR in accordance with Clause 4.0, and sheathed with black RS2 Heavy Duty Polychloroprene compound in accordance with Clause 6.0.

They shall have the following constructions as ordered by the Purchaser.

Type B1 — Single (Table 4)
A single core shall be sheathed with RS2 Heavy Duty Polychloroprene.

Type B2 — Circular and Twin and Multicore Cables (Tables 5 and 6)
Circular twin and multicore cables shall consist of the requisite number of cores insulated in accordance with Clause 4.0 and identified in accordance with Clause 8.0, laid up (Table 8) and sheathed with RS2 Heavy Duty PCP compound to form a compact cylindrical cable having a reasonably smooth finish. A binder tape (Clause 5.0) may be applied over the laid up cores at the option of the manufacturer.

Type C1 — Flexible Single (Table 7)

A single core shall be sheathed with RS2 Heavy Duty Polychloroprene.

Type C2 — Flexible Circular Twin and Multicore Cables (Table 7)

Flexible circular twin and multicore cables shall consist of the requisite number of cores insulated in accordance with Clause 4.0 and identified in accordance with Clause 8.0, laid up (Table 8) and sheathed with RS2 Heavy Duty Polychloroprene to form a compact cylindrical cable having a reasonably smooth finish. A binder tape (Clause 5.0) may be applied over the laid up cores at the option of the manufacturer.

TABLE 1

CONDUCTOR SIZES AND RESISTANCES

INSULATION THICKNESSES AND INSULATION RESISTANCES

CONDUCTOR (ANNEALED COPPER TO BS 6360) TINNED				RADIAL THICKNESS OF INSULATION	MINIMUM INSULATION RESISTANCE FOR 1 KM AT 20°C
NO. AND NOM. DIA. OF WIRES	NOMINAL AREA	NOMINAL DIA. OF CONDUCTOR	MAXIMUM RESISTANCE PER KM		
mm	mm^2	mm	ohm	mm	Megohms
1/0.85	0.6	0.85	33.2	0.60	530
1/1.13	1.0	1.13	18.2	0.60	450
1/1.53	1.85	1.53	9.96	0.60	350
7/0.67	2.5	2.01	7.56	0.80	350
1/1.78	2.5	1.78	7.56	0.80	350
7/0.85	4.0	2.55	4.70	1.00	300
7/1.04	6.0	3.12	3.11	1.00	250
7/1.35	10.0	4.05	1.84	1.00	240
7/1.70	16.0	5.10	1.16	1.00	200
7/2.14	25.0	6.42	0.734	1.20	180
19/1.53	35.0	7.65	0.529	1.20	150
19/1.78	50.0	8.90	0.391	1.40	150
19/2.14	70.0	10.70	0.27	1.40	130
19/2.52	95.0	12.60	0.195	1.60	130
37/2.03	120.0	14.21	0.154	1.60	110
37/2.25	150.0	15.75	0.126	1.80	110
9/0.30	0.65	1.10	31.70	0.80	450
16/0.30	1.15	1.43	17.80	0.80	400
50/0.25	2.50	2.00	8.21	0.90	330

TABLE 8

MULTICORE CABLE

MAKE UP FOR ALL TYPES

NO. OF CORES	NUMBER OF CORES IN CENTRE AND EACH LAYER				
	CENTRE	1ST LAYER	2ND LAYER	3RD LAYER	4TH LAYER
2	2	-			
3	3	-			
4	4	-			
5	5	-			
6	6	-			
7	1	6	-		
8	1	7	-		
10	2	8	-		
12	3	9	-		
14	4	10	-		
16	5	11	-		
19	1	6	12	-	
24	2	8	14	-	
27	3	9	15	-	
30	4	10	16	-	
33	5	11	17	-	
37	1	6	12	18	-
40	1	7	13	19	-
44	2	8	14	20	-
48	3	9	15	21	-
52	4	10	16	22	-
56	5	11	17	23	-
61	1	6	12	18	24

INTERLOCKING OF LEVERS IN A MECHANICAL LEVER FRAME.

When considering the interlocking for a lever frame, two methods of lever locking may be applied:-

1) Mechanical interlocking between levers.
2) Electrical locking of any lever.

Mechanical interlocking is limited to the application of locking between levers in the same frame.

When external factors such as track circuits, signal proving and point detection require inclusion in the interlocking, electric locks are used.

Normally, a combination of mechanical and electrical locking is utilised to achieve the required interlocking of a mechanical lever frame. Fig 1. shows a lever frame with associated mechanical and electrical locking.

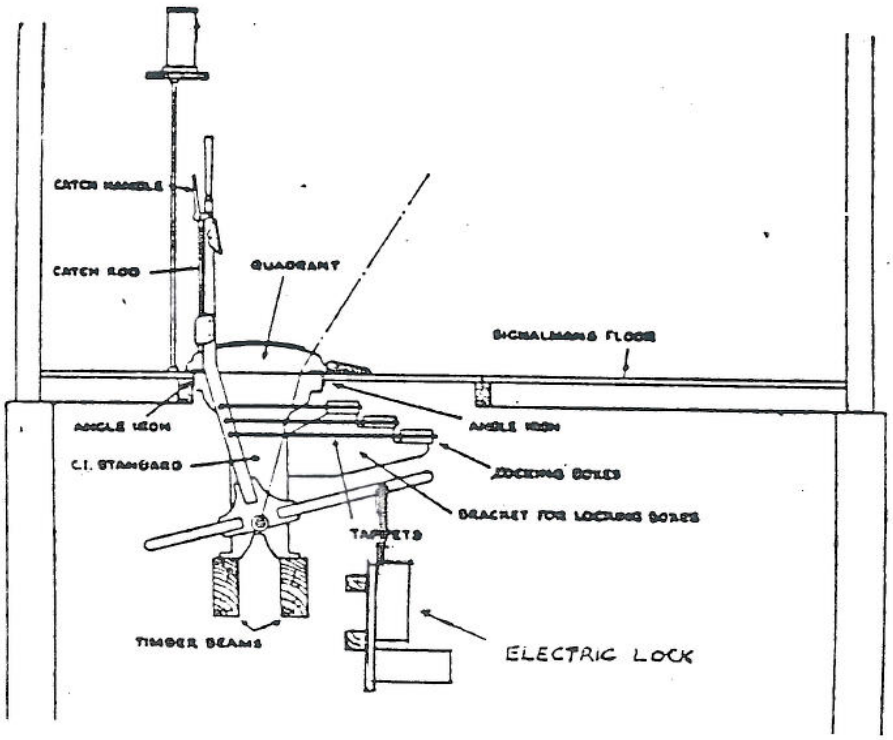


FIG. 1.

ELECTRIC LOCKS

Several different types of lever lock and circuit controller are in use and in consequence differ slightly in design, however, the basic principle of operation is the same.

The application of electrical control to mechanical levers demands a reliable and robust locking device for mechanically holding the lever against operation while conditions will not with safety, allow its movement. At the same time it must be capable of releasing the lever by electrical means when required.

BS 2	3	2

Fig.2. shows a typical electric lock and illustrates the component parts.

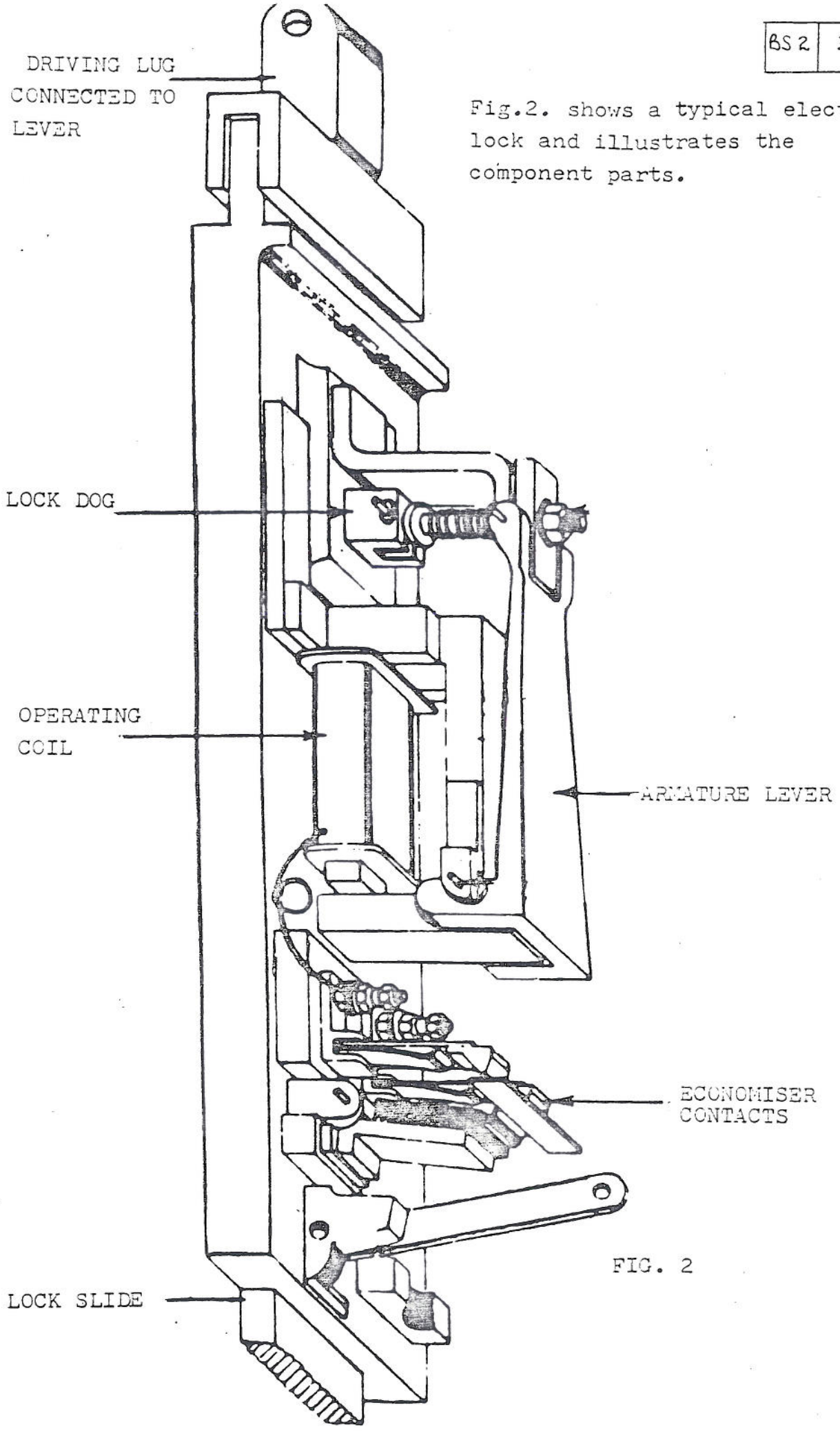


FIG. 2

DESCRIPTION OF COMPONENT PARTS

MOUNTING

The bases are arranged for mounting side by side at 4" centres or more on two parallel horizontal bars.
A travel of 8" is adopted for the standard lock slide.

DRIVE

An adjustable coupling and suitable connection rod are used to link the lever tail with the lock slide.

LOCK SLIDE

Steel bar which is notched as required for engagement by the lock dog.
(Where circuit controllers are fitted they are driven by the lock slide through a cam mechanism).

LOCK PROVING CONTACTS (LCCs)

Lock proving contacts can be fitted if required

LOCK DOG.

The solid steel lock dog is connected through an adjustable pull rod to the armature of an electro magnet which upon energisation pulls the dog out of the locking notch to release the lock.

ECONOMISER CONTACTS

The contacts are incorporated in the lock electro magnet circuit

CONTACTS OPEN/CLOSED

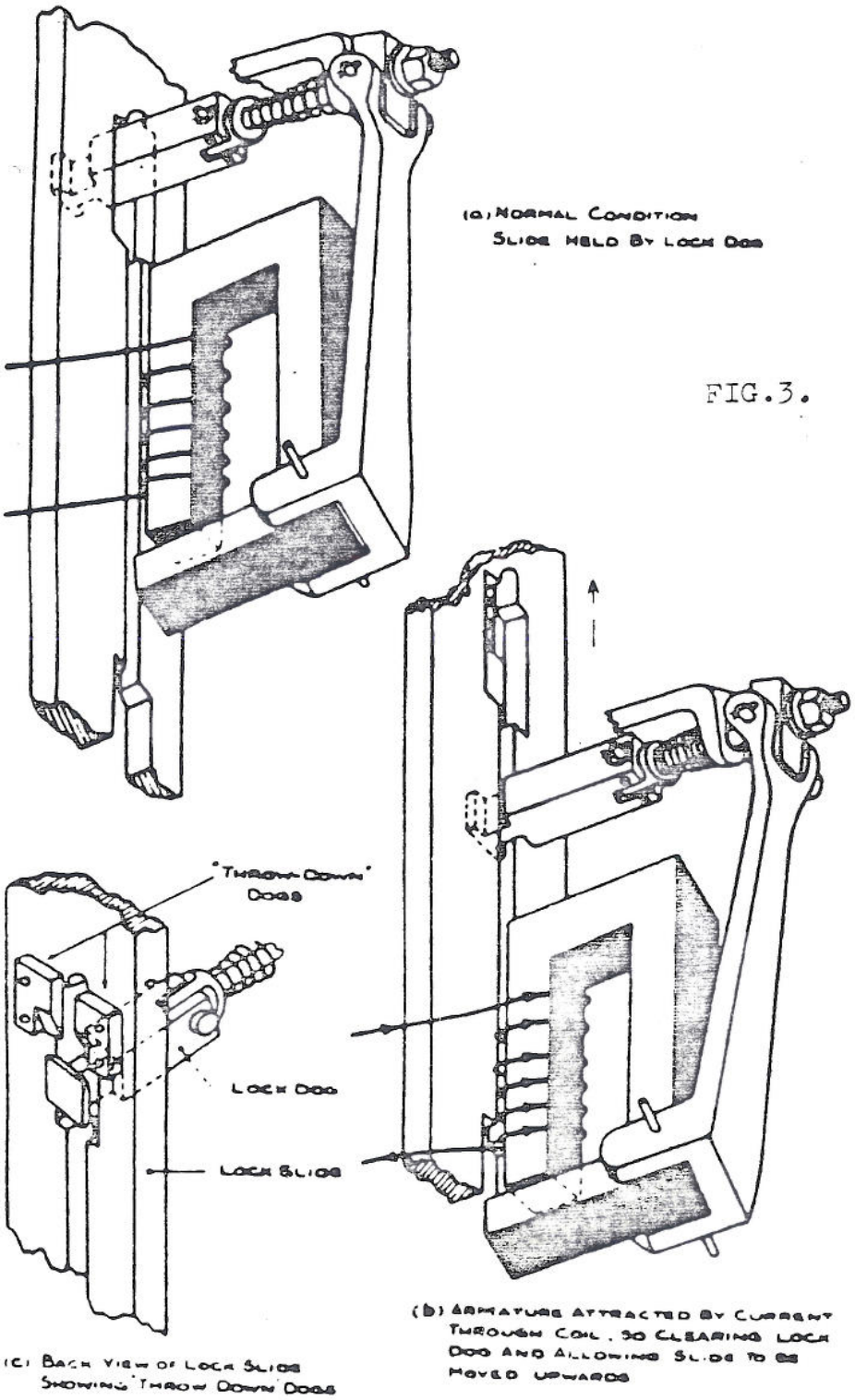
OPEN - Normally open - lock coil de-energised.

CLOSED - Initial movement of lever closes the contacts and energises the lock coil.(Providing all other conditions are correct)
At the end of each stroke the lever moves, the contacts are again opened.

OPERATION OF ELECTRIC LOCK

The electric lock is normally fixed in a vertical position below the lever frame. The lock slide (Tappet) is connected directly to the lever tail. Notches are cut in the tappet to accomodate the lock dog.
The steel locking dog drops into the notch when the lock coil is de-energised, and to ensure that it enters the notch a 'Throw Down' arrangement is provided on the tappet, which forces the dog into the notch for all locking positions.
When the electro magnet is energised, the lock dog is lifted clear of the notch and permits the tappet to move, thus releasing the lever. Fig.3. illustrates the locking operation.

LEVER LOCKS (SHOWING LOCK OPERATION AND THROW DOWN)



(a) NORMAL CONDITION
SLIDE HELD BY LOCK DOG

FIG.3.

(b) ARMATURE ATTRACTED BY CURRENT THROUGH COIL, SO CLEARING LOCK DOG AND ALLOWING SLIDE TO BE MOVED UPWARDS

(c) BACK VIEW OF LOCK SLIDE SHOWING THROW DOWN DOGS

Levers may be locked in any required position by suitably cutting the notches in the lock slide. Fig.4. shows in simple diagramatic form typical locking positions of a lever quadrant and the associated locking slides which may be employed.

N - FULL NORMAL POSITION OF LEVER

B - NORMAL INDICATION POSITION

D - REVERSE INDICATION POSITION

R - FULL REVERSE POSITION

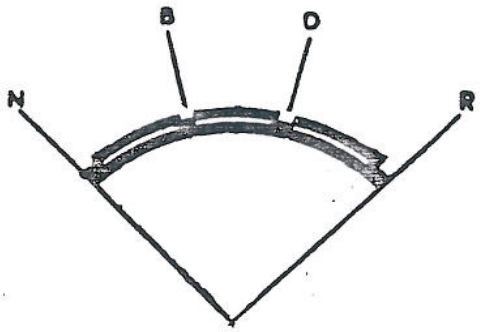


FIG.4a. TYPICAL LOCKING POSITIONS

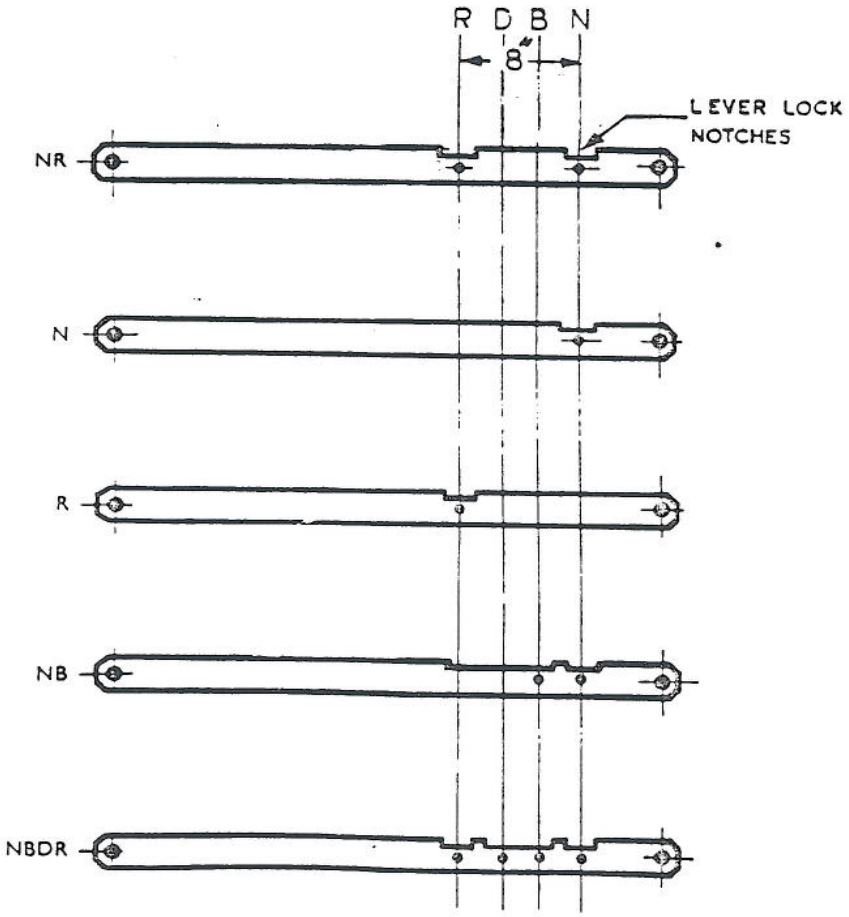


FIG.4b. TYPICAL LOCK SLIDE NOTCHINGS

COMBINED LEVER LOCKS AND CIRCUIT CONTROLLERS

The locks are mounted vertically and can be obtained to include all the lock positions associated with a lever. Connection is made by rods from an attachment on the lever tail, and a cam mechanism drives the circuit controller as the lever is moved from one position to another.

It is essential that the lock tappet travel is 3", otherwise difficulty will be experienced in the correct setting of the lever bands.

Lever bands are available for all positions in common use. The band setting is stamped on the band depicting the position at which the contact will make. Fig.6. illustrates a typical lever lock and circuit controller assembly.

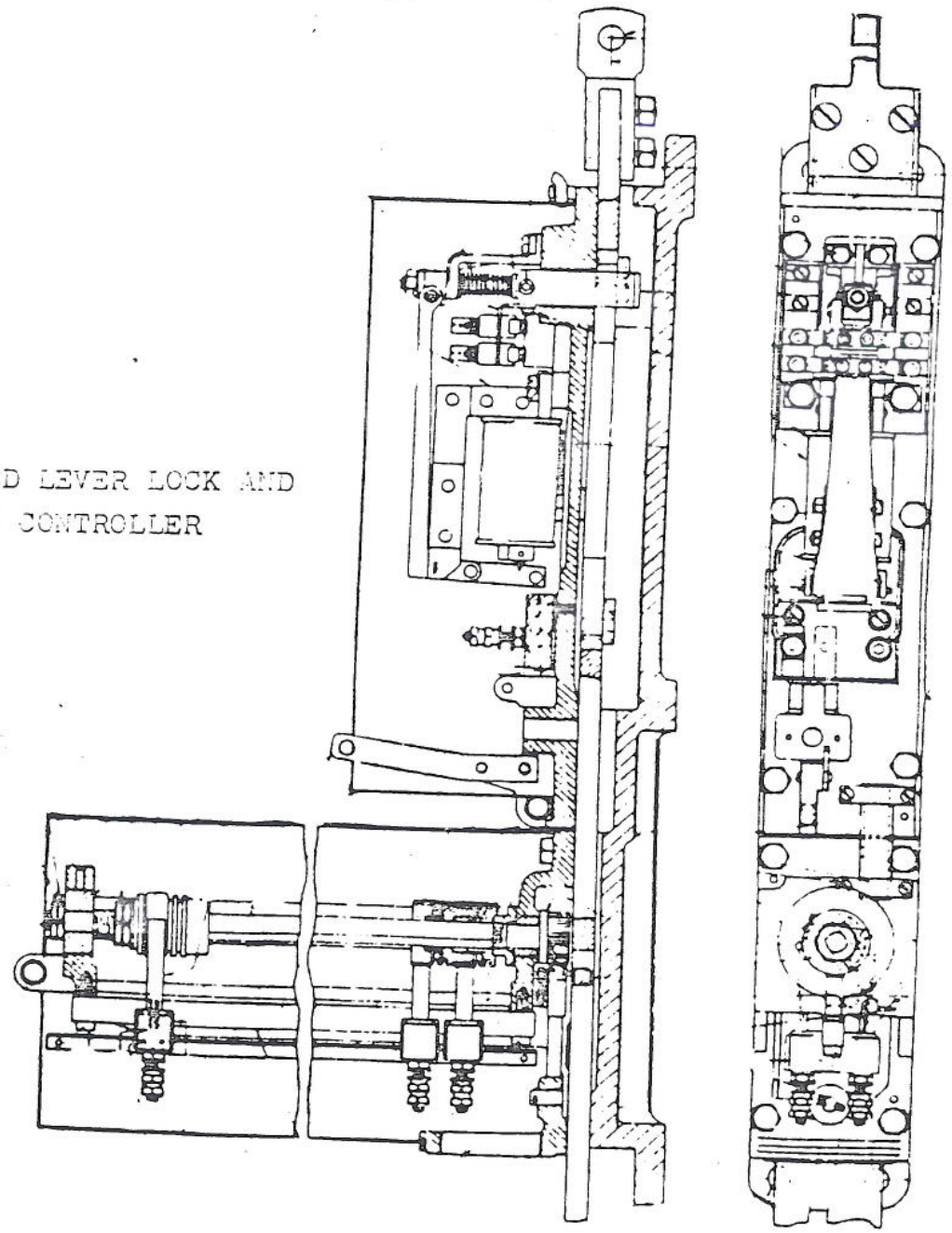


FIG.6. COMBINED LEVER LOCK AND CIRCUIT CONTROLLER

TESTING

Periodical tests should be made on all lever locks to ensure that the economising mechanism is functioning correctly and that a continuous current is not flowing through the lock coils. Earth tests must be made to ensure that no leakage of current to earth exists and that all insulations are in good condition. The testing of lever band settings should be carried out methodically. The lever should be operated over its full travel to ensure that not only is the contact making when it should be, but also that it is not making in any other position of the lever. When testing, the lever should be coupled to the apparatus it is intended to operate, because it has been found that settings made on a 'free' lever vary considerably to one on which points or signal s are connected. Difficulty is also experienced where slackness prevails in the frame itself.

MECHANICAL AND ELECTRICAL LOCKING - GENERAL REQUIREMENTS

Mechanical locking ensures that levers controlling points and signals can only be operated in a predetermined sequence which permits non conflicting routes to be set up. The reversal of a signal lever governing a route containing points, in addition to ensuring that all opposing signal levers are locked in their normal position, also locks tha' actual point levers in the route in their normal or reverse as required.
Additional safeguards are provided through electric locking by track circuits etc. comprising what is usually known as indication, approach, back, track and sectional release route locking, to ensure that the route is safe to be cleared and that the route ahead of a moving train cannot be interfered with until the train has traversed the route or has been brought to a rest and conditions are safe for the route to be altered.

ELECTRIC LOCK CIRCUITS

The following circuits have been simplified in order to illustrate particular details and principles, thus, they are not necessarily complete.

ELECTRIC LOCKING ON POINT LEVERS

TRACK LOCKING

The term 'track locking' is usually employed for electric locking of point levers, the arrangements being such that the lever is locked in the full normal or full reverse position whilst a train occupying the track circuited section in which the points are located, thus preventing manipulation of the points which would endanger the train.
An example of a simple circuit for track locking is shown in Fig.7. The AE contact shown is made immediately the lever is moved out of the normal position and remains closed until the lever is in the reverse points and vice versa.

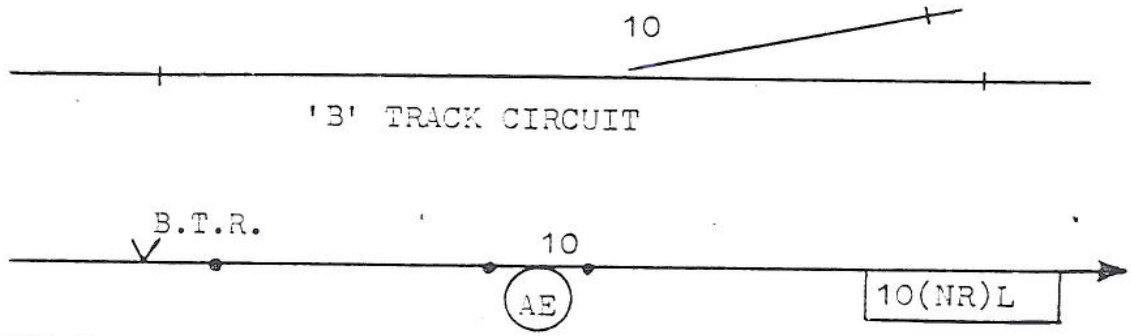


FIG.7.

POINT INDICATION LOCKING

Point indication locking ensures that the points concerned have taken up a position corresponding with the movement of the lever before the stroke of the latter can be completed, these remarks, of course, only applying to power operated points. A fundermental circuit arrangement is shown in Fig.8. Assuming that a pair of points have to be operated say from normal to reverse, the lever would be moved to the reverse indication locking position or 'D' position and the point machine would commence to operate. When the points have completed their movement and have been detected in the reverse position, the circuit to the lock would be completed over the reverse contact on the point indication relay, and the lever could then be fully reversed.

A similar requence is performed when the points are to be operated from the reverse to normal position.
Fig.8. illustrates the N.B.D.R. contacts used in the electric lock circuit. In addition, track locking is also employed.

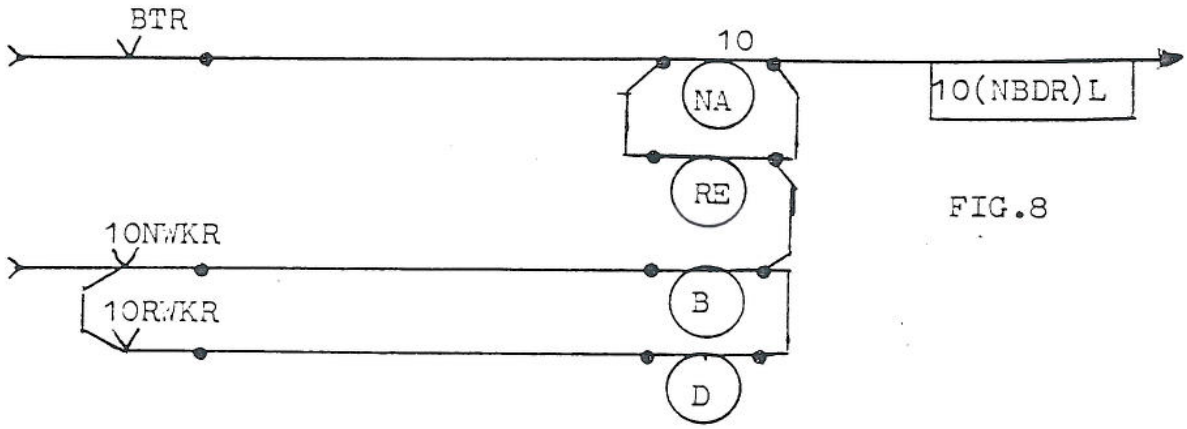


FIG.8

ELECTRIC LOCKING ON SIGNAL LEVERS

Fig.9. illustrates a colour light signal with position light route indicator.

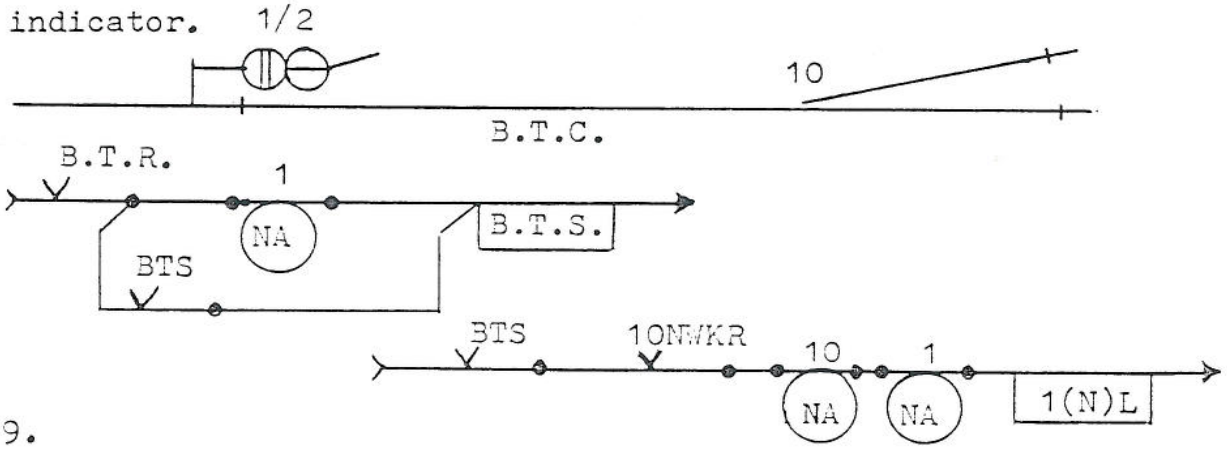


FIG.9.

NORMAL LOCKING OF SIGNAL LEVER

Consider the control of No.1.signal. It is necessary to prevent the actual signal lever from being reversed until the section ahead of it is clear and the route has been correctly set. This is achieved by providing an electric lock cut in the normal locking position. The circuit to the lock magnet being so arranged that it cannot be energised, and consequently the lever cannot be moved out of the normal position until the controlling track circuits are clear and the points are in their requied position. The electric lock circuit illustrates the required controls. The primary function of the stick relay B.T.S. is to ensure that once the lever has been reversed and a train has passed through the section, the signal lever must be restored to normal

before the signal can again be cleared for a following train. It will be seen that relay B.T.S. is energised over a front contact on track relay B.T.R. and a normal contact NA on the signal control lever No.1. This latter contact however is then bridged out by a front contact on relay B.T.S. immediately this relay has picked up. Once relay B.T.S. has energised, it will remain in that position even though the signal lever is subsequently reversed.

NORMAL INDICATION LOCKING ON SIGNAL LEVERS

This is sometimes known as 'check locking' and is defined as 'An arrangement to prevent the full stroke of a lever in an interlocking frame until such time as the apparatus controlled by that lever has completed its movement'.

Before the introduction of colour light signals arrangements were provided to make certain that in the event of a signal not returning to the danger position when its controlling lever was put to normal, this fact should be registered immediately. It will be realised that if under such conditions the lever could be returned to the full normal position, then such a movement would effect the release of the mechanical locking on the point levers in the route governed by that signal even though the signal itself was displaying a false clear aspect. A normal indication lock (B)L was therefore provided on signal levers which permitted the lever to be restored to a position roughly about threequarters of its travel from revers to normal, sufficient to allow the signal arm to return to danger. Before the B lock was energised to enable the lever to be fully restored to the normal position, however, the arm had to be proved in the danger position. To achieve this, a normal GCR contact was included in the circuit to the lever lock coil.

Such normal indication locking is now used to a great extent with all types of signals. Simple arrangements for both mechanical and multi-unit colour light signals are shown in Fig.10.

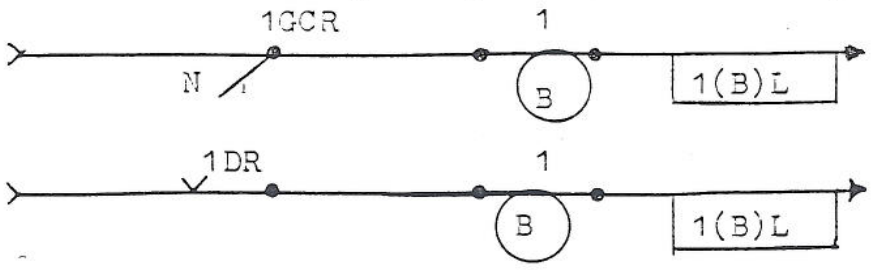


FIG.10

APPROACH LOCKING (Fig.11)

The purpose of approach locking is to prevent a change of route ahead of a signal once a driver has seen a proceed aspect at the signal, or has seen an aspect at a previous signal that would indicate to him that the signal ahead is displaying a proceed aspect.

There are many approach locking schemes but the one most commonly used is the prevention of the signal lever controlling the signal governing a route containing points, from being fully restored, as was the case with indication locking when a train has approached within a pre-determined distance of the signal, if this has once shown a clear aspect.

In Fig.11D the back lock in lever 4 will only be released to enable the lever to be restored to the fully normal position if the ALSR (Approach Lock Stick Relay) is energised.

A route is approached locked (preventing any manipulation of the route) when the ALSR is de-energised.

When the ALSR is energised, the route is free of approach locking.

APPROACH LOCKING RELEASE

The position of the train must be taken into a account and there are three possibilities to consider.

i) A train taking the route.

ii) A train approaching but not taking the route.

iii) No train approaching.

The approach lock stick relay (ALSR) when energised proves the route free of approach locking. The ALSR has a stick feed over its own front contact.

The ALSR is de-energised when the appropiate signal clears. To enable the route to be restored i.e. free of approach locking, the ALSR must be re-energised by one of the following methods (Refer to Fig.11A & 11C

A) NORMAL METHOD OF ALSR RE-ENERGISATION BY PASSAGE OF A TRAIN (FIRST & SECOND TRACKS OCCUPIED, FIRST TRACK CLEARED)

i) Signal replaced to danger behind train - 4RGPR Picks

ii) DTPR drops with track occupation

iii) DTPR ↓ drops DTSR

iv) ETPR drops as the train proceeds

v) DTPR picks when the train is clear (but DTSR remains down)

vi) 4 ALSR picks via 4RGPR↑, ETPR↓, DTPR↑, and DTSR↓ (ie, D track occupied and cleared and C occupied).

B) ALSR RE-ENERGISED WITH NO TRAIN APPROACHING (ALL TRACKS REMAINING CLEAR)

i) Signalman restores No4 lever to B position - Signal replaced to danger - 4RGPR Picks.

ii) ATPR, BTPR, CTPR and DTSR remain energised.

iii) 4ALSR picks via 4RGPR↑, ATPR↑, BTPR↑, CTPR↑, and DTSR↑.

C) ALSR RE-ENERGISED BY TIMING OFF IF A TRAIN IS ON THE APPROACH TRACK CIRCUITS.

i) Signalman restores No4 lever to B position - Signal replaced to danger - 4RGPR Picks.

ii) ALJR commences to time out.

iii) ALJR Picks (after 120 seconds)

iv) 4ALSR Picks via 4RGPR↑ and ALJR↑

v) 4ALSR then sticks up via its own front contact.

4(NB) LOCK CONTROL CIRCUIT.

4 NORMAL LOCK

i) The normal lock requires track circuits in the route clear and points in their required positions. In addition, back contacts of 4ALJR are included to ensure that this relay has been de-energised after its last movement and that the full time element will be available if required.

ii) Normal lock picks via 4ALJR↓, DTSR↑, 10N/KR↑, ETPR↑, and 4 lever band made in the NA position.

4 BACK LOCK

i) The back lock requires the signal aspect at danger (4RGPR energised) and that the route is free of approach locking - (ALSR energised)

11) The back lock picks via 4RGPR↑, 4ALSR↑ and 4 lever band made in the 'B' position.

ALSR CIRCUITS

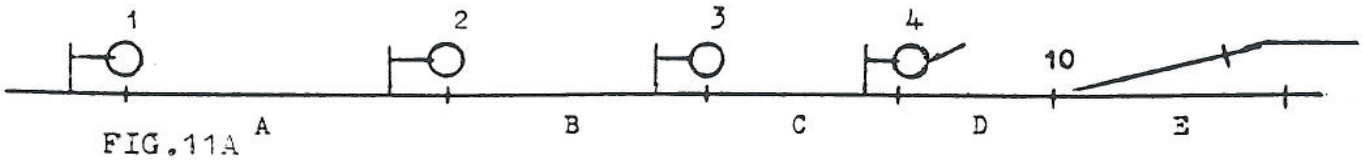


FIG.11A

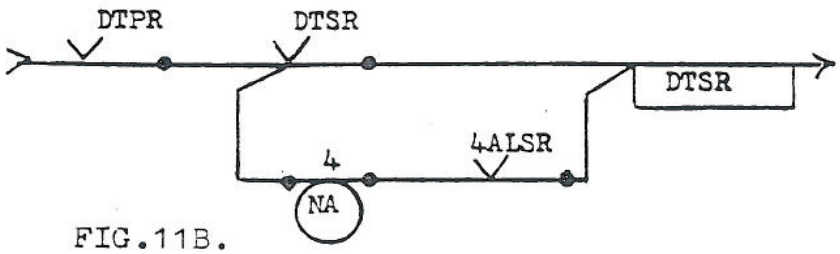


FIG.11B.

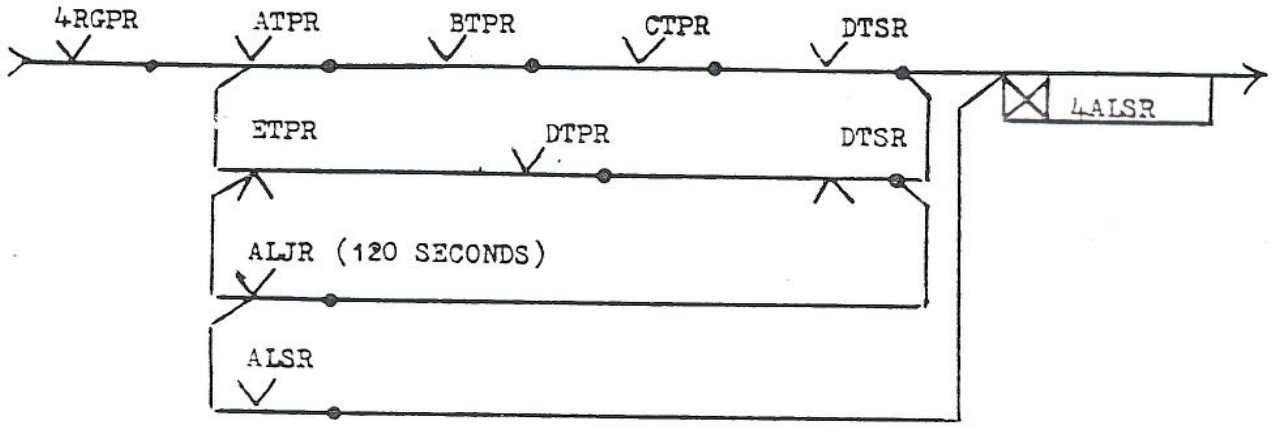


FIG.11C

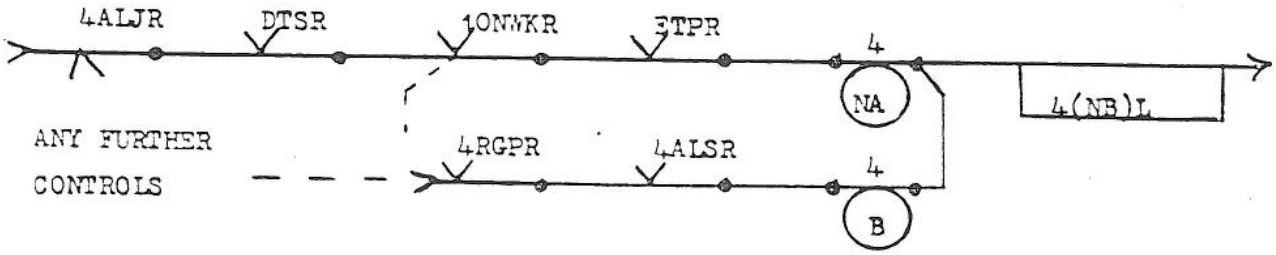


FIG.11D

ROUTE LOCKING

Once a train has passed a signal which has returned to Red, the route ahead must still remain locked and the points in the route will remain held either by direct track circuit locking or by route locking, and no conflicting route may be set until the train has cleared the points concerned.

Route Locking may be defined as a method of maintaining the locking between functions (ie between signals and points), by track circuit occupation in one direction only, thus permitting the early release of functions when the locking is no longer required.

The relays which provide route locking are called U.S.R's - 'Route Stick Relays'.

The USR's are normally up and drop out when the route is set. The USR's cannot re-pick until the train is proved to have reached and passed the section of line the USR's are controlling.

To improve flexibility the route is divided between several USR's instead of having one for the whole route. This allows the route locking to be removed behind the train as it passes through rather than having to wait until the entire route is clear. This is referred to as Sectional Release of Route Locking. It allows crossing routes to be set up as each part of the route is cleared whilst maintaining the route locking in front of the train.

The following circuits have again been simplified in order to illustrate particular details and principles, thus they are not necessarily complete.

We will now consider the geographical layout and associated circuitry in figure 12.

ROUTE LOCKING OF 10B ROUTE

In our example it will be necessary to prevent number 20 points from being called reverse whilst 10B Route is being used, thus we must route lock the points.

As can be seen, we provide a USR for each track circuit in the route and name the USR's in terms of the controlling track circuit and the direction of travel.

We have seen that the ALSR drops when the signal is cleared and this also initiates the route locking.

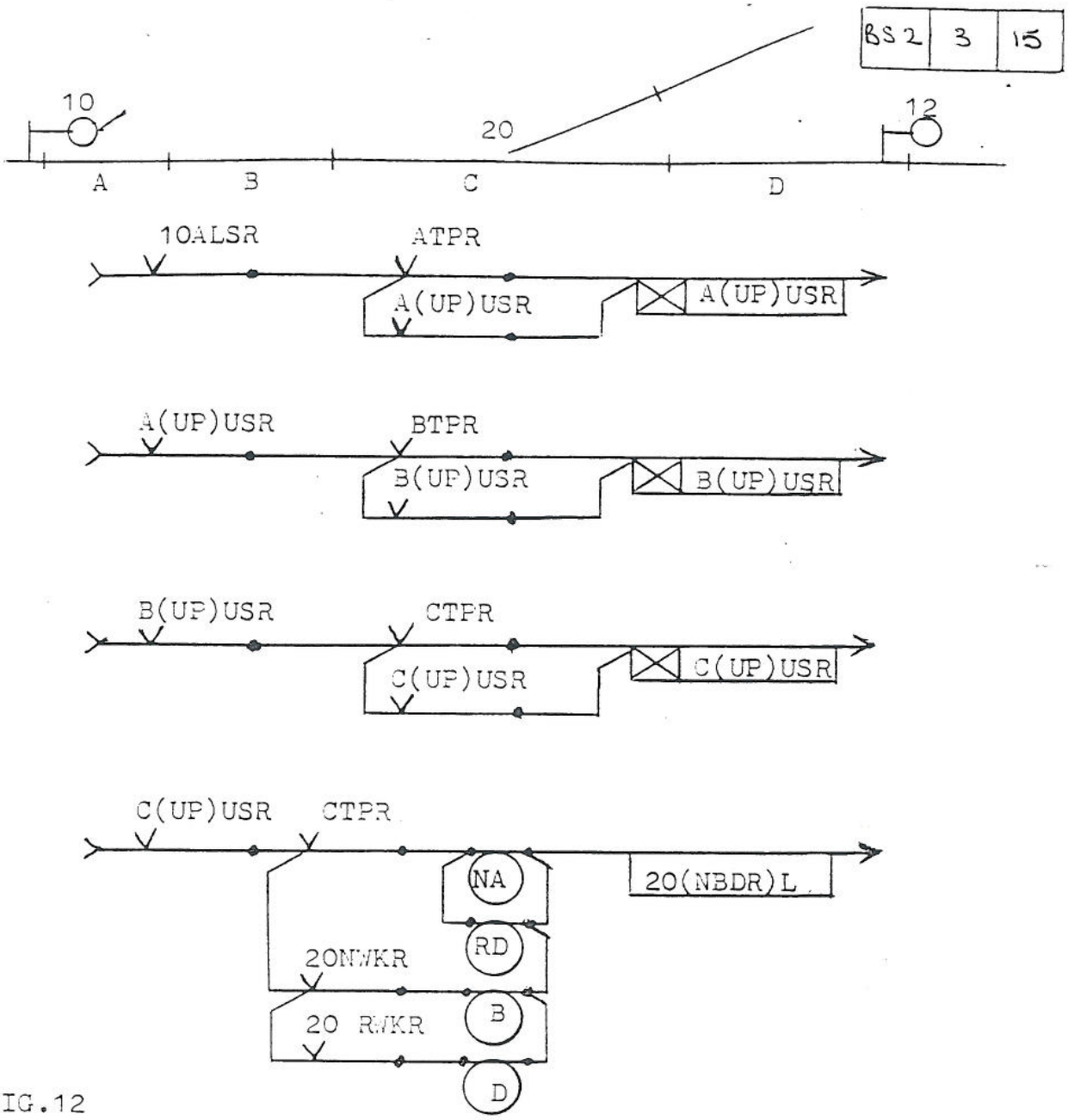


FIG.12

When 10 ALSR drops, A(UP)USR also drops and this in turn drops B(UP)USR.
B(UP)USR dropping also drops C(UP)USR.
C(UP)USR down breaks the circuit to 20(NBDR) Lock and thus locks number 20 points.
It can be seen that the USR's drop out in cascade.

SECTIONAL ROUTE RELEASE OF 10B ROUTE

This is defined as 'Route locking so arranged that a train, in clearing each section of the route, releases the locking affecting that section.
In our example, when the ALSR energisation conditions have been satisfied, ie first track past the signal occupied and cleared and second track occupied, the ALSR will pick and this will initiate the route release.

1) When the train has cleared 'A' track and 10 ALSR has picked, A(UP)USR will pick and stick.

2) With A(UP)USR energised and the train having cleared 'B' track, B(UP)USR will pick and stick.

3) With B(UP)USR energised and the train having cleared 'C' track, C(UP)USR will pick and stick.

4) With C(UP)USR energised and 'C' track clear, the route locking will be removed from 20(NBDR) Lock and number 20 points will again be free to be moved.

It can be seen that the route locking is released behind the train as it traverses the route.

Colour Light Signals

Colour light signals convey their instructions to the driver by coloured lights or ASPECTS.

RED :- Danger Stop at the signal.

YELLOW :- Caution be prepared to stop at the next signal.

YELLOW YELLOW :- Preliminary caution be prepared to find the next signal at Yellow.

GREEN :- Clear next stop signal exhibiting a proceed aspect.

On diagrams the aspect colours are represented as follows:-

RED  YELLOW  GREEN 

Two types of colour light signal are in use:-

a) Multi Unit

b) Searchlight.

The former is now the standard used but on older installations the later may still be in operation.

Signals may be :- 2. 3. or 4 aspects.

Two aspect :- Red/green (Stop Signals) Yellow/Green (Distant signals)

Three aspect :- Red/Yellow/Green

Four aspect :- Red/Yellow/Green/Yellow

The aspects have been stated in rising order. (Red being the bottom aspect).

In the four aspect signal the placing of the Green between the two Yellows is to give sufficient spacing to prevent the merging of the two Yellows.

Method of Operation.
Signals may be operated in three different modes.:-

CONTROLLED. SEMI AUTOMATIC. AUTOMATIC.

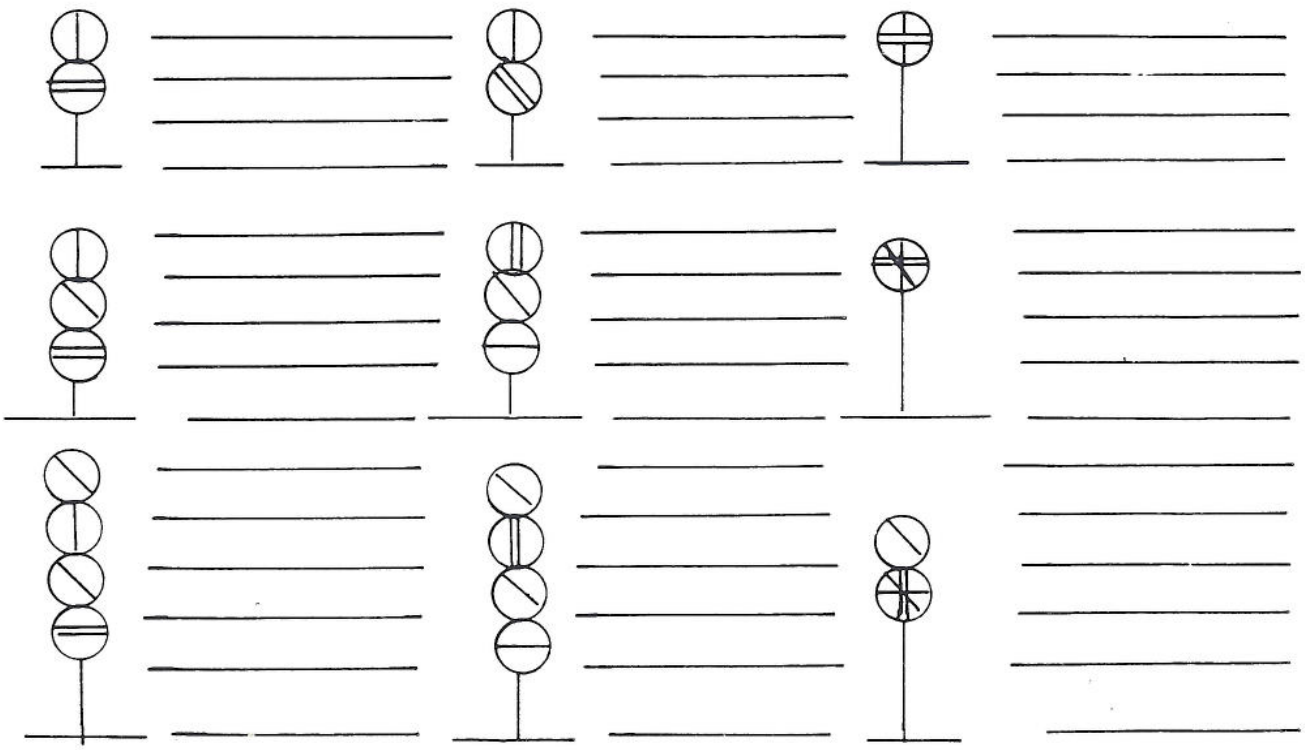
CONTROLLED SIGNALS.
Controlled signals are operated from a Signal Box(or in some cases from a ground frame.).In such cases the normal aspect of the signal will the most restrictive one i.e. Red for stop signals Yellow for distant signals.

SEMI AUTOMATIC SIGNALS.
Semi automatic signals are operated by the passage of trains, but when required they can be controlled by a signal box or ground frame.

AUTOMATIC SIGNALS.
Automatic signals are controlled entirely by the passage of trains. In such cases the normal aspect will be a proceed one.

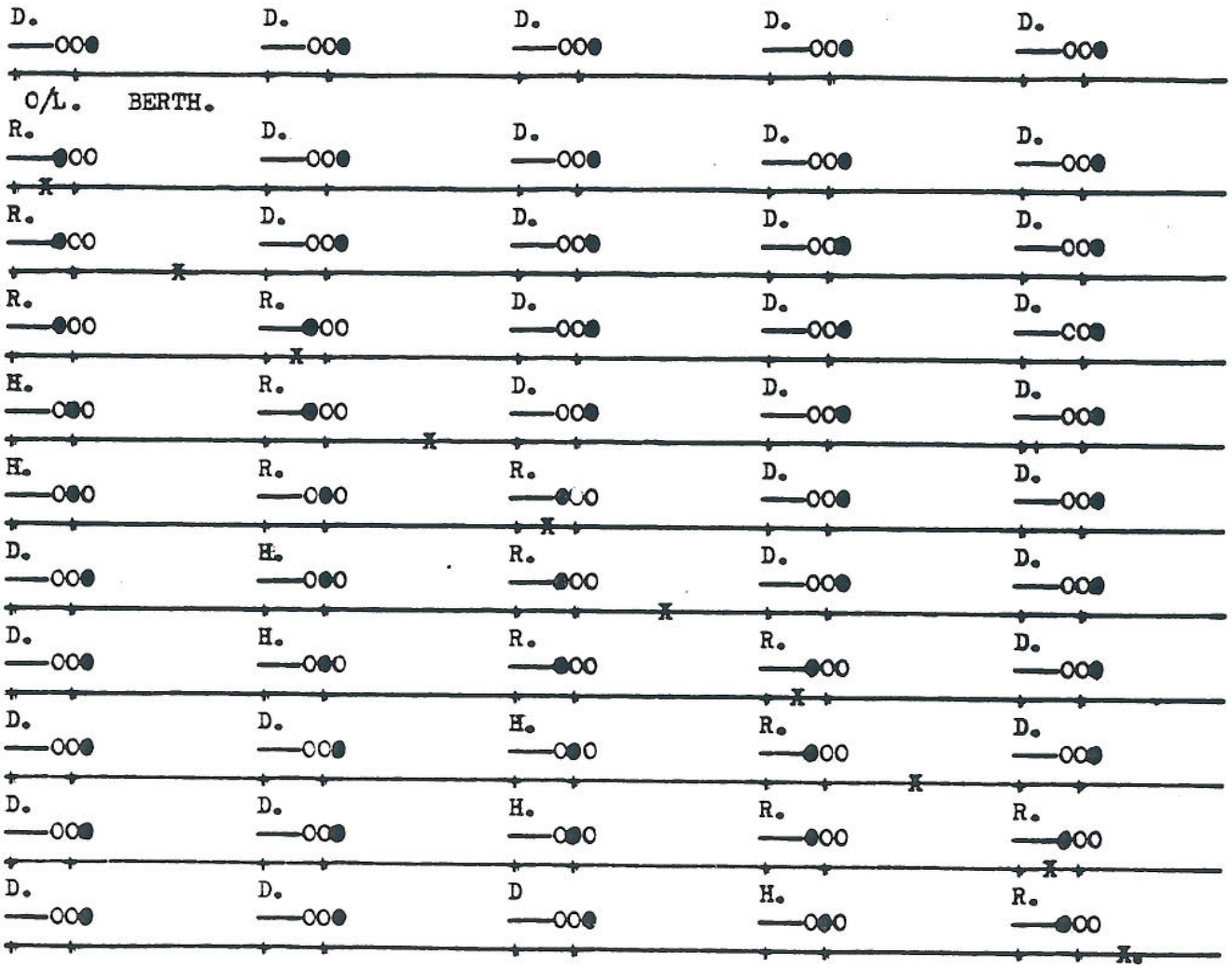
The normal aspect of a signal is indicated by the use of double lines on the colour symbol for that aspect.

Typical Signal Profiles.



Three Aspect Signals. Automatic Signalling Sections.

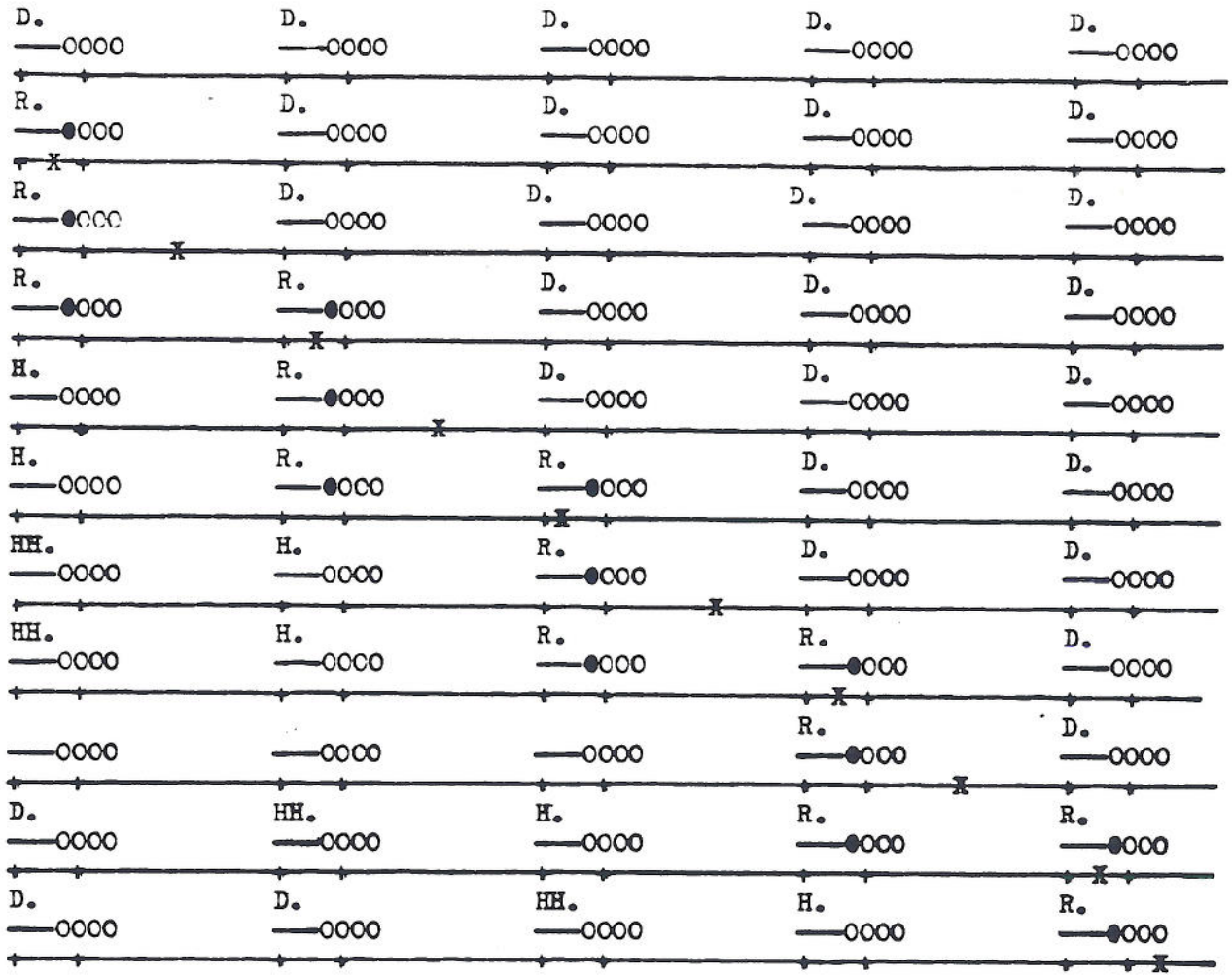
R - RED
H - YELLOW
D - GREEN



Typical three aspect sequence as observed by the passage of a train.

BS 2	4	4

Four Aspect Signals. Automatic Signalling Sections.



H – RED
HH – DOUBLE YELLOW
D – GREEN

Typical four aspect sequence as observed by the passage of a train

Colour Light Signals

Colour light signals may be considered under two broad headings :-

a) Controlled Signals

b) Automatic Signals.

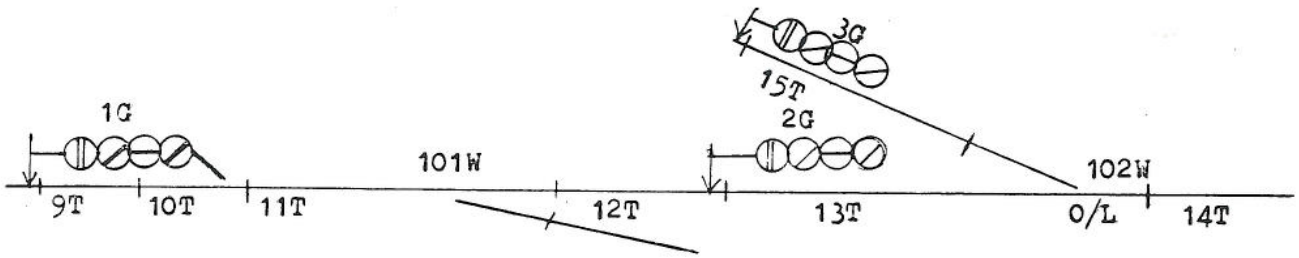
Controlled Signals

The functions included in the control of these signals are :-

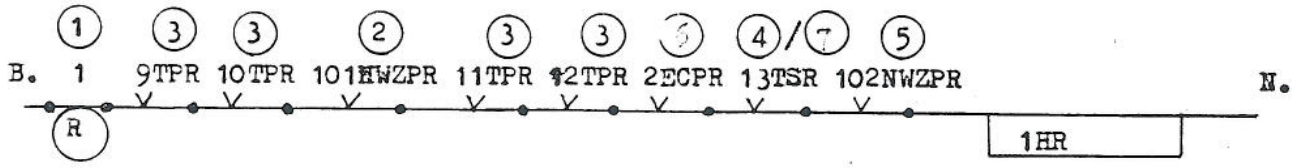
1. The control factor, Lever or Lock Relay.
2. Proof that the Route to the next signal is set.
3. Proof that the Route to the next signal is clear.
4. Proof that the Overlap to the next signal is clear.
5. Proof that any points in the overlap are set.
6. Proof that the lamp is lit in the next signal.
7. When block working is in use the signal is released by line clear for one movement only.

The above controls will be in the HR circuit for the signal.

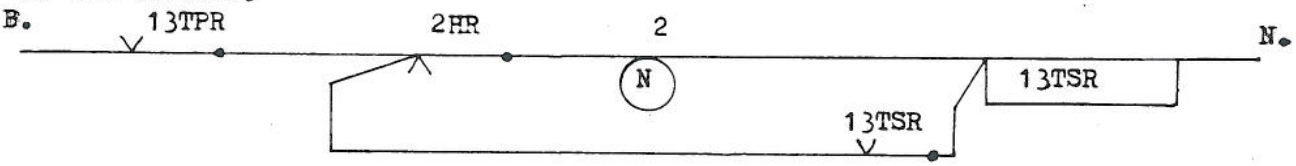
For the signal to clear to any more than a single yellow aspect, the aspect of the next signal will be the controlling factor and will be included in the HHR and DR circuits.

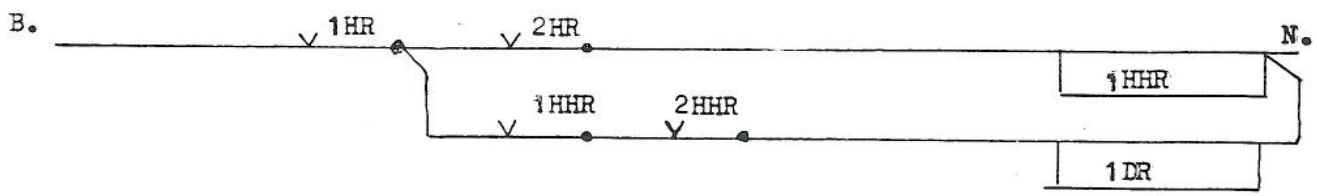


(No) Indicates function reference.



13 TSR Circuit.

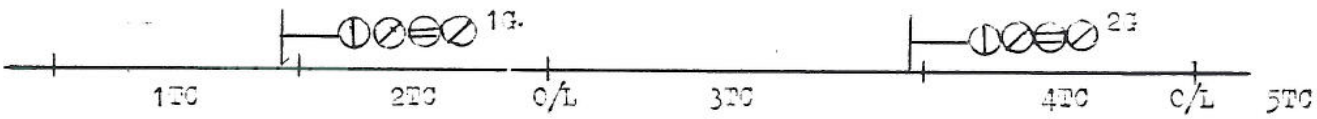


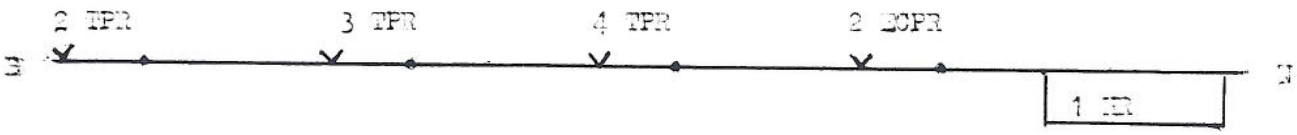


Automatic Signal Controls

The functions included in the control of these signals are :-

1. Section clear to next signal.
2. Overlap of next signal clear.
3. Lamp must be lit in next signal.

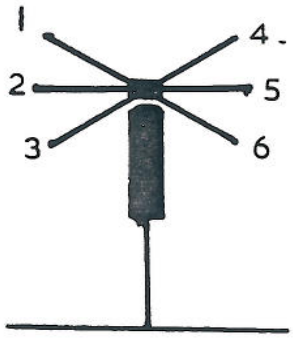


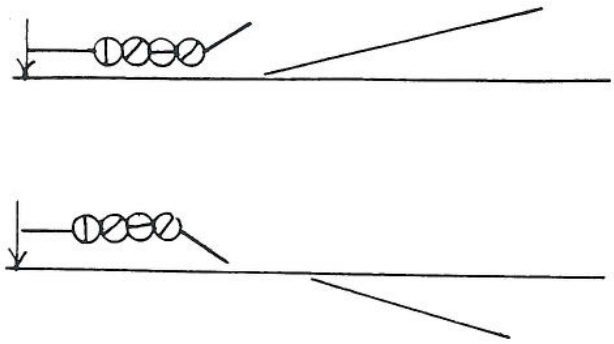


ND. The above should not be considered as actual circuits, but indicative of the functions included.

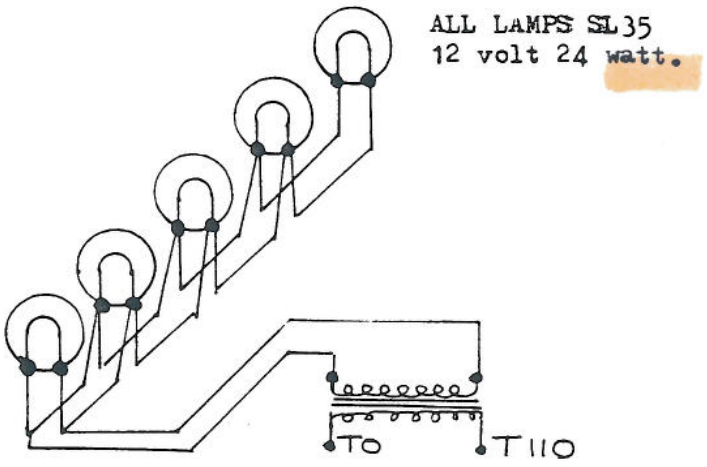
ROUTE INDICATORS

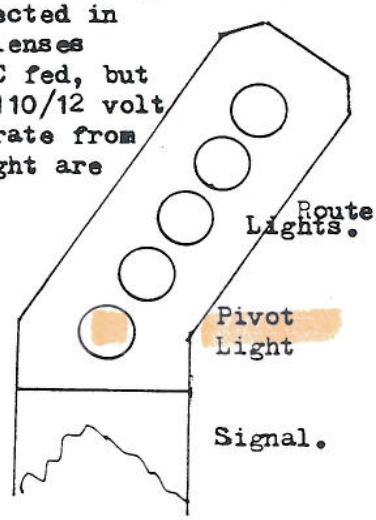
Route indication may be given by means of Junction Indicators which exhibit a line of white lights above the signal when a proceed aspect is displayed. No route indication being given for movements along the straight route.
In the diagram position No. 1 . would be used for a Single or first diversion to the left.Position No.4. would be used for a Single or first diversion to the right. Positions 2 and 3 would be used progressively for left hand diversions and positions 5 and 6 would be used progressively for right hand diversions.





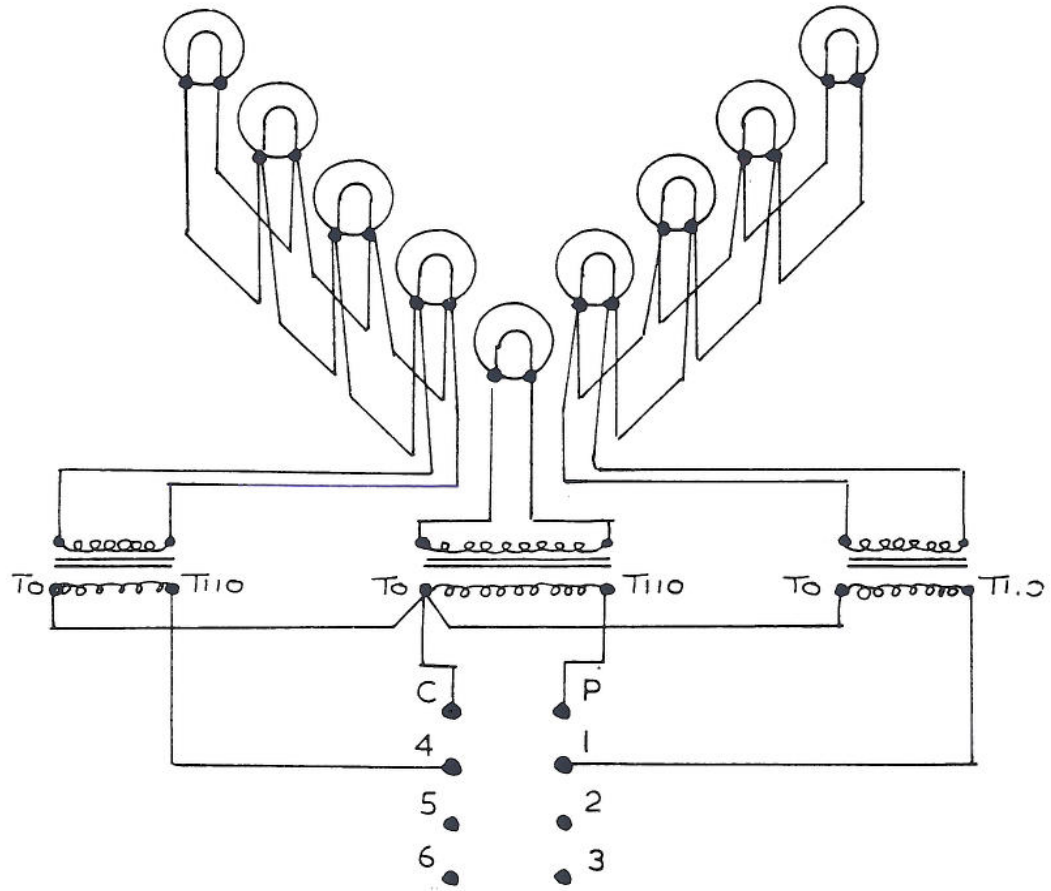
The junction arm unit when fitted in positions 1.3.4.6. should be 45 ° to the horizontal. It consists of 5 lamps of the SL 35 type connected in parallel. The lamps are fixed to the rear of independent lenses fitted with lunar white filters. The lamps may be AC OR DC fed, but the more common would now be AC using a lamp transformer 110/12 volt Two forms are in use, One type having the pivot lamp seperate from the route light, in the other form the route and pivot light are fed from the same transformer.





BS2	4	8

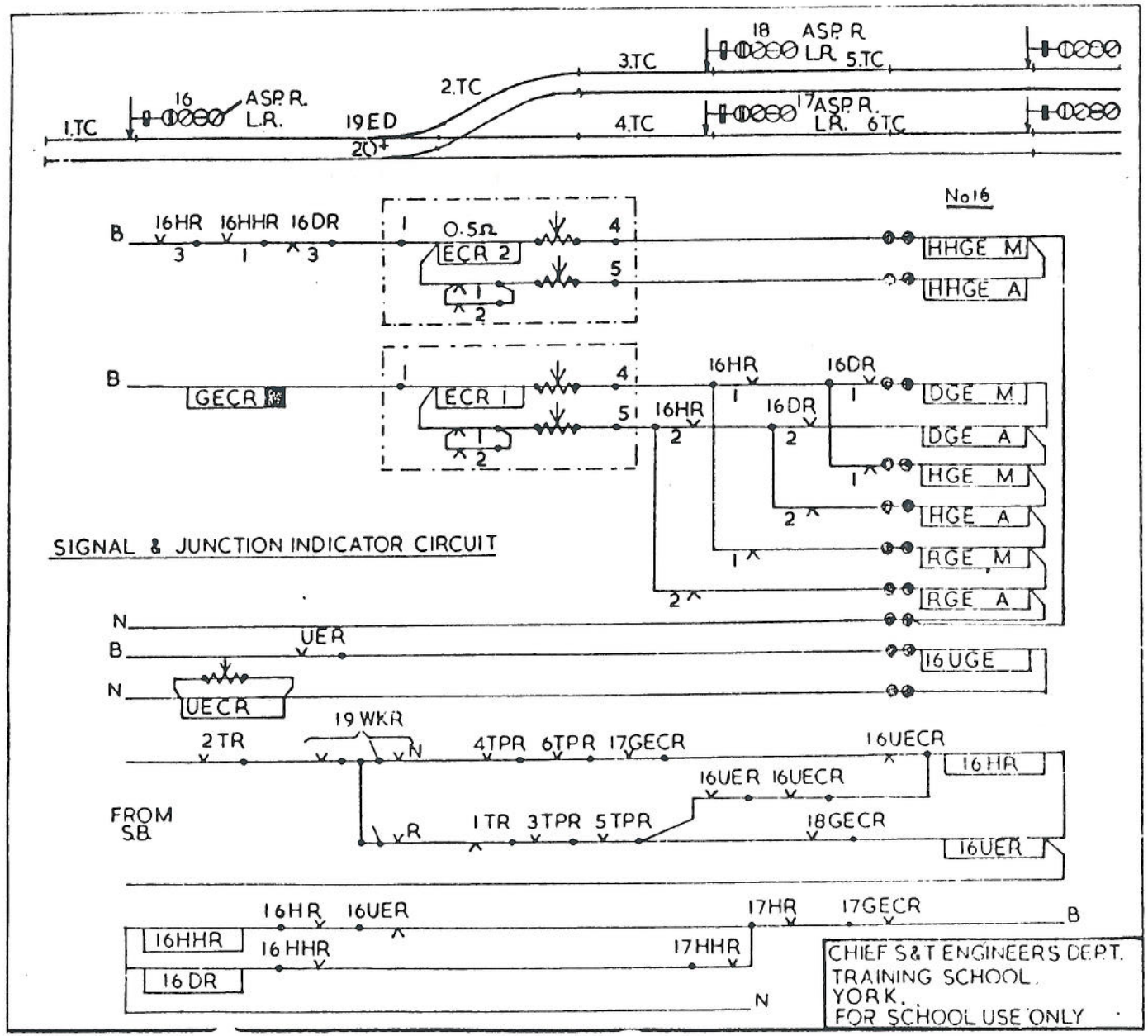
Wiring for Multi Arm indicators with common Pivot light.

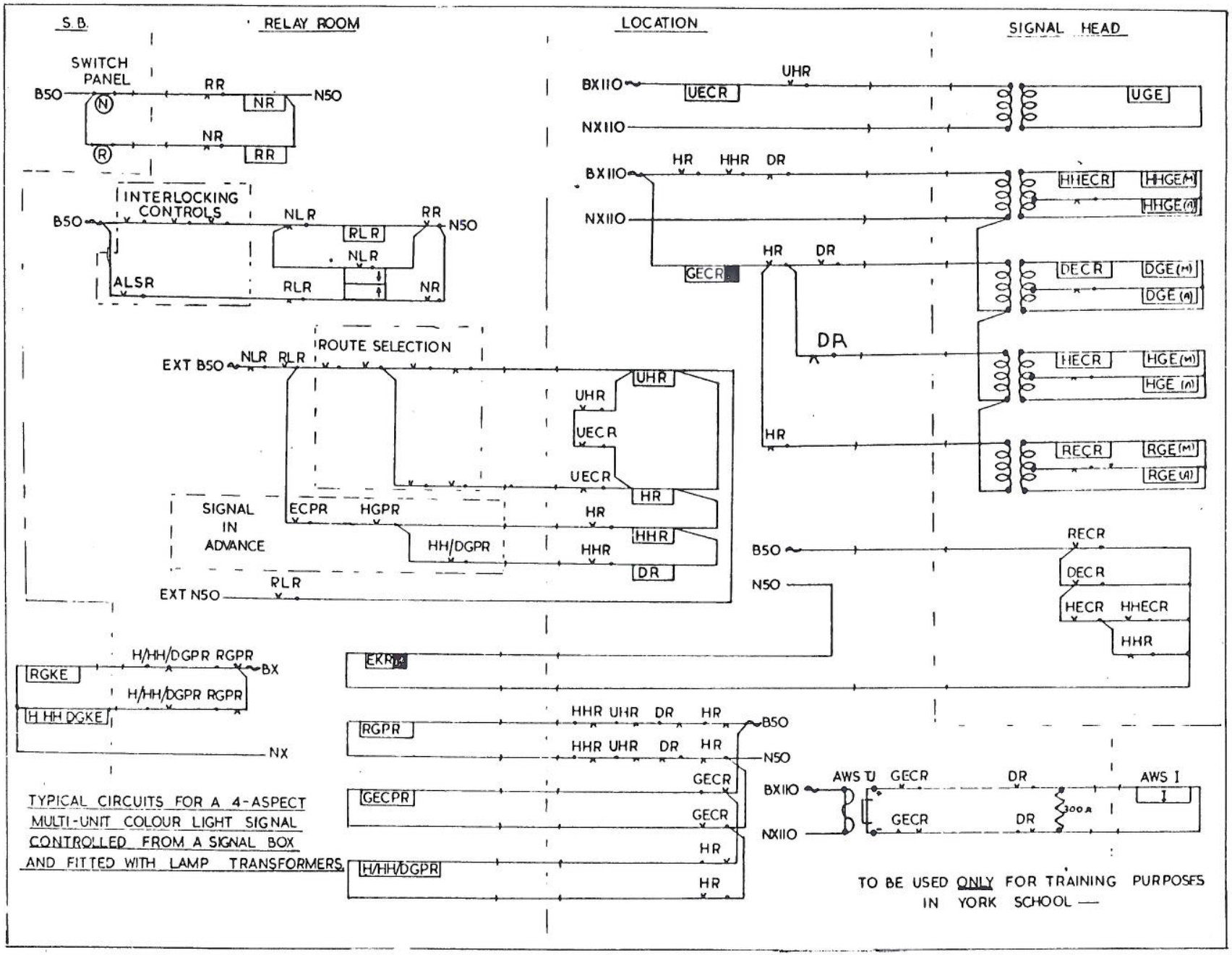


The Junction indicator provides additional information to a driver in respect of diverging routes.It is always used in addition to the signal.
To ensure that a driver responds to speed restrictions it may be necessary to approach release the routing signal, in such cases the general practice would be to hold the signal at red until the train had passed the signal in the rear, and to prevent it going to double yellow or green until the train had passed the AWS. magnet sighting point.
These requirements may chenge in relation to the line speeds and turn out speeds and the relation of the former to the later.
In all cases it is necessary to prove that the Junction indicator has lit. TO A MINIMUM OF 3 LAMPS. prior to the signal being allowed to clear.
This is necessary as the clearing of the signal without the junction indicator for a diverging route,would, be a mis -leading signal to the driver and could, in some cases be classed as a less restrictive aspeet.

The two diagrams shew a typical Junction indicator circuit for a DC. and AC.Signal It will be seen that the straight route (Main) operates the Signal HR direct. When the diverging route is selected UHR or UER is first energised to illuminate route lights, when the route lights are lit to a minimum of three lamps the UECR is operated and over the UECR the signal HR is then energised.

Proof that a minimum of three lamps are lit in the Junction indicator is obtained by the UECR, which must be energised to operate the HR for that route.


1.TC
16
ASP. R.
L.R.
19 E D
2.TC
3.TC
4.TC
18
ASP. R
L.R. 5.TC
17 ASP. R.
L.R. 6.TC
20+
No 16
B
16HR 16HHR 16DR
0.5Ω
ECR 2
HHGE M
HHGE A
GECR
ECR 1
16HR
16DR
DGE M
DGE A
HGE M
HGE A
RGE M
RGE A
SIGNAL & JUNCTION INDICATOR CIRCUIT
N
UER
16UGE
UECR
19 WKR
2TR
4TPR 6TPR 17GECR
16UECR
16HR
16UER 16UECR
FROM S.B.
1TR 3TPR 5TPR
18GECR
16UER
16HR 16UER
17HR 17GECR
16HHR
16 HHR
17HHR
16 DR
CHIEF S&T ENGINEERS DEPT.
TRAINING SCHOOL.
YORK.
FOR SCHOOL USE ONLY


S.B.
RELAY ROOM
LOCATION
SIGNAL HEAD
SWITCH PANEL
B50
N50
RR
NR
INTERLOCKING CONTROLS
NLR
RLR
ALSR
ROUTE SELECTION
EXT B50
EXT N50
UHR
UECR
HR
HHR
DR
SIGNAL IN ADVANCE
ECPR
HGPR
HH/DGPR
BX110
NX110
UGE
HHECR
HHGE(M)
HHGE(A)
GECR
DECR
DGE(M)
DGE(A)
HECR
HGE(M)
HGE(A)
RECR
RGE(M)
RGE(A)
RGKE
H/HH/DGPR RGPR
H HH DGKE
BX
NX
EKR
RGPR
GECPR
H/HH/DGPR
AWS U
AWS I
300Ω
TYPICAL CIRCUITS FOR A 4-ASPECT MULTI-UNIT COLOUR LIGHT SIGNAL CONTROLLED FROM A SIGNAL BOX AND FITTED WITH LAMP TRANSFORMERS.
TO BE USED ONLY FOR TRAINING PURPOSES IN YORK SCHOOL —

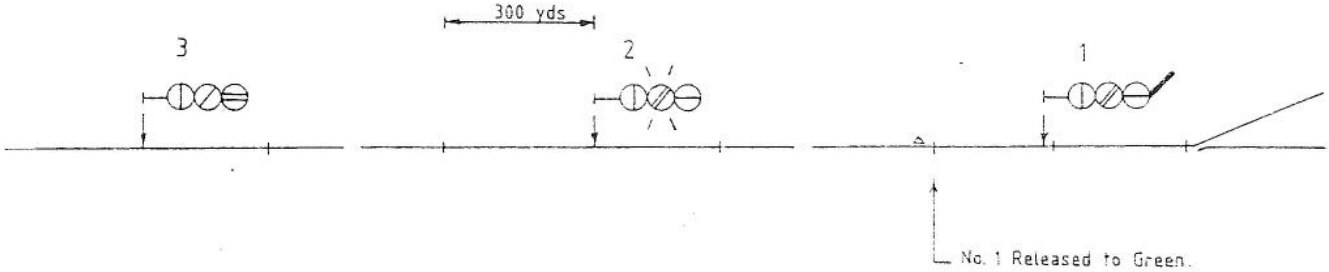
FLASHING "SPEED" SPECIFIED ON DISTANT SIGNALS

In some instances where junction indicators are used, the approach release of a junction signal from red to a proceed aspect may result in an unacceptable time loss due to the reduction in speed being greater than that which is required to negotiate the junction.

Under such circumstances it is not permissible for the junction signal to display an unrestricted proceed aspect without prior warning to the driver of the junction ahead, as the braking characteristics of a High Speed Train are such that the necessary reduction in speed may not be attainable. To deal with this situation the junction signal may display however an unrestricted yellow aspect, together with a flashing yellow in the first signal in the rear and, in 4 aspect territory, a flashing double yellow in the second signal in the rear.

This sequence of aspects will enable the driver, without undue braking of his train, to negotiate the "turnout" at the correct speed.

3 Aspect Signalling

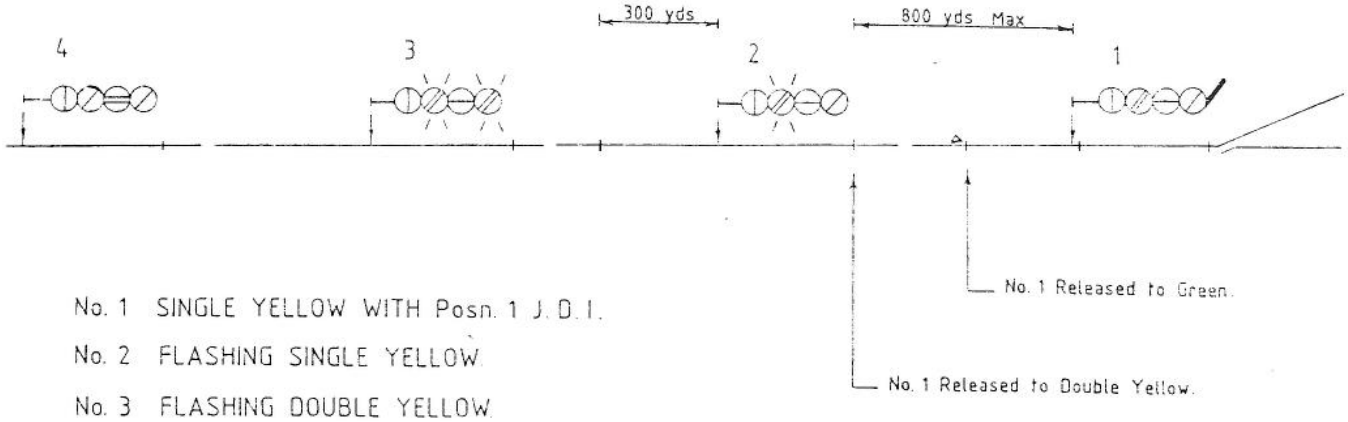


No. 1 SINGLE YELLOW WITH Posn. 1 J.D.I.

No. 2 FLASHING SINGLE YELLOW.

No. 3 GREEN.

4 Aspect Signalling



No. 1 SINGLE YELLOW WITH Posn. 1 J.D.I.

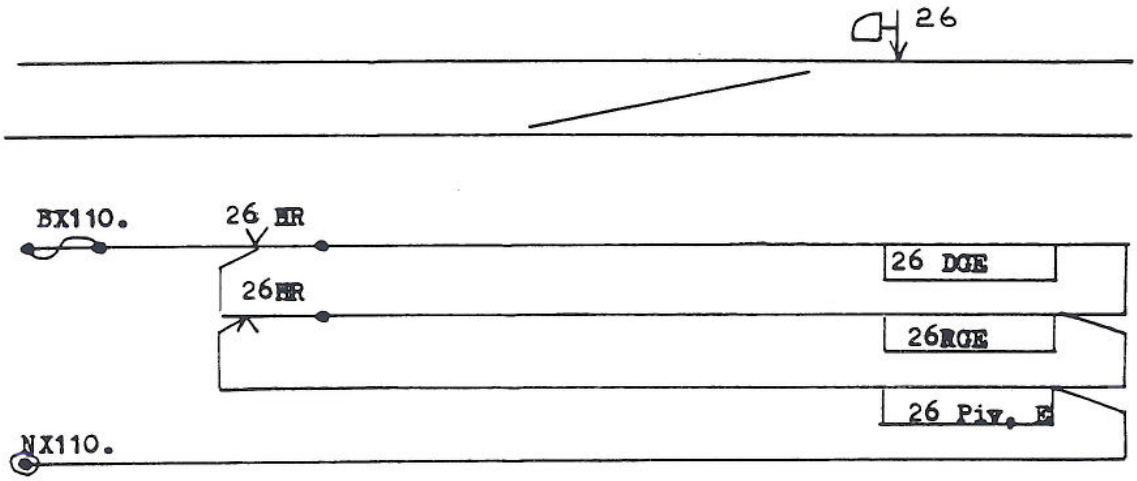
No. 2 FLASHING SINGLE YELLOW.

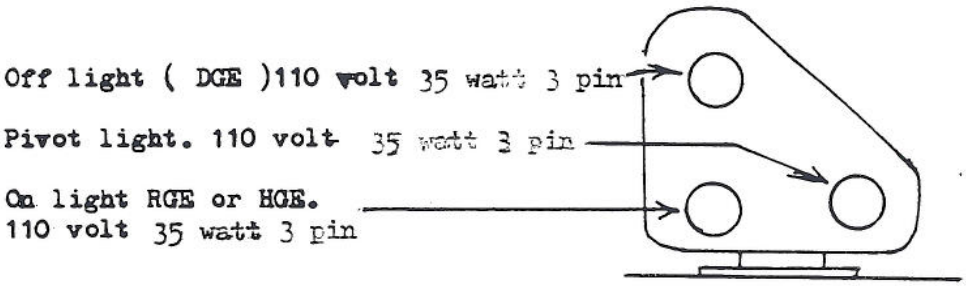
No. 3 FLASHING DOUBLE YELLOW.

No. 4 GREEN.

Ground Shunting Signals.

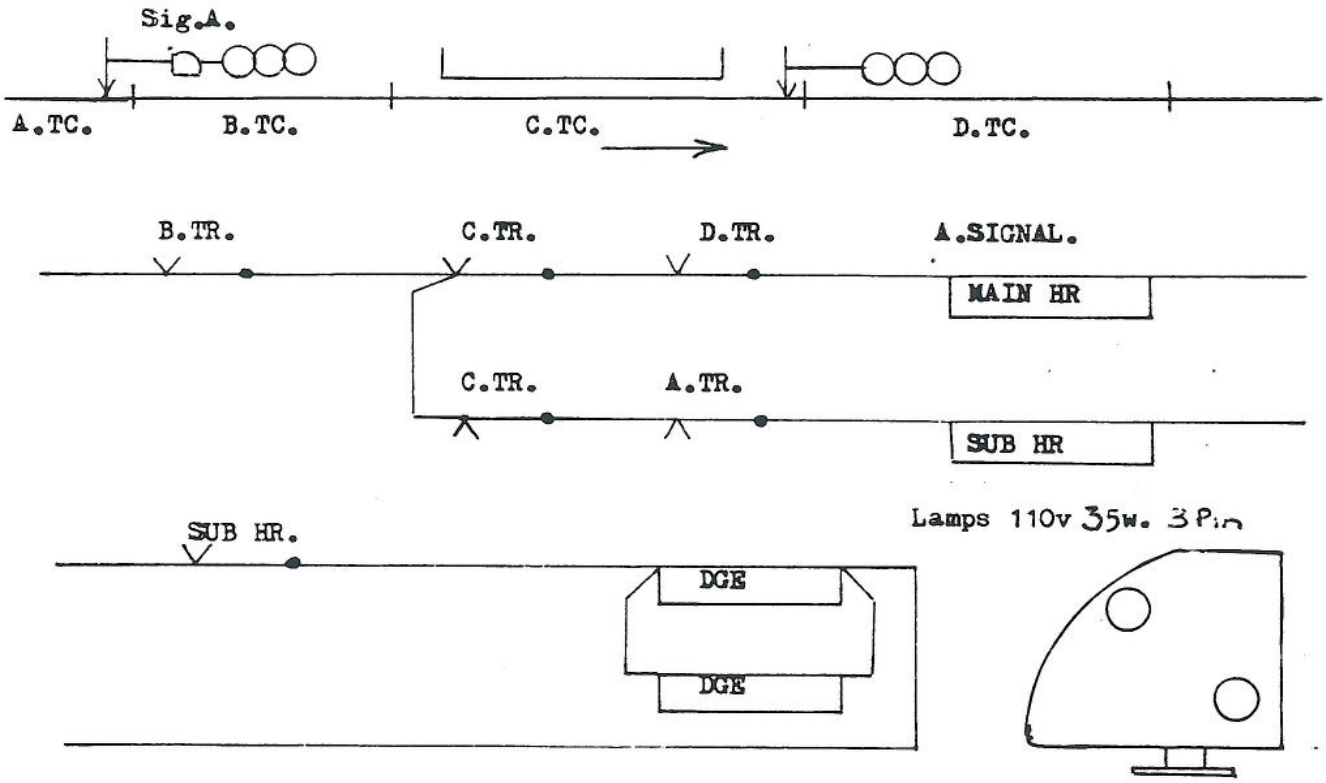
Ground shunting signals are in general positioned approximately 1829 mm (6ft. from the first points over which they apply.
The position light signal showing one Lunar white light and one Red or one Yellow light disposed horizontally for the on aspect and two Lunar white lights at an angle of 45 degees for the off aspect, is used in all power signalling areas.



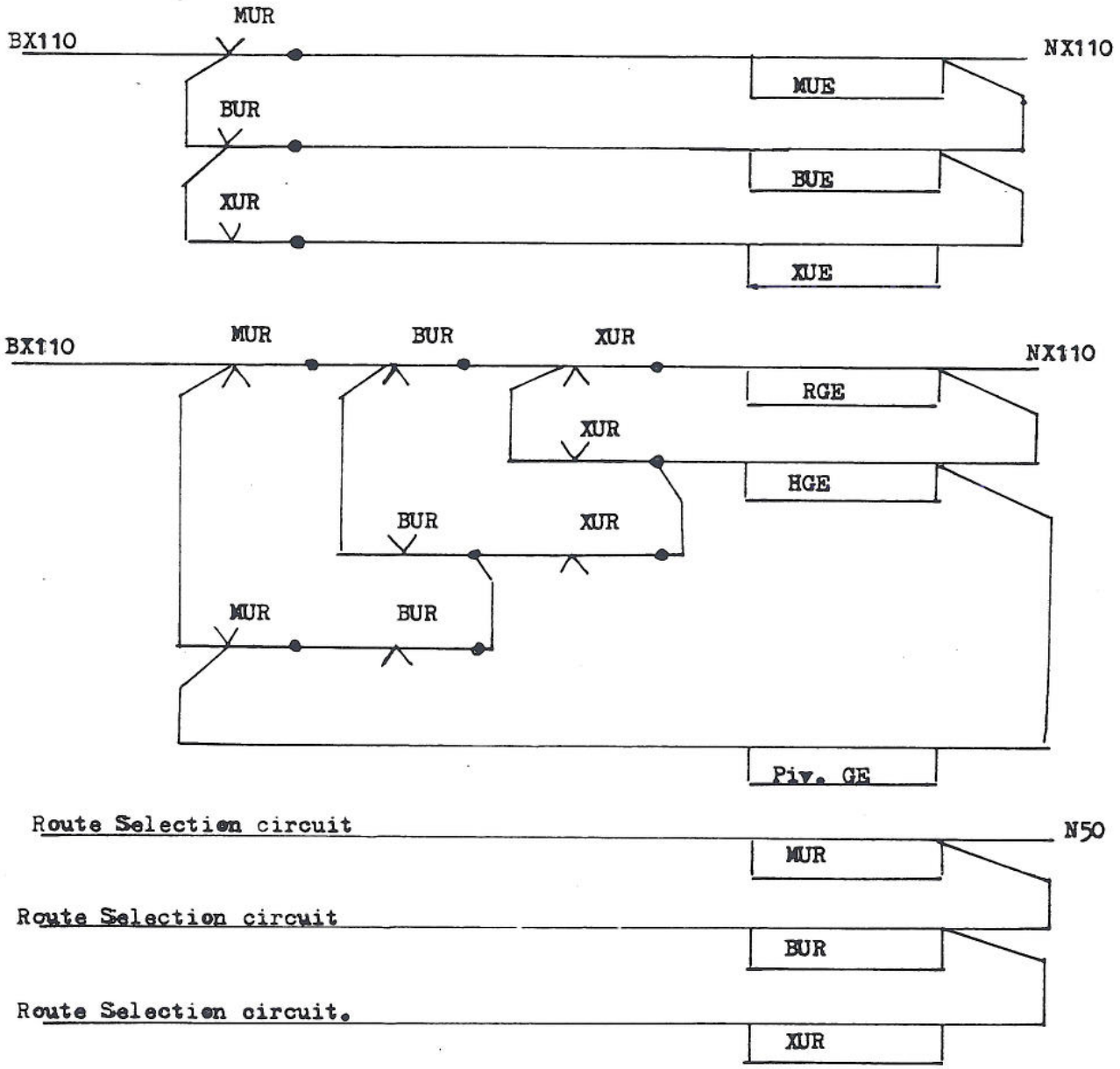


SUBSIDIARY SIGNALS

Subsidiary signals are used in conjunction with Colour light Signals.
A Subsidiary signal takes the form of an elevated position light signal. No normal indication is given but in the off condition it exhibits two white lights at 45 degrees. The control circuit is such that it is cleared by the same device as main signal, but requires the appropriate track circuits occupied.



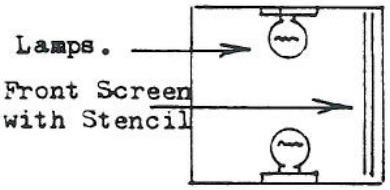
The control of the route indication lamps is over contacts of UHR. for each route. UHR control being over the route selection circuit from the S.B.

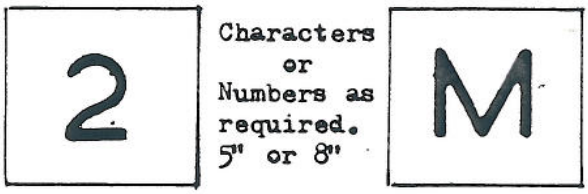


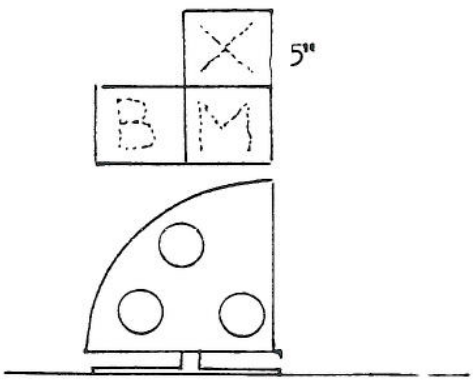
STENCIL TYPE ROUTE INDICATORS

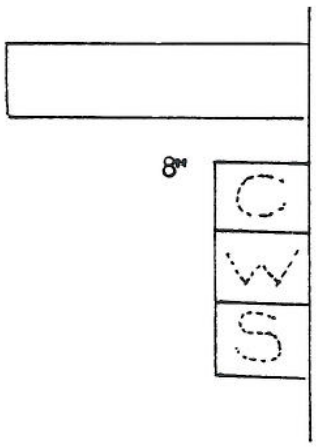
Stencil type route indicators may be used in conjunction with Shunting signals or Ground or Subsidiary signals.
The line speed will generally be low and usually will be shunting movements.

The route indicator is rectangular in form and the character is either 5" or 8" high. A single character is displayed by each unit further characters when required necessitating further units. They use white characters on a lunar white ground and are generally single sided only. Where there is a specific requirement for double sided indication, the rear indication will be amber filtered.
The Lamp used will be 110 volt 40 watt 2 pin BC. in some cases two lamps may be used to give a more even illumination.



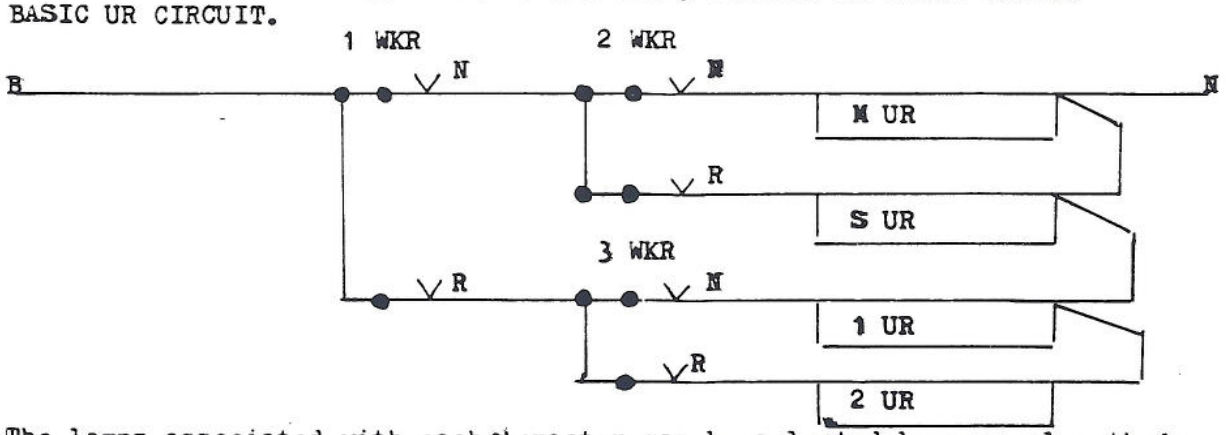




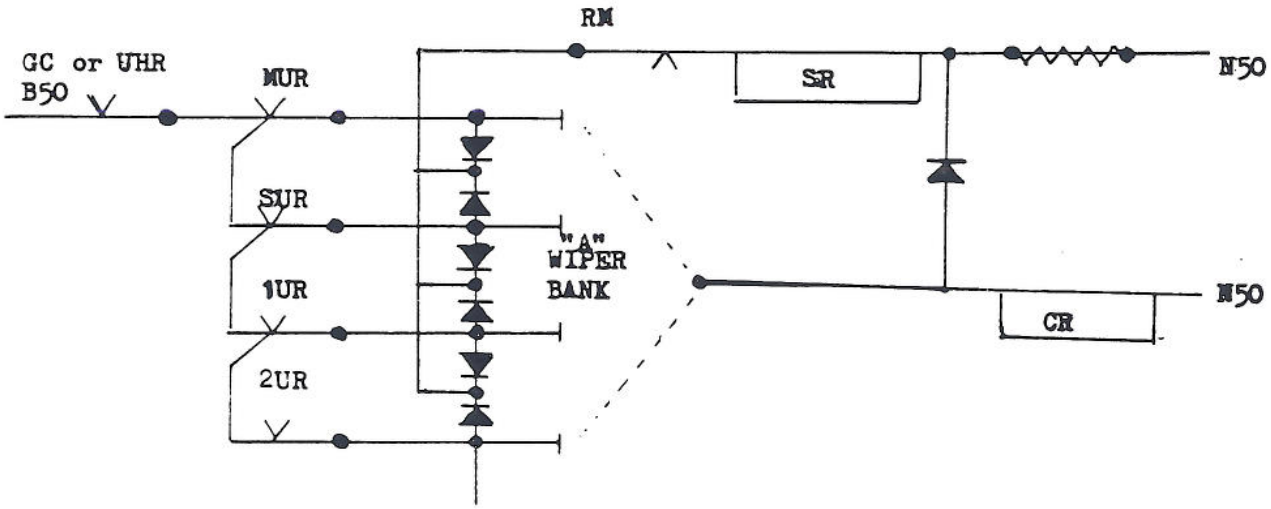


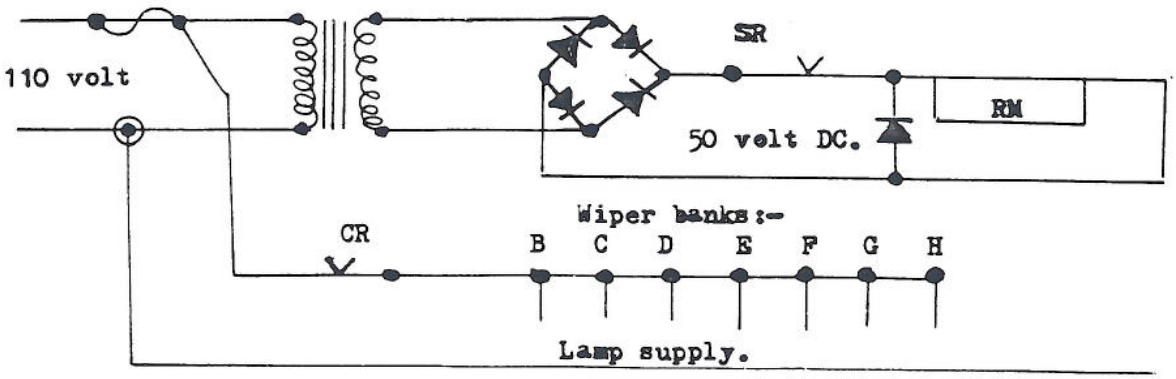
The selected route is determined by the use of Route relays, a relay being allocated to each route. Abasic route relay circuit is shown below.

BASIC UR CIRCUIT.



The lamps associated with each character may be selected by several methods, initiated by the energisation of the UR. The method of lamp selection differs one type using Relays to select lamps another as described below uses Uni-Selectors for the Lamp control.





MULTI-LAMP ROUTE INDICATORS.

Multi Lamp indicators present their information in the form of Letters or Numbers built up by a number of illuminated lamps.The unit is in overall shape square and the lamps are assembled to the rear of a Lunar white screen, they are numbered as shown in the diagram and the selection of a specific lamp configuration will give the required character.

as viewed from the rear.

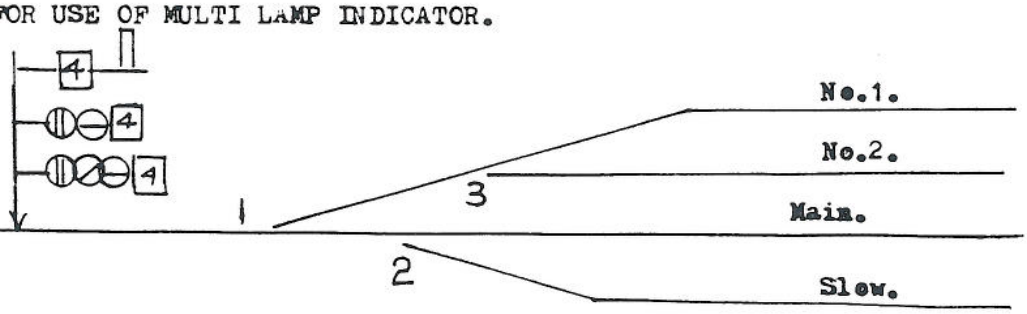
X	6	5	4	3	2	X
X	X	12	11	10	X	X
X	20	X	18	X	16	X
X	27	26	X	24	23	X
X	34	33	32	31	30	X
X	41	40	39	38	37	X
X	48	47	46	45	44	X

7	6	5	4	3	2	1
14	13	12	11	10	9	8
21	20	19	18	17	16	15
28	27	26	25	24	23	22
35	34	33	32	31	30	29
42	42	40	39	38	37	36
49	48	47	46	45	44	43

Single sided indicators are fitted as standard, but under special circumstances double sided indicators may be fitted, in which case the rear indicator would have an orrange glass screen fitted.
Multi lamp indicaters are used in general practice on lines having a line speed of 40 mph or less.
In special circumstances Multi lamp indicators may be used at line speeds over 40 mph but, in such cases extra precautions are employed such as the proving of the lamps to prevent the danger of a mutilated character giving a misleading indication and the holding of the signal clearing when a diverging route is selected.

TYPICAL LAYOUT FOR USE OF MULTI LAMP INDICATOR.

Some types of signal that may be used.



B.R. STANDARD SIGNAL LAMPS

The following lamps are the current standard and will be used for the purposes stated for all new work.

FUNCTION	TYPE OF LAMP
Multi-aspect	SL 35 12v 24/24w independant filament. 3pin BC.
Searchlight—main aspect	SL 32 12v 12/16w " " 2pin SBC
4th (YY) aspect	SL 35 12v 24/24w
Junction Indicator	SL 35 12v 24/24w
Theatre Route Indicator	110v 15w BC piggy clear 2pin BC.
Stencil Route Indicator	110v 35w pearl 2pin BC.
Position light subsidiary	110v 35w pearl 2pin BC.
Position light shunting signal all aspects	110v 35w 2pin BC (eventual standard 3pin BC)
Banner Repeater	110v 15w piggy 2pin clear BC 2 lamps in parallel.
Limit of Shunt	110v 35w clear 2pin BC 2 lamps in parallel.
Toton signals	Under review. 110v 25w 3pin BC SL33 now
Red/Green lights for LC	SL35 12v 24/24w
LC Flashing lights	24v 36w SBC.
LC Barriers Bells & Gate lamps	24v 5w SBC.
LC Gatelamps (Battery Standby)	12v 5w.
Semaphore signals to oil lamp standard	SL1 4.5v 0.5w SBC.
Semaphore signal, intensified light	SL 35 12v 24/24w.

An A.C. lamp feed circuit must be provided for all running signals fed from a mains with a standby supply. The transformer and filament change-over relay are to be mounted in the signal head in accordance with B.R. spec. 903A. D.C. lamp feed may only be used where there is no mains standby and a secondary cell is provided instead.

The following types of lamp are still in service but are obsolescent and must not be used for new work. Only the SL 17 is likely to remain for years and all other types should be replaced by the appropriate standard type when opportunity arises.

SL 13 6v 12w, SL 16 12v 12w, SL 17 12v 25w, SL 18 12v 24w, SL 21 12v 33w, SL 22 12v 14w, SL 33 110v 25w, SL 34 12v 16/24w.

ADJUSTMENT OF COLOUR SIGNAL LAMPS

Signal Maintenance Instruction (SM 2) Extract

1. Record Cards

A record must be kept at each signal, on Signal Lamp Record Card BR. 13286/1.

2. Voltage on Lamps

	Maximum Voltage	Minimum Voltage
Lamps rated at 6 volts	6v.	5.7v.
Lamps rated at 12 volts	~~11.5v.~~ 10.7	~~11.5v.~~ 10.5

The figures tabulated below show the effect of voltage variation on the lamp life and light value:-

Lamp Volts	Average Lamp Life (weeks)	Light Value (%)
12.0	8	100
11.5	11	86
11.4	12	84

3. Adjustment of Lamp Voltages - 12v. Lamps

When the lamps are fed direct from a rectifier, with no standby battery, the rectified a.c. is not smooth and both a Technicians AVC and a Model 8 AVC which are moving coil instruments do not give a true reading of the lamp voltage. This can be determined with a moving iron type meter. The ratio of lamp voltages as read on a moving iron type meter and a Technicians AVC meter will vary depending on the particular rectifier set and lamp proving relay used since it is related to the degree of smoothing provided by the combination. The degree of smoothing is not the same for rectifier sets supplied by different manufacturers or for different batches of rectifiers by the same manufacturer. The D.S. & T.E./D.S. & T.A. will ensure that where signals lamps are fed from a rectifier without a standby battery the lamp voltages are checked with a moving iron meter and the Technicians AVC meter and the Technician advised of the voltage reading on the AVC which will correspond to 10.5 volts on the moving iron meter. The equivalent AVC meter reading must be inserted on the front of the Signal Lamp Record Card.

Adjustment of A.C. Colour Light

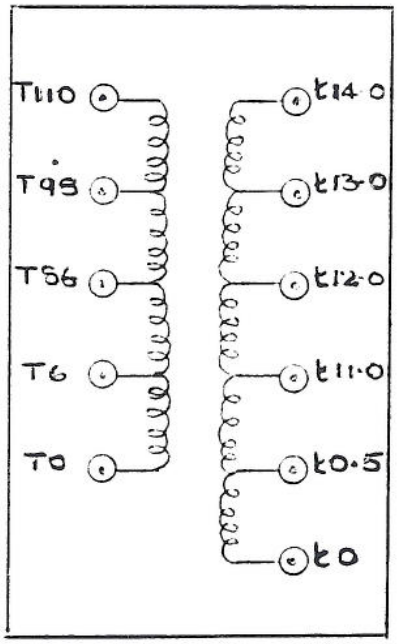
When setting up lamp voltages in the standard A.C. Colour light head, each aspect has its own individual 110v./12v. transformer situated within the signal head.

It must be remembered that the Primary (110v.) setting must be adjusted first, to the incoming voltage value, which may not be an exact 110v.

Next the Secondary tappings for the Main and Auxilary Filaments are adjusted to the voltages prescibed in Signal Maintenance Instruction SM 2.

The Main Lamp Filament is adjusted first and will use a higher voltage tapping than the Auxilary. This is because the Main Filament circuit includes an ECR which is connected in series with the Main Filament to provide Filament Proving, and provide change over facilities for the lighting of the Auxilary Filament should the Main Filament fail.

Typical A.C. Colour Light Head Transformer



BRITISH RAILWAYS

Signal & Telecommunications
Engineering Department

SIGNALLING MAINTENANCE SPECIFICATION

Vol. 2
No. SG31
Date. 07/84
Page 01
Issue 01

SIGNAL LAMP

GENERAL

0.1 Check, where applicable, the state of the first filament failure indications before commencing tests, using a telephone or by visiting the signal box/relay room.

0.2 The back of the signal should not be opened with a train approaching as this may give a false indication to the driver.

0.3 If a train is approaching wait until the train has passed the signal before opening the back of the signal.

0.4 Where it is necessary to illuminate a particular aspect, arrangements should be made with the signalman to clear the signal to the appropriate aspect.

0.5 A Signal Lamp Test Record card must be kept in the signal head.

0.6 Where both filaments of a lamp have failed or where no aspect is displayed a Signalling Failure Report form must be completed and submitted to the Supervisor.

LAMP CHANGING

0.7 When a lamp is changed the record card should be endorsed, under the appropriate aspect, with the words "LAMP CHANGED" followed by the date.

0.8 When a lamp is changed the lamp voltage should be measured and adjusted if necessary, the value and other details should be recorded on the record card.

0.9 When inserting the new lamp, where the auxiliary filament is normally extinguished, tilt it slightly towards the auxiliary contact of the lamp holder (towards the right when viewed from the rear) to check that the main filament extinguishes and the auxiliary filament illuminates. See Appendix A for details.

SIGNAL LAMP

0.10 Allow the lamp to return to its normal position and check that the main filament is illuminated and the auxiliary filament is extinguished.

QUARTZ–TUNGSTEN HALOGEN LAMP

0.11 Before removing a Quartz-Tungsten Halogen lamp from its packaging it should be noted that the envelope must not be contaminated. The envelope should be handled using the packaging or a clean folded paper tissue. If the envelope becomes contaminated it should be cleaned with methylated spirit and allowed to dry, before being inserted into the lamp holder in the manner described above.

SIGNAL WITH FIRST FILAMENT FAILURES INDICATION

0.12 As soon as possible after a failure the failed filament must be identified. The lamp must be replaced within one week.

0.13 Arrange to illuminate the aspect with the lamp failure.

SIGNAL WITHOUT FIRST FILAMENT FAILURE INDICATION

0.14 Controlled Signals normally at red, renew the red and yellow (1st yellow of a four aspect signal), aspect lamps at prescribed intervals. 26 WEEKLY

0.15 Automatic and Controlled Signals not normally at red, renew the red and normally displayed aspect lamps at prescribed intervals. 26 WEEKLY

0.16 All other lamps of Controlled and Automatic Signal aspects to be renewed at prescribed intervals. 52 WEEKLY

POSITION LIGHT SIGNAL NOT ASSOCIATED WITH MAIN ASPECT.

0.17 The pivot and red/yellow lamps to be renewed at prescribed intervals. 26 WEEKLY

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SIGNAL LAMP

0.18 The white 'Off' lamp to be renewed on failure.

POSITION LIGHT SIGNAL
ASSOCIATED WITH MAIN ASPECT

0.19 The lamps to be changed on failure.

ROUTE INDICATORS/BANNER SIGNALS
(Junction/Stencil/Theatre/Fibre Optic)

0.20 The lamps to be changed on failure.

SEMAPHORE SIGNAL
(Electrically Lit)

4.5, 6 and 12 Volt Lamps.

The lamps to be changed at prescribed intervals. 26 WEEKLY

LAMP VOLTAGE

0.21 On installation all aspect voltages should be measured, adjusted if necessary and the values recorded.

0.22 The measurements to be taken with the voltmeter connected across the terminals of the lamp holder.

COLOUR LIGHT SIGNAL

0.23 To obtain the maximum life from the lamp it is necessary to adjust the lamp voltage as near as possible to the minimum voltage shown below..

	Maximum Voltage	Minimum Voltage
Lamps rated at 6 volts	6V.	5.7V
Lamps rated at 12 volts	10·7 v.	10·5 v.

SIGNAL LAMP

0.27 The supply voltage should be set to give a lamp voltage as detailed in items 0.23 and 0.24.

QUARTZ–TUNGSTEN HALOGEN LAMP

0.28 The lamp voltage should be set between:–

11.7 and 11.3 Volts for 12 Volt lamps.

0.29 If the supply voltage tends to fluctuate it should be anticipated, because lamp life is greatly reduced when a lamp is allowed to operate outside the range shown above. Therefore a high lamp voltage is required if the supply voltage is currently high or visa versa a low lamp voltage is required if the supply voltage is currently low.

SEMAPHORE SIGNAL
(Electrically Lit)

0.30 4.5 Volt lamp should have a lamp voltage of 4.5 Volts.

0.31 6 Volt lamp should have a lamp voltage of 4 Volts.

0.32 12 Volt map should have a lamp voltage of between 10·7 and 10·5 Volts.

LAMP HOLDER

0.33 Special attention must be given to spring pressures when carrying out routine maintenance. Technicians must use their experience to determine whether the pressure required to insert the lamp into the holder feels right. Movement of the lamp in the holder must not result in the lamp going out. The tension may be increased by slight upward pressure on the spring but where this is not possible or the desired tension cannot be obtained the springs must be replaced.

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Engineering Department

SIGNALLING
MAINTENANCE
SPECIFICATION

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SIGNAL LAMP

Service A

13 WEEKLY

Signals with:—

1.1 Double filament lamps with first filament failure indication must have the first filament failure indication checked to ensure that the main filaments are intact.

1.2 Double filament lamps without first filament failure indications and single filament lamps must have all aspects illuminated to check that all filaments are intact.

1.3 If any of the above types of lamp are found to be defective they should be replaced.

VOLTAGE CHECK

1.4 Measure the voltage of the lamp that is illuminated and adjust as necessary.

1.5 If an adjustment has to be made in item 1.4 all other lamp voltages must be checked and adjusted if necessary.

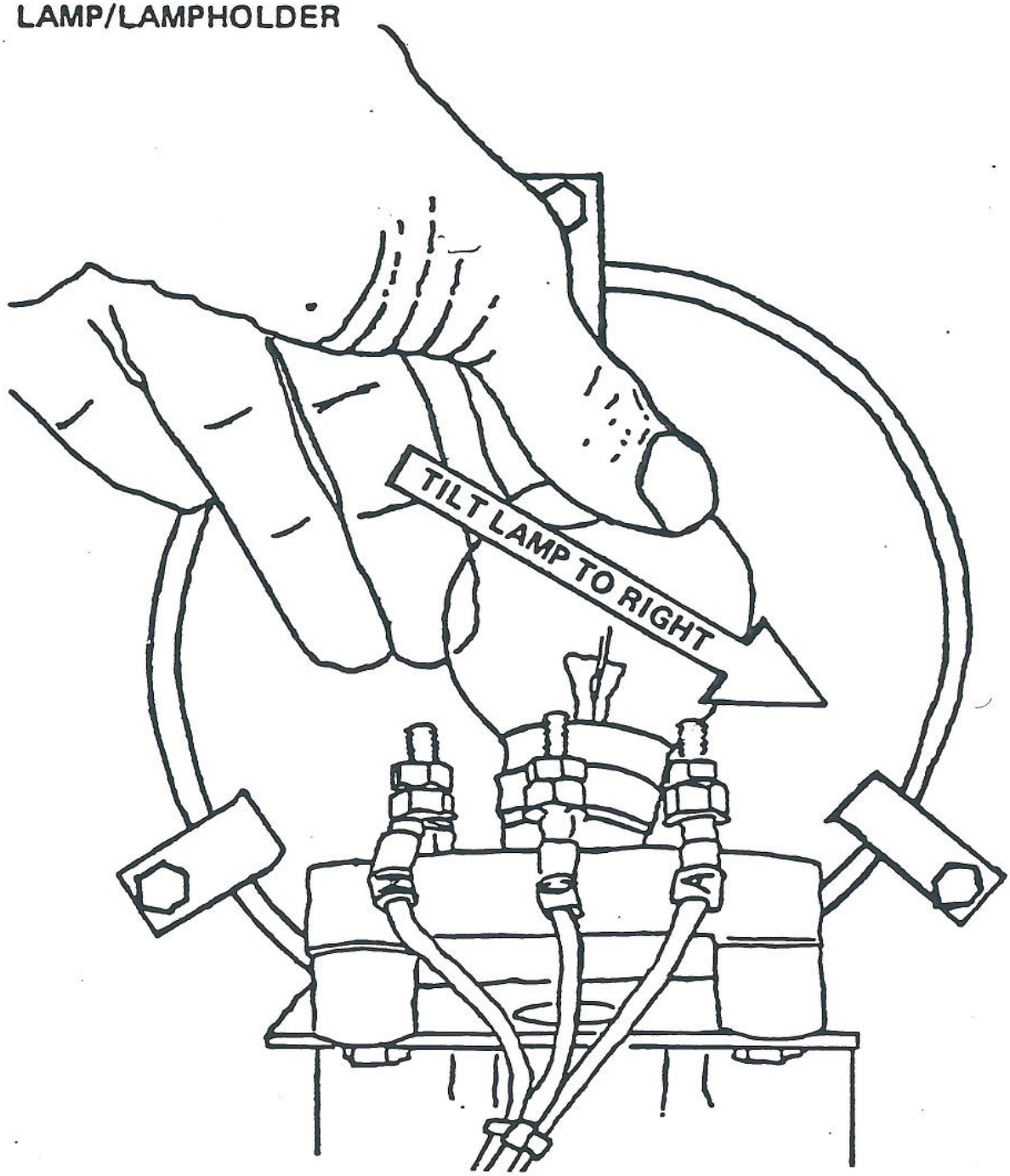
SIGNAL LAMP

1.6 Record the value/s of the lamp voltage/s and other details on the record card.

SIGNAL LAMP

APPENDIX A

LAMP/LAMPHOLDER



Read All

POWER OPERATED POINTS

Point Machines Principle of Operation

The type of Point machine used by British Railways may vary between installations but they are all similar in the principle of their operation. A thorough knowledge of one type of point machine should enable a ready understanding of other types of point machine to be obtained.

The two types of point machine to be dealt with on this course are the WBS Style 63 machine and the AEI HW 1000 machine.

Department of Transport Requirements

1. All points to have two or more stretcher bars.
2. Facing points on passenger lines, and all points regularly used in the facing direction by passenger trains to have :-
   a) A bolt-lock through a third stretcher bar, with its bolt either worked through a locking bar or controlled by a track circuit.
   b) A stock rail gauge tie. (sole plate).
   c) Apparatus to detect that each switch is in its proper position and that the points are bolted before the relative signals can be cleared.
3. Where power worked points are controlled from a mechanical frame, completion of the stroke of the points lever to be prevented until the points have reached the corresponding position.
   Signals leading over power worked points to be at danger before the points are operated by hand in an emergency (or for point testing).
   Correspondence between the position of the points and the controlling lever when the power operation is resumed to be ensured.
   Levers controlling power worked points to have shortened handles.
4. Unbolting of facing points in a track circuited section to be prevented when the track circuit is occupied. Whenever possible, the length of the track circuit concerned to be sufficient to allow the movement of power worked points to be completed before the train reaches them. If initiated immediately before the track circuit is occupied, account to be taken of the time needed to complete the stroke of the points and of the likely speed of traffic over them.
5. Approach control arrangements to be provided for power worked facing points remote from the signal box.

A set of power operated facing points can be regarded as correctly set when:-

a) The closed switch is located against the stock rail.
b) The open switch is appropriately clear of the corresponding stock rail.
c) The switches are held in position by an external force.
d) They are held locked.
e) They must not be allowed to unlock during the passage of a train.
f) The correct setting of the switches to be proved (detected).
g) The stock rail must be tied.
h) The detection and locking operation must be to known tolerances.

Point Machines - General Definitions

Point Mechanism

That portion of a point operating machine; consisting of clutch, reduction gears, cams and bars used for the conversion of the rotary movements of the motor in the machine into the straight drive for operating the points and locking mechanism. It also includes the pole changing contacts.

Throw Bar

That part of the point mechanism which provides the thrust for the operation of the point switches.

Lock Bar

That part of the point mechanism which acts in conjunction with the lock slides to effect the locking of the points.

Lock Slides

That part of the point mechanism which acts in conjunction with the lock bar to effect the locking of the points, and to which the lock rod is connected.

Detector Slides

That part of the point mechanism which controls the detector contacts, and to which the detector rods are connected.

Point Drive Rod

A rod by means of which motion is transmitted from the throw bar to the points.

Lock Rod

A rod by means of which motion is transmitted from the points to the lock slides.

Detector Rods

Rods by means of which motion is transmitted from the point tongue to the detector slides.

Detector

A device for proving that the points and/or lock bolt are in the correct position.

Time of Operation

The time required to open the detector contacts, unlock, move and relock the points and to close the detector contacts.

Clutch Slip Current

The current which flows in the motor circuit when an obstruction is placed between the switch and stock rail whilst the points are operated.

Right Hand Operation

The operation of a point machine which fixed to the right hand side of the track as seen when facing the points.

Left Hand Operation

The operation of a point machine which is fixed to left hand side of the track as seen when facing the points.

Rated Voltage

The value of the voltage marked on the motor and intended to be applied to its terminals, and upon which is based the performance of a machine complying with its standard.

Snubbing Device

A device employed in addition to the clutch to minimise the physical shock of stopping the machine at the end of its stroke.

Clutch Mechanism

Spring adjustable friction discs provided to avoid overloading the point machine if point movement is obstructed.

Cut-Off Contacts (Normal to Reverse and Reverse to Normal)

Contacts which are operated with the point movement to provide a cut-off of power to the point motor at the end of the point movement, and to reverse the connection for the next movement of the points. They also provide the facility to restore the points if movement is obstructed. Both sets of contacts (N to R and R to N are 'made' during point movement).

Detection Contacts

Contacts provided to detect the position of each switch rail and lock plunger when final movement is completed.

Snubbing Contacts

Contacts which are operated with point movement to provide a feed to the snubbing circuit when the points have completed their movement.

Crank Handle

A means of hand cranking the point machine to operate the points in an emergency, or during testing. Contacts are provided to isolate the motor connections when the crank handle is inserted.

OVERLOAD PROTECTION.

If the points are obstructed during their movement the motor would continue to run on the clutch. This is obviously not desirable in that if it were not noticed immediately the motor could burn out.

The W J R is used to disconnect the supply to the contactor relay should the points become obstructed.

A de-energised contact of the W J R is in the N W R and R W R circuit.

The W J R is normally down and is controlled via N L R and R L R front contacts and N K R and R K R back contacts. It is a slow to pick relay.

When the points are operated a voltage is applied to the W J R, the relay will only pick after a period of 7 - 9 seconds has elapsed.

During this period the points should have completed their movement and detection obtained, cutting the feed to the W J R.

Should detection not be obtained within this time, the motor would run on the clutch until the W J R energised, de-energising the W R thus disconnecting the supply to the motor.

POINT MACHINES - GENERAL CONSTRUCTION

Machine

The machine shall be so constructed that at any position during operation it may be stopped, reversed or obstructed without damage.
The pole-changing contacts in the machine shall be such as to enable the direction of working of the machine to be changed at any part of its stroke. It will not complete its operation until the locking mechanism has completed its function.

No movement of the mechanism shall result from external forces applied to the mechanical connections.

The machine shall be suitable for either right-hand or left-hand operation, and shall be so constructed that it can readily be converted on site from right-hand to left-hand operation and vice versa.

If the detector forms an integral part of the machine it shall be provided with suitable contacts for proving when the detector slides and lock bar are in their full normal and reverse positions.

When in the locked position the machine shall be capable of withstanding a total thrust of 20,000 lb. from the switch through the connections, thus ensuring that, in the event of a run through, the damage is confined to the connections between the machine and the points.

All contact springs shall be corrosion-resisting and of sufficient strength and current carrying capacity to function satisfactorily in their respective circuits.

The motor cut-off contacts shall be housed in the mechanism case.

The machine shall be capable of being operated by the use of a crank handle. A contact shall be provided which, before the crank handle can be engaged to operate the mechanism, shall be automatically opened to disconnect the motor circuit. This circuit shall not be capable of being re-connected until the crank handle has been withdrawn from the machine.

It shall only be possible to re-set the crank handle contacts by manual operation once the crank handle has been withdrawn from the machine.

The machine shall be capable of operating between the limits of 75 per cent and 125 per cent of the appropriate rated voltage.

Motor

This is to be suitable for operation from a secondary cell battery floated on a constant potential charger at 130 volts maximum, and for operation by a full wave rectifier A.C. supply of up to 120 volts mean value.

Detection

Contacts to indicate that the closed switch is correctly normal or reverse and locked and that the open switch is in the correct position. Provision to be made for double cutting of the detection circuit.

L.M.S. STYLE 163 POINT MACHINE

General

The Style 163 Point machine may be situated in either right-hand (R.H.) or left-hand (L.H.) locations.

In a R.H. location the machine is situated on the R.H. side of the track, when the points are viewed in the facing direction. Conversely, a L.H. location is one where the machine is on the L.H. side of the track, viewed in the facing direction. Machines are normally supplied for L.H. mounting unless specifically requested for R.H. mounting. There are, however, no mechanical differences between machines for R.H. and L.H. locations. The throwbar and lock blades have drop lugs which can be fitted to either end of their respective members. The detector blades can be withdrawn and replaced from the opposite side of the machine.

The external electrical connections may be made so that either the L.H. or the R.H. point tongue is normally closed. R.H. point tongue is closed by clockwise rotation of the motor, viewed from the terminal block end.

1. Preparation and Mounting of the Machine

a) Ensure that the sleepers which are to support the machine are level and that the surrounding ballast is well tamped down to prevent sinkage during the passage of a train.

b) Lay the machine in in its correct position on the timbers, i.e. the centre line of the machine is to be 3' 3" from the running edge of the adjacent rail. In the other plane the wide pair of foot fixing bolts, i.e. those at 1' 7" pitch, should be 1/4" back from the centre line of the first chair, when viewed from the facing direction.

NOTE: It is essential that an extended sole plate is fitted, this will avoid machine movement relative to the track and lock fouling.

At the motor end of the machine select that a pair of fixing holes which are nearest to the sleeper centre line, mark off and drill, then fit 3/4" dia. by 5" coach screws. 3/4" dia through bolts are recommended for clamping the machine at the sole plate end. After final clamping of the machine has been carried out recheck that the mounting dimensions have been maintained.

2. Incoming Cable and Wire Form

Before proceeding with connecting the lockblades, the detector blades and throwbar, it is advisable at this stage to make up the incoming cable form.

3. Point Throw Setting

Connect up the drive rod lug and associated insulating washers, tightening up the 3/4" Hex. bolt and 5/8" B.S.W. bolts securing the throwbar lug. Philidas nuts should be fitted to the bushes, etc.

Hand crank the machine to one end of its stroke (the lockblade may have to be operated by hand at this stage to allow the lock to enter properly).

Adjust the slipping connection at the points so that the closed switch tongue is just in contact with its stock rail. Tighten the slipping connection a further 1/16" (1·59mm) MAXIMUM to impart a "pinching" action to the switch tongue. Tighten the slipping connection lock nut.

Hand crank the machine to the opposite end of stroke and repeat this setting for the other switch.

IMPORTANT NOTE: It is essential that high pinching loads are not placed on the machine in order to overcome badly fitting switch tongues, especially from chamferred and undercut switches. Comparing the Style 63 Point Machine with other Point Machines, the hand crank action is considerably lighter and due allowance must be made for this when setting the point throw pinch. Excessive point pinch can be observed in two ways:-

a) Due to high load imparted, the slipping connection will twist and a distinct deflection of the drive stretcher can be observed. This, of course, should not be allowed to remain.

b) When cranking by hand, a positive metallic click can be heard accompanied by an immediate drop in effort required to operate the hand crank. Both of these effects should be eleiminated by releasing the point pinch, as this will round off the lock corners.

Recheck the securing bolts are fully tightened and that the nuts used are of the Philidas type. (i.e. self locking).

4. Detection Setting

When setting up the detection contacts of the Point Machine a set procedure must be followed to ensure correct adjustment.

All movements of the point machine to enable setting and testing must be made by use of the crank handle.

a) First set the point switch blades to fit snugly to the stock rail, as described in the previous paragraph.

b) Set the lock and detector slides to the guide lines marked on the lock and detector blades. (The guide lines are set to the inside planed edge of the machine).

c) At the lock stretcher rod adjusting screw (which is positioned in the centre of the track), turn back the nuts, from the fully tightened position, approximately 6mm (1/4") either side.

d) Place the 5mm end of the F.P checking gauge between the switch and the stock rail, opposite the bolt securing the first slide chair, and close the switch onto the gauge to hold it in position.

e) Lock the points by manipulating the lock slide to allow the lock dog to enter the lock notch.

f) Adjust the relevant detector slide until the detector contacts just break.

g) Remove the 5mm gauge from between the switch and stock rail and replace it with the 3·5mm end of the gauge. The contacts should just make.

To adjust the setting of the detection for the opposite switch repeat sections d, e, f and g. above.

Read All

h) Tighten all check nuts.

j) This completes the detection setting.

5. Lock Setting:

Because, during the adjustment of the point detection, the lock rod adjusting nuts were loosened to facilitate lock operation, a Facing Point Test must now be carried out.

a) Place the 1•5mm gauge between the switch and stock rail, at a point opposite the bolt securing the first slide chair of the appropriate switch. (This is determined by observing which closed switch will be locked by the lock blade connected to the lock rod via the drop lug.

b) Using the crank handle, turn it until the switch grips the gauge and the lock dog enters the lock notch. Observe that the machine travels its full stroke.

c) At the centre of the switches, where the lock rod adjusting nuts have been left loosened, pull the rod up to the lock face of the lock notch, (On the W.B.S Style M63 machine the lock rod is pulled away from the closed switch). Tighten the two lock adjusting nuts by first tightening the nut nearest to the closed switch.

d) Remove the 1•5mm gauge and replace it with a 3•5mm gauge, the points should not lock and the machine should not complete its stroke.

e) Remove the 3•5mm gauge and observe that when the points are operated, using the crank handle, to the position which has just been adjusted to the gauges, that the lock does not catch the lock notch face.

(Should this happen, wear takes place on the lock dog and the face of the lock notch which must be avoided).

f) The opposite switch is now adjusted by placing the 1•5mm gauge between the switch and stock rail at a point opposite the bolt securing the first slide chair. Crank the points until the gauge is held and the points have fully completed their stroke and the lock dog has entered the lock notch.

g) Loosen the nuts at either end of the split lock blade and push the free blade away from the closed switch until it hits against the lock face. Tighten the nuts at either end of the split lock blade by tightening the nut nearest the switch first.

h) Remove the 1•5mm gauge and replace it with a 3•5mm gauge placed in the same position between the switch and stock rail. The points should not lock, and the machine should not complete its stroke.

j) Remove the 3•5 gauge and observe that when the points are operated by the crank handle, to the position which has just been adjusted to the gauges, that the lock dog does not catch the lock notch face.

k) The Facing Point Lock Test has now been completed.

A.E.I.HW 1000 POINT MACHINE

General

As with the WBS Style M63 Point Machine, the machine may be fitted either on the right-hand or left-hand side of the track.

Standard point fittings are used throughout the installation.

Preparation and mounting of the machine are also as for the Style M63 machine.

1. Point Throw Setting

Connect up the rod lug and assiciated insulating washers, tightening up the 3/4" Hex. bolt and 5/8" B.S.W. bolts securing the throwbar lug.

Philidas nuts should be fitted to the basket coupling, etc.

Hand crank the machine to one end of its stroke (the lockblade may have to be operated by hand at this stage to enable proper adjustment of the switch blades).

Adjust the slipping connection at the points so that the closed switch tongue is just in contact with the stock rail. Tighten the slipping connection a further 1/16" (1.59mm) MAXIMUM to impart a "pinching" action to the switch tongue. Tighten the slipping connection lock nut.

Hand crank the machine to the opposite end of stroke and repeat this setting for the other switch.

2. Detection Setting

Adjust the lock and detector blades so that the Guide lines on the blades are in line with planed edge of the machine with the points Normal and Reverse respectively. (Adjustment is made, in the case of detection, at the detector blade end. The lock can be adjusted at the Lock stretcher and the lock blade end).

When adjustment is being made to the lock, the blade relating to the far switch must be adjusted first. The screw at the Lock stretcher end should be set central, the blade adjusted at the blade end to line up the guide marks with the box. The points should then be operated to the opposite position and the other lock blade adjusted at the blade coupling to line up the other guide line.

The points should now be tried, using the crank handle, both Normal and Reverse positions.

It is at this stage that the detection must be adjusted using the Facing Point Test Gauge. To do this the lock must be positioned so as not to foul the lock notches in the respective Normal and Reverse positions. This is acheived by loosening the nuts on the Facing point detector rod connection to the lock stretcher back to give 5mm clearance of the lock detector rod in both directions.

Position the points Normal with the 3 mm Gauge in a position between the switch and stock rail opposite the bolt securing the first slide chair. The Facing point lock detector rod will have to be operated by hand to allow the [illegible] lock.

Adjust the detection contacts to make, then backlash to just break.

Operate the points sufficiently to change the gauge to the 3.5mm gauge, close and lock the switch once more in the Normal position and check that the detector contacts are now made. If the setting is not correct, adjustment must be made at the detector blade.

It may be necessary to repeat this operation several times to obtain correct setting.

AU

Operate the points to the Reverse position with the 5mm gauge between the switch and stock rail in the correct position. The lock will, again, need to be operated by hand to allow the point machine to complete its movement.

Adjust the detection contacts to make, then re-adjust to just break.

As with the Normal switch, operate the points sufficiently to change to the 3•5mm gauge, close and lock the switch once more in the Reverse position and check that the detector contacts are now made. If the setting is not correct, adjustment must be made at the detector blade.

It may be necessary to repeat this operation several times to obtain the correct setting.

3. Lock Adjustment

The lock must so adjusted and maintained that with a 3•5mm gauge inserted between the switch and stock rail at a point opposite the bolt securing the first slide chair, the lock dog must not enter the lock notch in the lock blade for both closed positions of the points.

With a 1•5mm gauge so inserted, the lock dog should just enter the lock notch without interference.

Procedure

a) Crank the machine to close the far switch (the switch farthest away from the point machine), with the 1•5mm gauge inserted between the switch and stock rail. Ensure that the lock has entered the lock notch and the has fully travelled.

b) Pull the lock detector rod away from the closed switch until the lock slide is felt to come into contact with the lock notch. Screw up the nut furthest from the point switch until there is no free play in the rod movement. Tighten the check nut to ensure security.

c) Open the points to allow for changing of the 1•5mm gauge to the 3•5mm gauge. The points should not lock.

d) Try the points again ensuring that with the 1•5mm gauge in place the points will lock and with the 3•5mm gauge in place they will not lock.

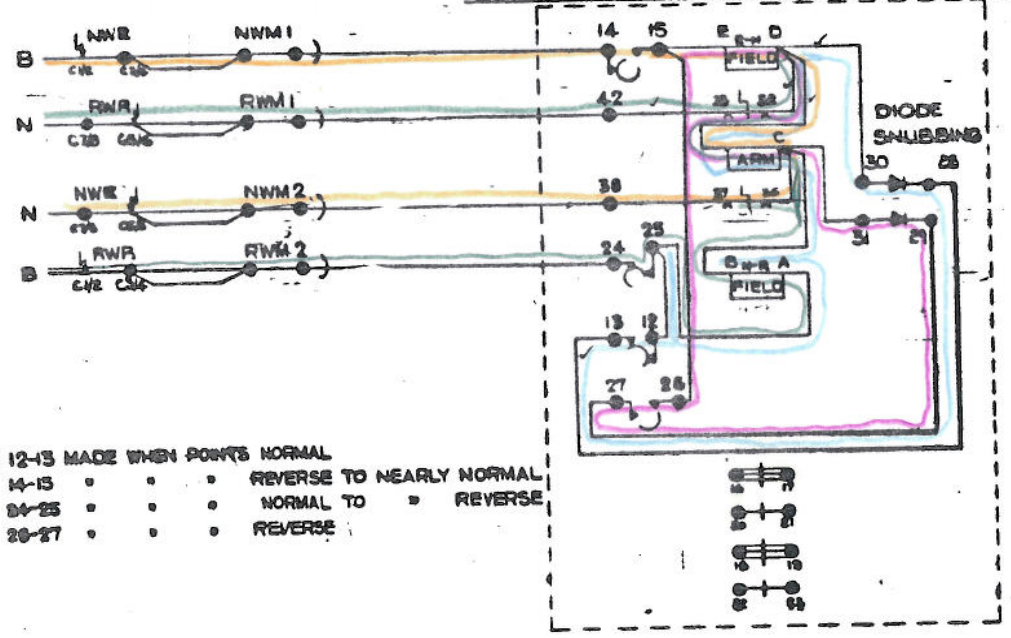
e) Move the points over, positioning the 1•5mm gauge in the opposite side switch. On the lock blade coupling tighten the remaining loose nut, the one furthest from the closed switch, until the pressure of the lock blade is just felt. Tighten the check nut to ensure security.

f) Move the points sufficient to change the gauge to the 3•5mm gauge. With the 3•5mm gauge in the points the lock must not enter the lock notch.

g) Try the points again ensuring that with the 1•5mm gauge in place the points will lock and with the 3•5mm gauge in place they will not lock.

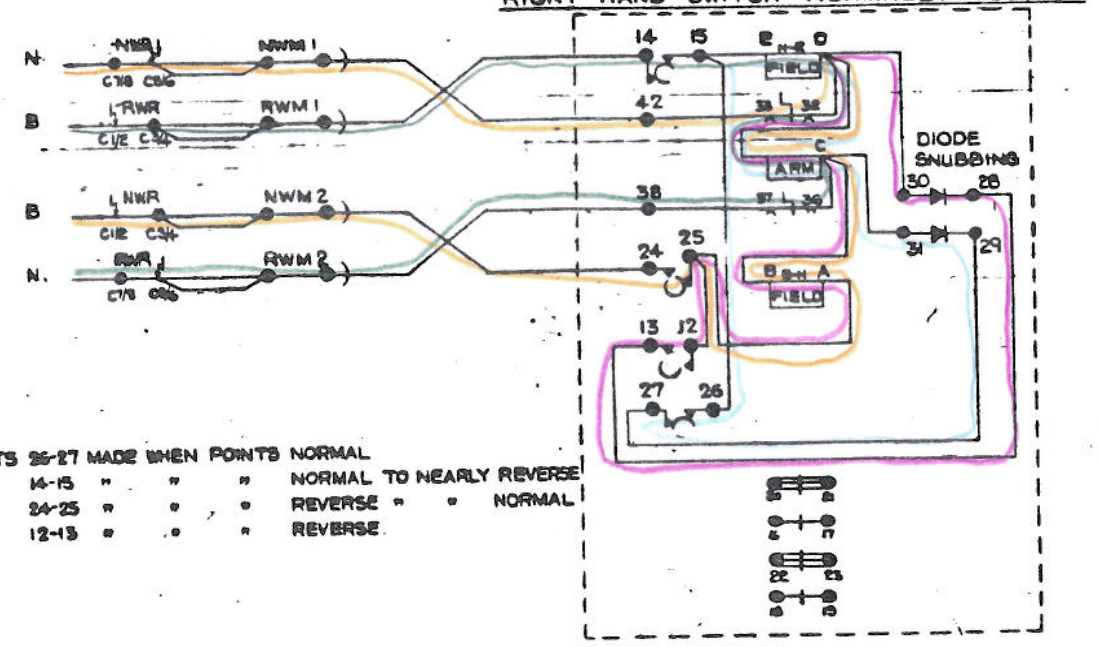
h) Remove the gauges, and with the crank handle removed, have the points operated with the power on to the Normal and Reverse positions, checking that the points lock and detect.

LEFT HAND SWITCH NORMALLY CLOSED



CONTACTS 12-13 MADE WHEN POINTS NORMAL
" 14-15 " " " REVERSE TO NEARLY NORMAL
" 24-25 " " " NORMAL TO " REVERSE
" 26-27 " " " REVERSE

RIGHT HAND SWITCH NORMALLY CLOSED



CONTACTS 26-27 MADE WHEN POINTS NORMAL
" 14-15 " " " NORMAL TO NEARLY REVERSE
" 24-25 " " " REVERSE " " NORMAL
" 12-13 " " " REVERSE

If diode & goes fuse will blow
31-29 R to N
30-28 N to R

CONTACTS MOVE IN A CLOCKWISE DIRECTION FOR MOVEMENT N→R
CONTACTS MOVE IN A ANTI-CLOCKWISE DIRECTION FOR MOVEMENT R→N.

WEIGHT OF MACHINE :- 650 LBS (294 KG)

CONSTANT LOAD AT THROW BAR	STARTING SURGE CURRENT	DRIVING CURRENT
500 LB.	15A	3A.
750 LB.	15A	5A
1200 LB.	15A	8A

SEE DRG 74-YS-600/7 FOR CONTROL & DETECTION CIRCUITS.

A	FEB 8.	JH	Drawn	SB / M.R	Corr.	ST 5845	British Rail. E.R. Chief Signal and Telecommunications Engineer
DIODE SNUBBING & SECOND E-HC PROVIDED.			Checked	GB	Auth.		WBS STYLE 63 POINT MACHINE (110V) (4 WIRE CONTROL)
			Approved	G.W.H.	Date	8-8-74	
			FOR CHIEF Signal and Telecommunications Engineer				

British Rail

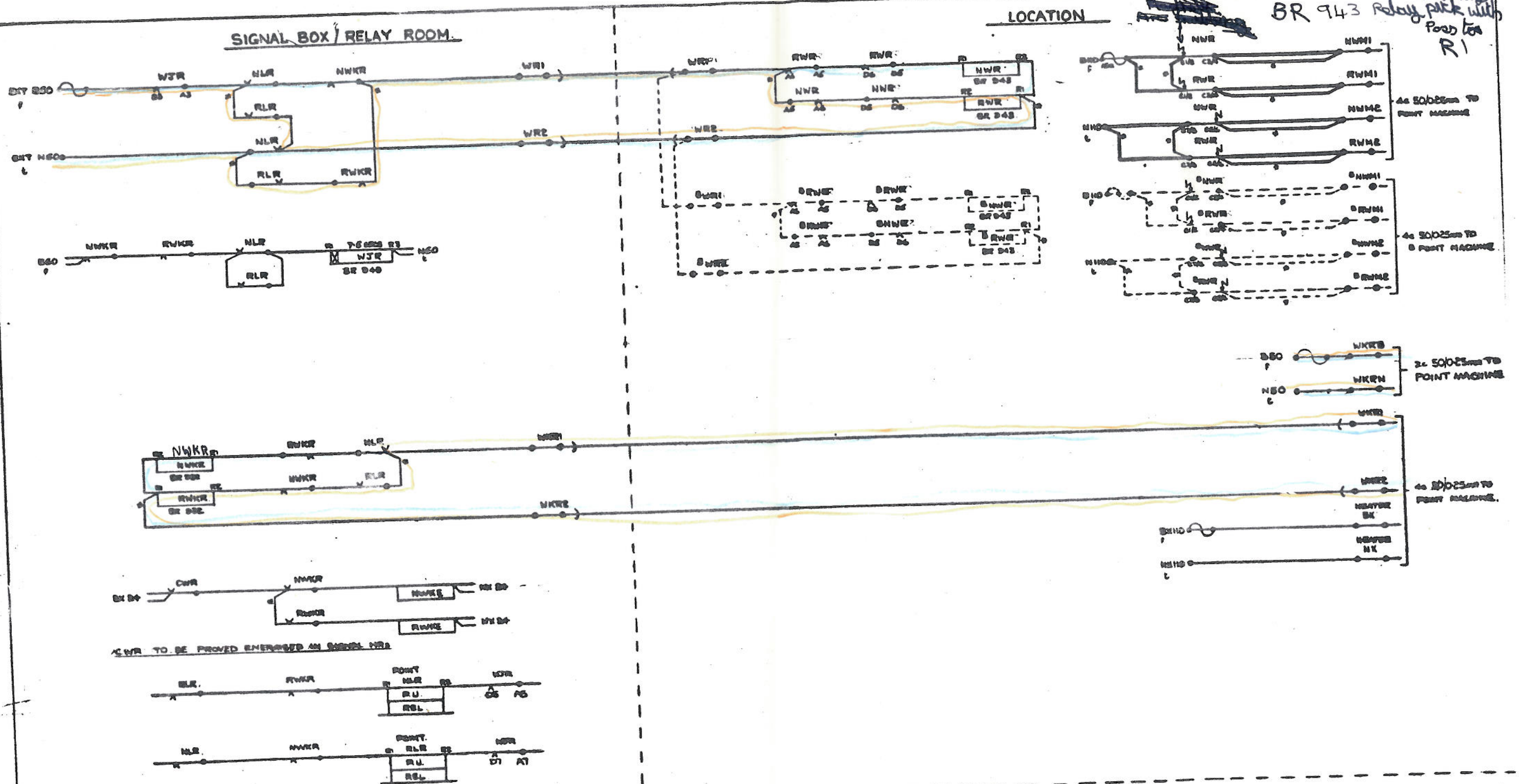
No. 74-YS-600/10 A

Magnetic Arc blowout

LOCATION

SIGNAL BOX / RELAY ROOM.

BR 943 Relay pack with Pegs for R1 will only



FOR LEVER FRAME - CIRCUITS AS ABOVE EXCEPT :-
NLR & RLR CONTACTS REPLACED BY (A) & (B) LEVER BANKS.

—— WIRING TO BE 3/0.30 mm
—— WIRING TO BE 16/0.20 mm
---- CIRCUITS FOR SECOND POINT MACHINE.

RELAYS
BR 250 12F 4B
BR 932 12F 4B.
BR 943 2F (HD) 4B.
BR 949. 1F 3B

SEE DRG 74-YD-900/5 FOR CONTROL CIRCUITS FOR 940 240 50V POINT MACHINE.

C	MARCH 75	B	FEB 75	A	JULY 74	Drawn		Corr.	ST. 5540
BR 932 BF 4B REPLACED BY 12F 4B. WWR CONTACTS IN N/RLR CCT MOVED TO N SIDE OF COILS.		CWR RE-INSTATED. WRs DE-ENERGISED IN CWR CIRCUIT.		CWR REMOVED. WR's DE-ENERGISED IN WWR CIRCUIT. WWR CIRCUIT MODIFIED.		Checked	GB	Auth.	
						Approved	G.W.H	Date	8-1-74

FOR CHIEF Signal and Telecommunications Engineer

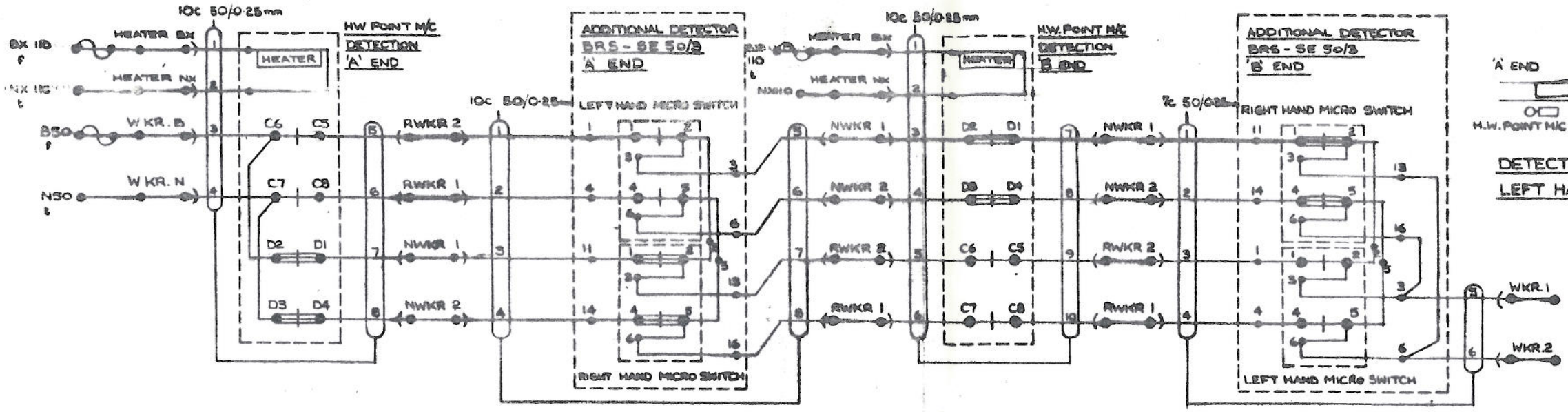
British Rail. E.R.
Chief Signal and Telecommunications Engineer

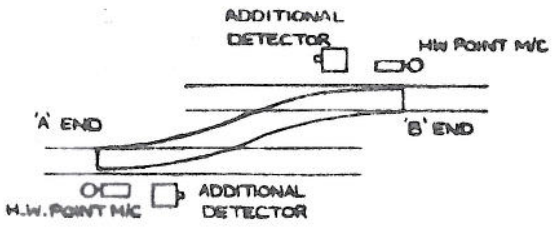
British Rail

CONTROL & DETECTION CIRCUITS FOR POINT MACHINES

No. 74-YD-900/7

A B C

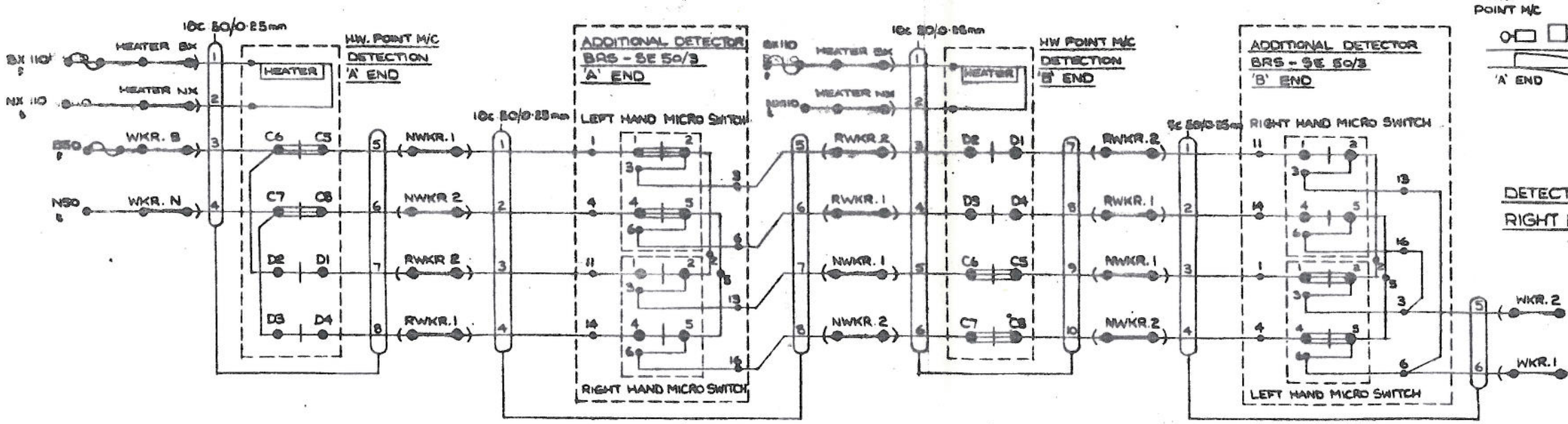


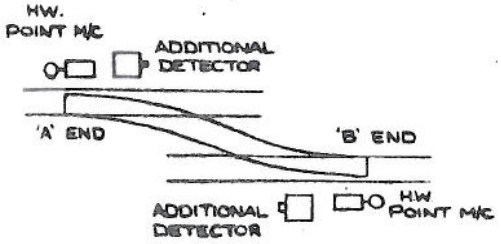


DETECTION CIRCUIT (DOUBLE END)
LEFT HAND SWITCH NORMALLY CLOSED

ADDITIONAL DETECTOR CONTACTS

CONTACTS 1-2, 4-5 OF RIGHT HAND MICRO SWITCH AND 2-3, 5-6 OF LEFT HAND MICRO SWITCH MAKE WHEN POINTS ARE LEFT HAND NORMALLY CLOSED.





DETECTION CIRCUIT (DOUBLE END)
RIGHT HAND SWITCH NORMALLY CLOSED

ADDITIONAL DETECTOR CONTACTS

CONTACTS 1-2 4-5 OF LEFT HAND MICRO SWITCH AND 2-3, 5-6 OF RIGHT HAND MICRO SWITCH MAKE WHEN POINTS ARE RIGHT HAND NORMALLY CLOSED.

Revisions	A	JAN 81
CABLES CHANGED.		

DRAWN	J. D. M.	CHECKED	D R B
	29-4-77		

Eastern Region
Chief Signal and Telecommunications Engineer

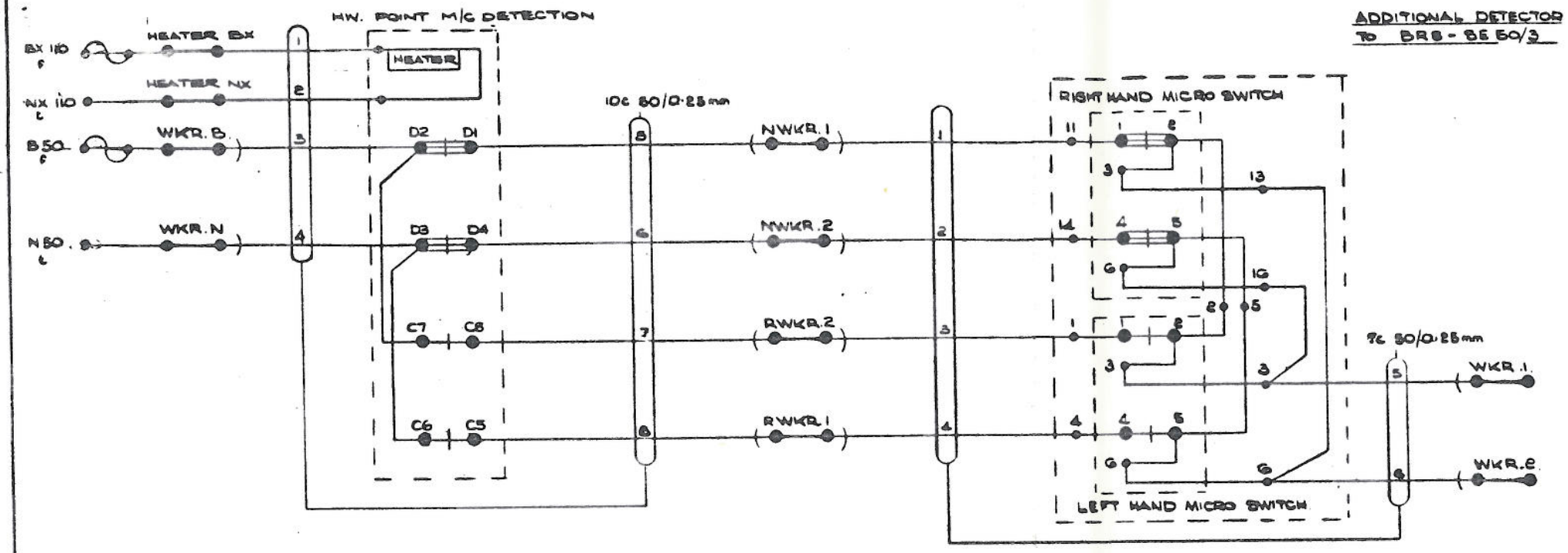
TYPICAL CIRCUIT FOR ADDITIONAL DETECTORS USED ON LONG SWITCHES (DOUBLE END)

British Rail

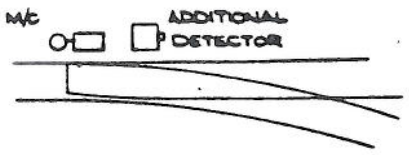
for Chief S & T Engineer

No. 74-YS-500/23

A

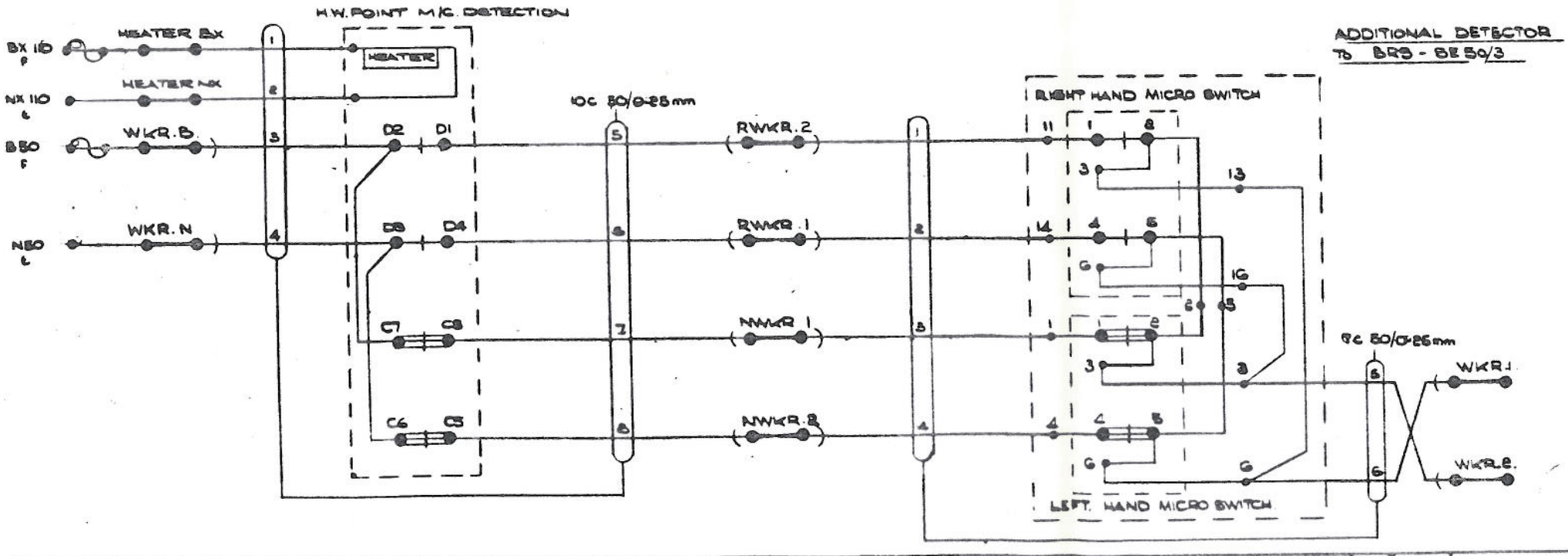


ADDITIONAL DETECTOR TO BR8 - BE 50/3

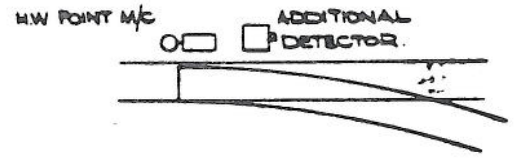


DETECTION CIRCUIT (SINGLE END)
LEFT HAND SWITCH NORMALLY CLOSED

NOTE :- ADDITIONAL DETECTOR CONTACTS
CONTACTS 1-2, 4-5 OF RIGHT HAND MICRO SWITCH AND 2-3, 5-6 OF LEFT HAND MICRO SWITCH MAKE WHEN POINTS ARE LEFT HAND NORMALLY CLOSED.



ADDITIONAL DETECTOR TO BR3 - BE 50/3



DETECTION CIRCUIT (SINGLE END)
RIGHT HAND SWITCH NORMALLY CLOSED

NOTE :- ADDITIONAL DETECTOR CONTACTS
CONTACTS 1-2, 4-5 OF LEFT HAND MICRO SWITCH AND 2-3, 5-6 OF RIGHT HAND MICRO SWITCH MAKE WHEN POINTS ARE RIGHT HAND NORMALLY CLOSED

A	JAN 81	Drawn		Corr.	
CABLES CHANGED.		Checked		Auth.	
		Approved		Date	

For Chief Signal and Telecommunications Engineer

British Rail. E.R.
Chief Signal and Telecommunications Engineer

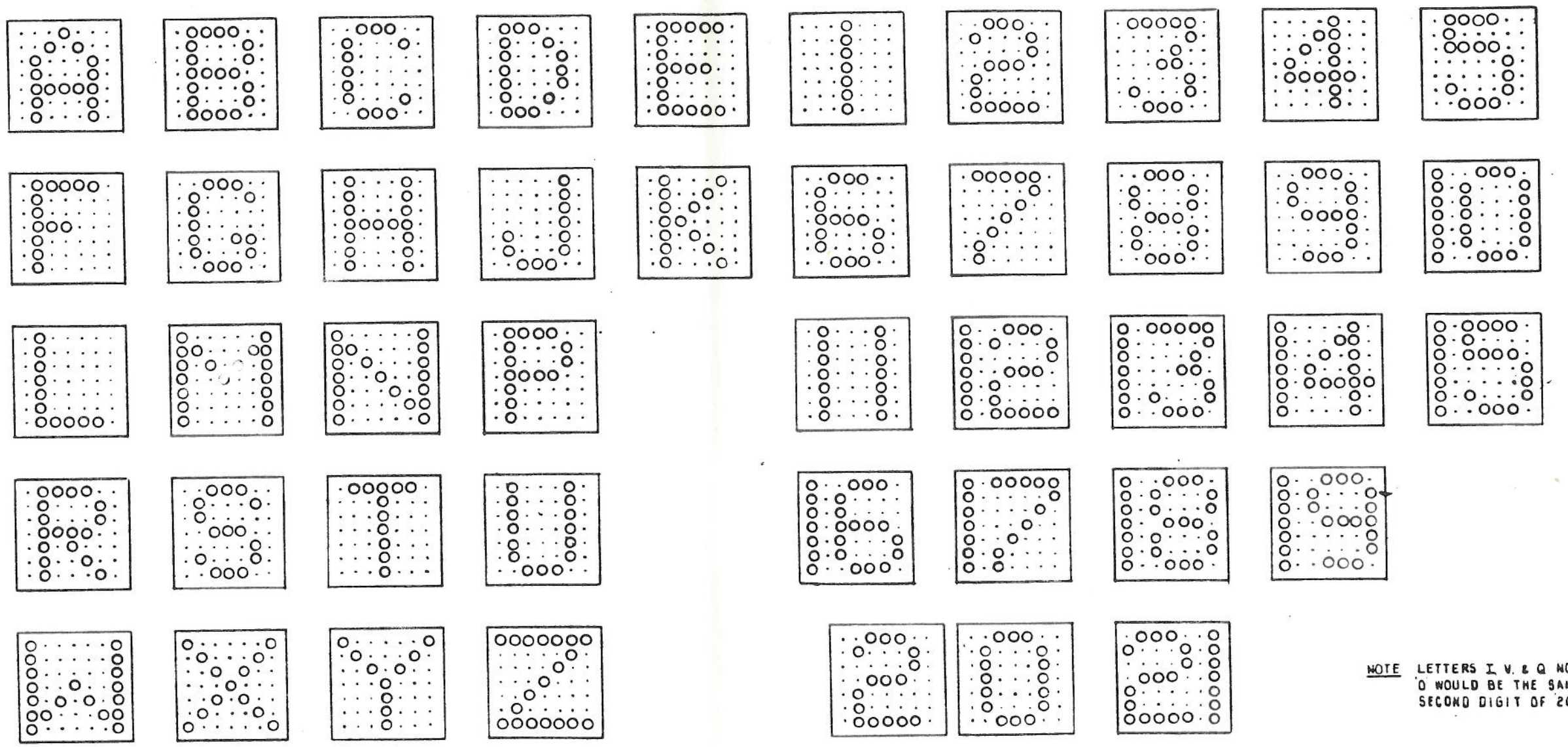
TYPICAL CIRCUIT FOR ADDITIONAL DETECTORS USED ON LONG SWITCHES (SINGLE END)

British Rail

for C.S.&T.E.

No. 74-YS-500/24

A



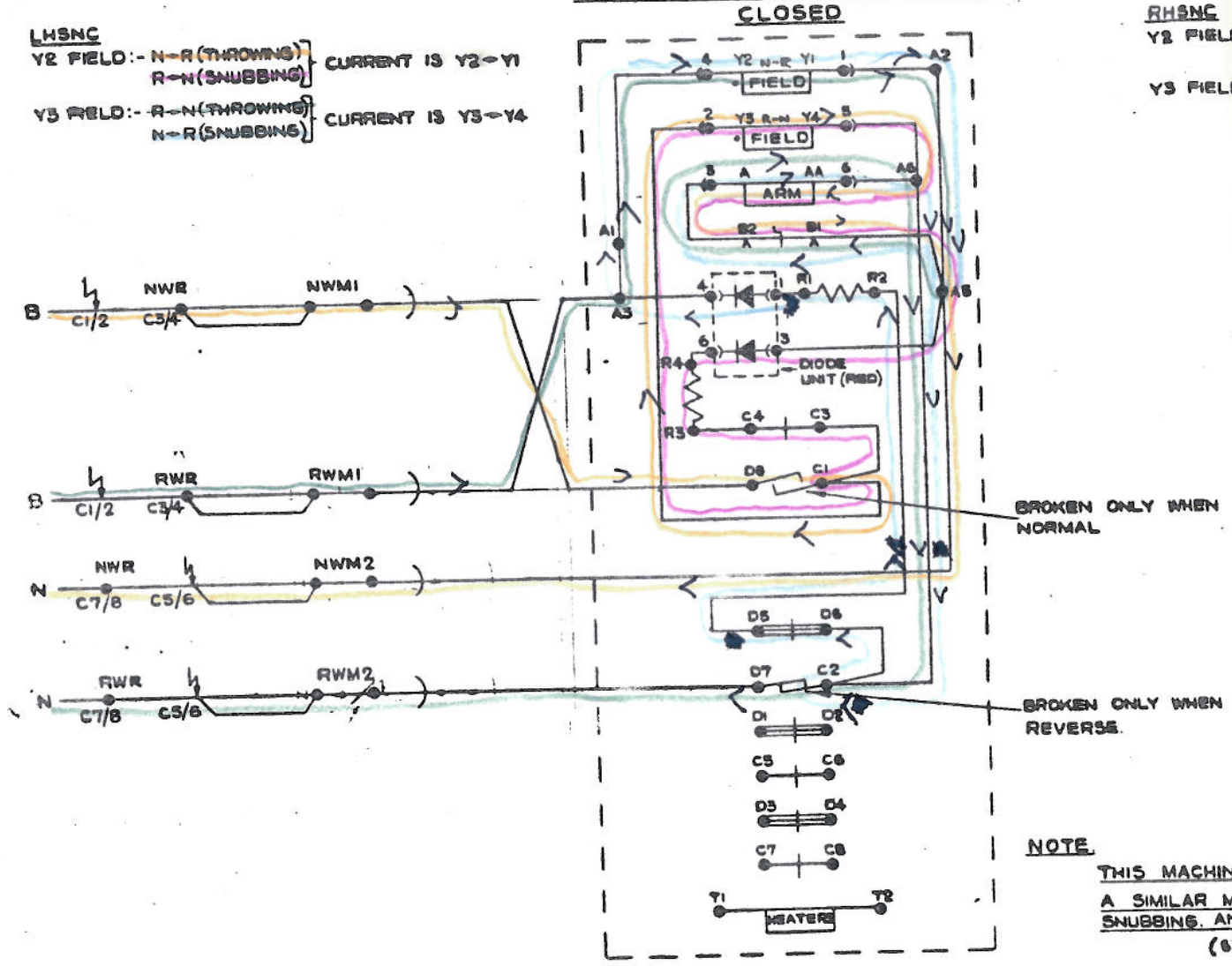
NOTE LETTERS I, V, & Q NOT TO BE USED.
O WOULD BE THE SAME AS FOR THE SECOND DIGIT OF 20

Revisions		Eastern Region Chief Signal and Telecommunications Engineer	British Ra
		MULTI - LAMP ROUTE INDICATORS STANDARD CHARACTERS	Chief S & T En
	HKB 26·6·77		No 74-YS-500/26

Switching N-R atm A B2 A5 3 B. R4 C4 C1 R-N Field A6 AA
" R-N AA A6 C2 D6 R2 1 4 A3 N-R Field A2 A5 B2 A

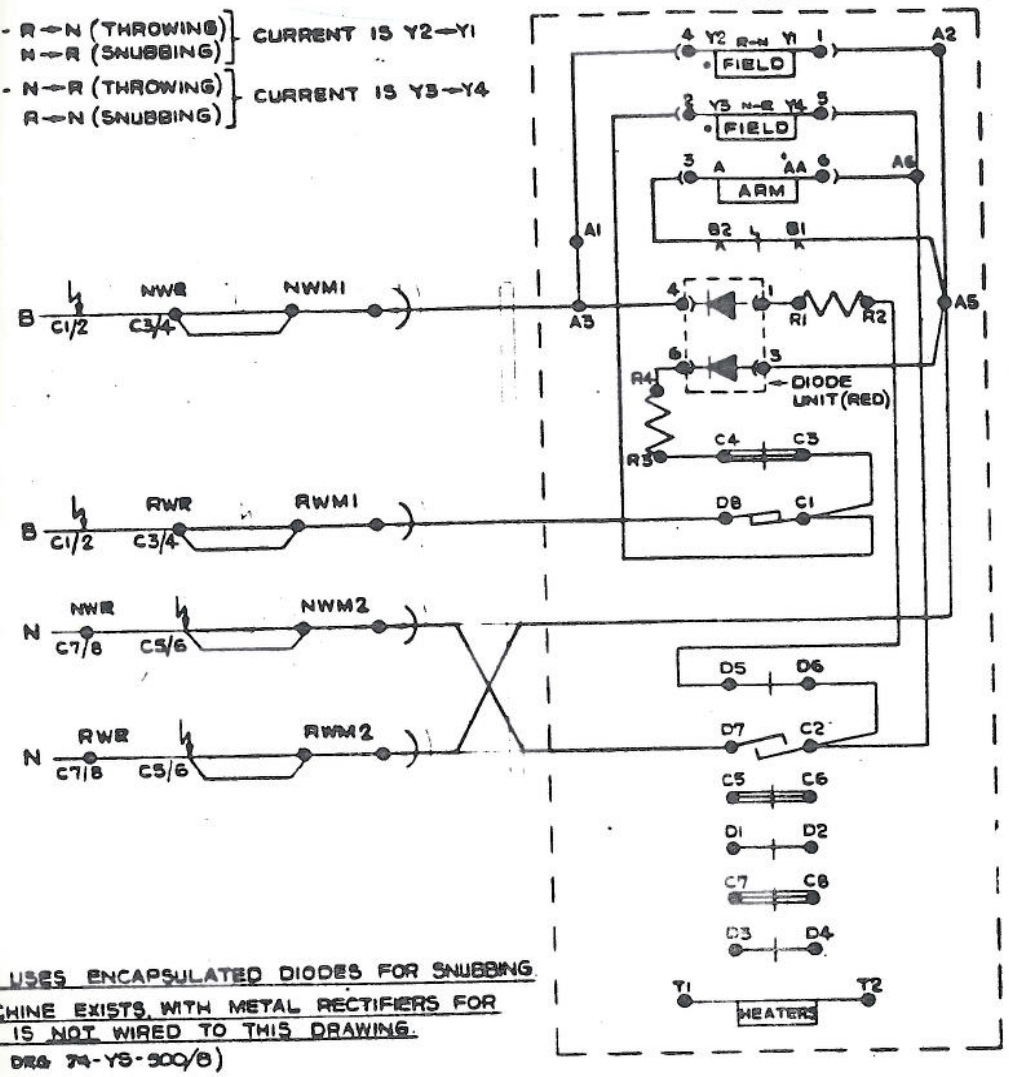
LEFT HAND SWITCH NORMALLY CLOSED

LHSNC
Y2 FIELD :- N→R (THROWING) / R→N (SNUBBING) } CURRENT IS Y2→Y1
Y3 FIELD :- R→N (THROWING) / N→R (SNUBBING) } CURRENT IS Y3→Y4



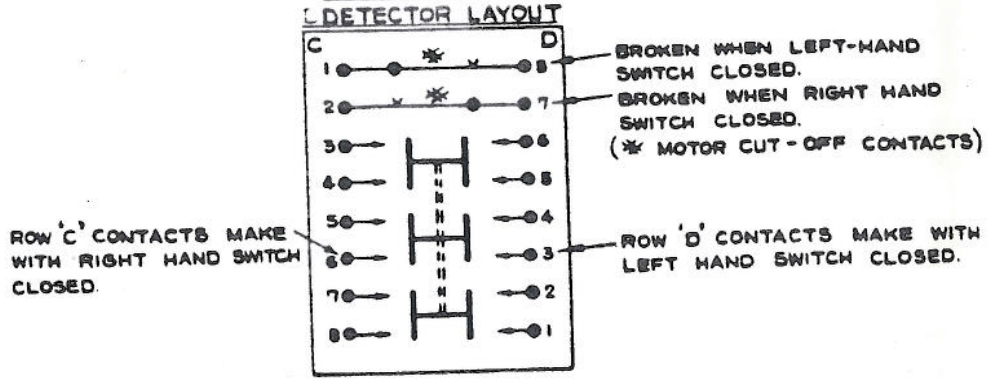
RIGHT HAND SWITCH NORMALLY CLOSED

RHSNC
Y2 FIELD :- R→N (THROWING) / N→R (SNUBBING) } CURRENT IS Y2→Y1
Y3 FIELD :- N→R (THROWING) / R→N (SNUBBING) } CURRENT IS Y3→Y4



NOTE.
THIS MACHINE USES ENCAPSULATED DIODES FOR SNUBBING
A SIMILAR MACHINE EXISTS, WITH METAL RECTIFIERS FOR SNUBBING, AND IS NOT WIRED TO THIS DRAWING.
(SEE DRG 74-YS-300/8)

PLAN VIEW OF DETECTOR LAYOUT



IN ALL CASES THE FLUX DUE TO THE FIELDS IS IN THE SAME DIRECTION.

+VE SHOULD ALWAYS CONNECT TO D8
−VE SHOULD ALWAYS CONNECT TO D7

+VE ON D8 CLOSES LEFT HAND SWITCH
−VE ON D7 CLOSES RIGHT HAND SWITCH

NEVER TEST WITH POWER UNLESS DETECTION IS CORRECTLY ADJUSTED.

(SEE 74-YS-500/8) FOR FURTHER DETAILS OF CONTACTS)
SEE DRG 74-YS-500/7 FOR CONTROL & DETECTION CIRCUITS
WEIGHT OF MACHINE 485 LBS. (220 KG)

DRAWN	MR	CORR.	ST 5040	British Rail E.R. Chief Signal and Telecommunications Engineer	British Rail
CHECKED	RG	AUTH.			
APPROVED	G.W.H	DATE	2-6-72	GEC-GS STYLE HW1101 (NON-IMMUNE) DC	–
FOR CHIEF SIGNAL AND TELECOMMUNICATIONS ENGINEER				POINT MACHINE (30-110V) (WITH ENCAPSULATED DIODES FOR SNUBBING)	No. 74-YS-300/9

BRITISH RAILWAYS

Signal & Telecommunications
Engineering Department

SIGNALLING MAINTENANCE SPECIFICATION

Vol. 2
No. PC41
Date. 07/84
Page 01
Issue 01

POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

0.1 Reference should also be made to the following specifications:—

PA11. POINTS. Joint S & T/CE Checks
PA21. POINTS. Facing Point Lock Test
PA31. POINTS. Detection Test
PA51. POINTS. Fittings

0.2 The machine should not be operated electrically until any adjustments made have been verified by operation with the crank handle to ensure that the machine is operating without undue strain on any of its parts.

0.3 The last operation of all services is to test by operation from the signal box and to observe the apparatus functions correctly.

Service A

Exterior

1.1 Clean and grease with lithium based grease all surfaces on lock blades, detector blades and driveslide.

1.2 Examine throw bar, lock and detector blades. Adjust and tighten where necessary.

1.3 Examine machine holding down bolts. Tighten where necessary.

1.4 Check case casting and ensure that no cracks are forming.

1.5 Remove all fire risks and potential obstructions from or near machine, e.g. oily waste, paper and ballast.

1.6 Wipe and examine side retainer plates. Tighten down screws where necessary.

1.7 Examine and oil with mineral oil cover hinges and lubricate padlock. Ensure that the cover gasket is providing a good seal between the cover and casting. Adjust hinges where necessary.

POINTS. W.B. & S.CO. STYLE 63 POINT MACHINE

Interior

1.8 Isolate motor at crank handle contact.

1.9 Examine lock blades and lock dog using crank handle. Check state of lock notches and dogs for chamfer.

1.10 Examine centrifugal snubbing switch when fitted. Check that the contacts make when the pendant is moved by hand. Continue moving the pendant gently until the outer spring is restricted by the back stop. Ensure that the pendant striker arm does not pass beyond the inner spring. Release the pendant and note that it returns correctly to the central position. Apply slight smear of silicone grease to back of snubbing contacts and pendant striker.
(Lubrication is not necessary if Nylatron rollers are fitted to pendant striker).

1.11 Wipe external surface of motor and examine holding down bolts. Tighten where necessary.

1.12 Examine all wiring and terminals. Clean and protect terminals as necessary.

1.13 Examine drive belt and check that the drive belt screws at the base of the motor are locked.

1.14 The belt should have a vertical play of 2 mm to 5 mm at the centre of its free span. To adjust if necessary, slacken off the motor fixing screws; then loosen the jacking screw locknuts and turn each jacking screw an equal amount until belt tension is correct. Tighten motor fixing screws and jacking screw locknuts. It is important to avoid over-tightening of drive belt.

1.15 Examine clutch adjustment nuts and locknuts. Tighten if necessary.

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POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

1.16 Examine detection contacts and ensure by visual examination that the reverse detection contacts are broken when the points are normal and the normal detection contacts are broken when the points are reversed also that normal and reverse detection contacts remain broken during travel.

1.17 Examine motor control and snubbing contacts and ensure that the contact surfaces are not heavily worn either by abrasion or arcing. If necessary clean or replace contacts

1.18 Examine nuts and bolts on circuit controller and check for loose wires on terminals.

1.19 Examine detection rocker arm and ensure that circlip on centre pivot is intact and correctly positioned.

1.20 Examine cable entry and ensure cable is not chafing, that there is no obstruction to the detection blades. Check drain holes are not blocked.

1.21 Examine plummer block, driveslide, drive roller, escapement crank, throw bar, lock and detection blades.

1.22 If diode snubbing is fitted and is not effective, check that the diodes/rectifiers conduct in one direction only using a meter.

1.23 Clean and grease with lithium based grease lock blades, detector blades and throw bar. (6 grease nipples and surfaces).

1.24 Clean and grease with lithium based grease driveslide. (1 grease nipple and surfaces).

1.25 Clean and grease with lithium based grease escapement crank, escapement drive rollers, throw bar drive roller and drivescrew plummer block. (4 grease nipples).

POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

1.26 Clean and grease with lithium based grease ball nut. (1 grease nipple).

1.27 Clean and grease with lithium based grease drivescrew thrust bearing (1 grease nipple).

1.28 Clean and oil with mineral oil circuit controller, camshaft bearings and cams, push rods, detection rocker arm pivot and rollers. One or two drops of mineral oil at each rubbing surface is sufficient.

1.29 Check contact fingers and terminals. Clean and protect as necessary excluding contact faces.

1.30 Check heaters where fitted.

1.31 Check lid and machine for foreign bodies.

1.32 Reset isolating contacts.

1.33 Observe correct operation of the machine before replacing lid and that the snubbing is effective. There should be no 'kick-back' on the motor.

1.34 Ensure RKB222 padlock is fitted to crank handle cover.

Service B

Exterior

2.1 Scrape, brush wash and examine machine cover and casting.

Interior (Motor should be isolated).

2.2 Clean interior of case.

POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

2.3 Examine motor commutator all round, using crank handle to turn the motor. The commutator should be a light coffee colour. Clean the commutator surface by hand cranking the machine and pressing a clean, lint-free cloth moistened with switch cleaner on to the commutator.

2.4 Examine motor brushes. The brushes should slide freely in their holders and seat fully on the commutator.

2.5 Apply lithium based grease through grease nipples (2) on motor. Care should be taken not to overfill.

2.6 Clean circuit controller contact segment surfaces using a clean lint free cloth moistened with switch cleaner.

2.7 To assist in setting the contacts, numbered positions are engraved on the driveside which can be aligned with the datum mark inscribed on the machine casing. The setting marks are situated at the ball screw end of the driveside and are accessible by removing the ball screw over. (See Appendix 'A').

2.8 Always crank the machine from mid-stroke towards the setting marks to eliminate backlash.

2.9 Ensure that the motor contacts break at driveside mark 2 and that the snubbing contacts make after mark 2 and at or before mark 3. (See Appendix 'A').

2.10 Check that the full stroke is at mark 4 (See Appendix 'A'), if not ascertain why and correct as necessary. If driveside setting is correct — adjust contacts. The above procedure should be applied to both normal and reverse operations.

POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

2.11 Using the hand crank check visually the amount of contact lift on all snubbing contacts and for slow acting circuit controller on the motor contacts. Contacts should lift 1 mm to 2 mm when the segments engage and make contact with the springs. Check that the motor contact pressures on rotating segments are 0.7 kg to 0.9 kg, using a spring balance hooked under the end of the contact finger. (See Appendix 'C'). The pressure should be noted when the contact just lifts off the surface of the segment.

2.12 On quick acting circuit controller motor contacts hand crank the machine to the mid-stroke position. The contact arm should be held back by the latch. With the contact arm in this position insert the 1 mm setting strip down in between the shorting strip and the shorting strip carrier. In this condition, the contact arm spring should be 11 mm long. Check that the moveable contacts just touch the shorting strip contacts and adjust if necessary. Remove the 1 mm setting strip.

2.13 Clean normal and reverse detection contacts with a clean, lint-free cloth moistened with switch cleaner. Using a non-metallic gauge, check that a minimum contact opening of 2 mm exists between the fixed and moving contacts during travel. Check the normal and reverse detection contact pressures are 0.7 kg to 1.1 kg at the end of stroke, using a spring balance hooked under the end of the contact finger. (See Appendix 'C'). Use a meter to indicate when contacts are just broken.

2.14 Examine that each detection push rod rests correctly in the cam recess. Test by inserting the detection setting gauge between the rocker arm roller and detection blade notch surface and ensure that each closed detection contact will just break in normal and reverse positions. (See Appendix 'B'). Ensure that push rod lock nuts are tight. If detection does not break ensure firstly that the push rod length is correct by inserting a 2 mm gauge between the associated rocker arm roller and the bottom of the detector blade notch. (See Appendix 'B').

POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

2.15 Examine that the detection rocker arm rollers are free from wear, rotate freely and drop correctly into the notched surface of the blades under spring pressure.

2.16 Examine crank handle cut out contact; ensure visually that contacts break when crank handle is inserted and contacts remake when crank handle is removed and cutout is re-set.

2.17 Restore power and check clutch slips slightly with each power operation by marking a pencil mark across the clutch plates before operating the machine and noting a small displacement. If the movement exceeds 10 mm contamination of the linings may be suspected. If the clutch is found to have no radial movement, the linings may have corroded on the clutch plates or the central bronze bush has seized on the pulley or the clutch is set too tightly.

2.18 Measure the motor operating current whilst operating the points normal to reverse and reverse to normal.

2.19 Place obstruction between point switch and stock rail and operate the points. Using the higher of the operating currents, check that the clutch slip current is 25% – 50% in excess of this figure but does not exceed 15 amps.

2.20 Note, where applicable, overload protection takes 6 to 9 seconds to operate.

2.21 If necessary adjust clutch. Remove obstruction from points.

2.22 Examine contact cam-shaft drive rack and fixing screws on driveside. Tighten as necessary.

2.23 Examine controller nylon gear wheel.

2.24 Remove the centrifugal clutch housing cover plate and underlying circlip.

POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

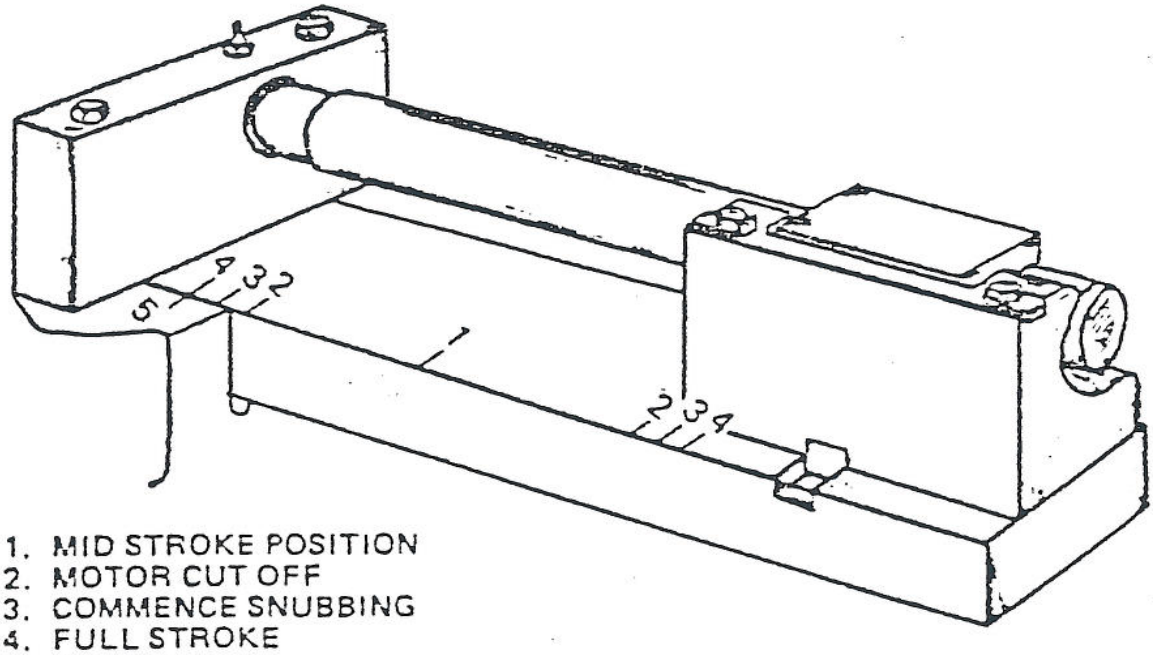
2.25 Carefully pull off the clutch housing and remove the plunger cage and plungers. Clean all parts using a clean, lint-free cloth moistened with switch cleaner. Examine plungers and clutch housing. Replace the leathers where the tip of a plunger has been rubbing on the clutch housing and replace clutch housing if it has become scored. Apply a small amount of lithium based grease to the ballrace. Re-assemble components.

2.26 Examine centrifugal snubbing switch. Ensure that the ends of the inner springs are clear of the clutch housing. The ends of the plastic striker arm should be just clear of the backs of the inner springs. The gap between each pair of carbon contacts should be 3 mm and the clearance between the back of the outer spring and its spring keeper should be 3 mm. Adjust the springs and keepers accordingly.

POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

APPENDIX A

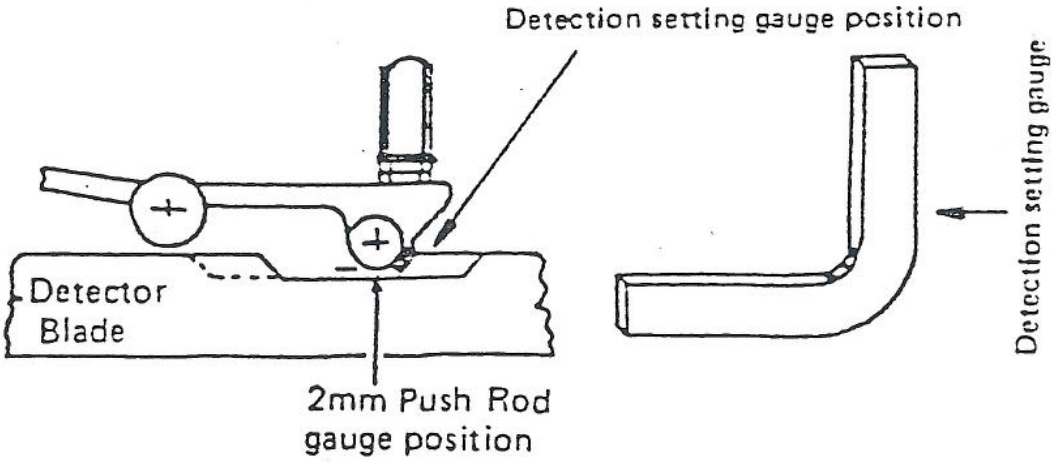
Position of Setting Marks



1. MID STROKE POSITION
2. MOTOR CUT OFF
3. COMMENCE SNUBBING
4. FULL STROKE
5. DATUM MARK

APPENDIX B

Setting Guage for Detection Operating Roller

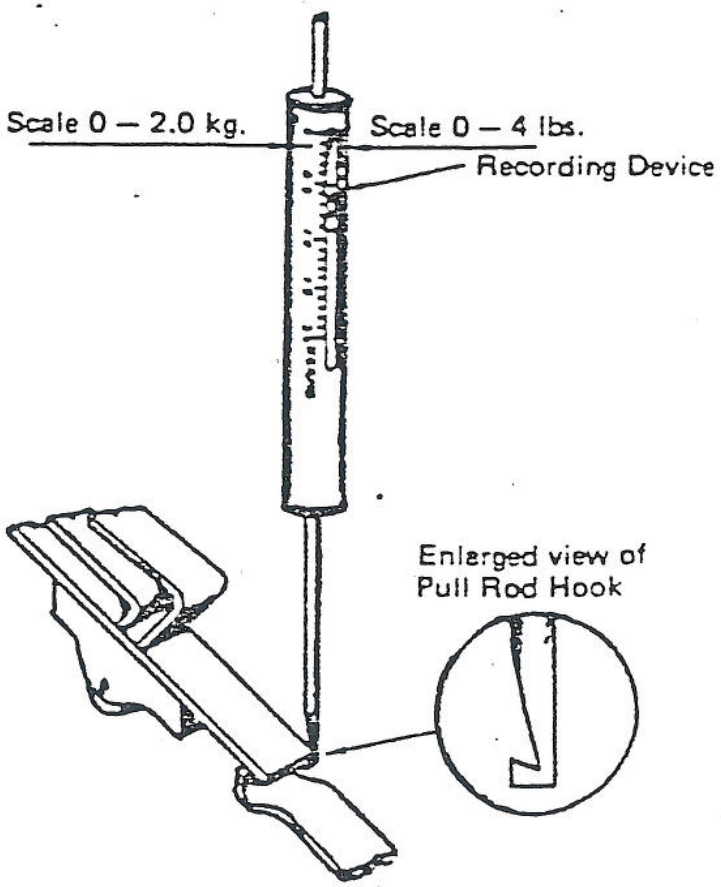


POINTS. W.B. & S. CO. STYLE 63 POINT MACHINE

APPENDIX C

Recording Spring Balance

Correct Position of
Spring Balance when
Taking Spring Pressures



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POINTS, GEC-GS, TYPES HW1000 & HW2000 POINT MACHINES

0.1 Reference should also be made to the following specifications:-

PA11 POINTS, Joints S & T/CE Checks
PA21 POINTS, Facing Point Lock Test
PA31 POINTS, Detection Test
PA51 POINTS, Fittings.

0.2 Type HW 1000 machine is fitted with a spring loaded dry plate clutch.

0.3 Type HW 2000 machine is fitted with an eletro-magnetic clutch.

0.4 The machine should not be operated electrically until any adjustments made have been verified by operation with the crank handle to ensure that the machine is operating without undue strain on any of its parts.

0.5 The last operation for all services is to test by operation from the signal box and to observe that the apparatus functions correctly.

Service A

Exterior

1.1 Clean and grease with adhesive type grease all surfaces on lock blades, detector blades and drive slide.

1.2 Examine, throw bar lock and detector slides. Adjust and tighten where necessary.

1.3 Examine machine holding down bolts. Tighten where necessary.

1.4 Check case casting and ensure that no cracks are forming.

1.5 Remove all fire risks and potential obstructions from or near machine, e.g oily waste, paper and ballast.

1.6 Examine crank handle cut-out contact cover.

POINTS, GEC-GS, TYPES HW1000 & HW2000 POINT MACHINES

1.7 Lubricate padlock

1.8 Examine hinges and lubricate with mineral oil

Interior

1.9 Isolate motor at crank handle contact.

1.10 Examine lock dog and notch using crank handle to operate machine. Check state of lock notches and dogs for chamfer.

1.11 Examine clutch springs and nuts. (HW1000 only).

1.12 Test that magnetic clutch (HW2000 only) is free by holding the motor gear stationary and rotating the crank handle.

1.13 Examine motor holding bolts (including motor casing through bolts).

1.14 Examine intermediate gear holding bolts.

1.15 Examine driveslide and throw bar retainer plate holding bolts.

1.16 Examine bevel gear casting bolts.

1.17 Examine nut on main gear stud in centre of bevel gear casting.

1.18 Examine detection casting holding bolts.

1.19 Examine resistors and rectifier/diode units.

1.20 Examine terminals, also plug couplers. Clean and protect as necessary.

1.21 Check split pins associated with detection roller, lock slide connection arms and lock bar rollers.

POINTS, GEC-GS, TYPES HW1000 & HW2000 POINT MACHINES

1.22 Examine detection contact adjustment, ensure rollers rest on bottom of notches both normal and reverse and rotate freely.

1.23 Examine motor control and detection contacts and either snubbing contacts (HW1000 only) or magnetic clutch contacts (HW2000 only) and ensure that the contact surfaces are not heavily worn, either by abrasion or arcing. If necessary, clean or replace contacts.

1.24 Examine cable entry. Ensure that the cable gland is effective and the cable sheath is not chafing. Check drain holes are not blocked.

1.25 Examine terminals. Clean and protect as necessary.

1.26 Examine wiring.

1.27 Check heaters where fitted.

1.28 Wipe and examine lock slide retainer plate and bolts.

1.29 Check that the bearing surfaces of the throw bar, driveslide, lock and detector blades are free from abrasion and rust. Clean and smear with lithium based grease.

1.30 Smear lithium based grease on gear teeth of intermediate and bevel gears where necessary, remove any surplus.

1.31 Examine ballraces and retaining screws.

1.32 Apply mineral oil to rollers in throw bar movement and detection movement.

1.33 Check contact fingers. Clean and protect as necessary excluding the contact faces.

1.34 Reset isolating contacts.

POINTS, GEC-GS, TYPES HW1000 & HW2000 POINT MACHINES

1.35 Observe correct operation of the machine before replacing lid. There should be no "kick-back" on the motor. If snubbing (HW1000 only) is not effective, check that the diodes conduct in one direction.

1.36 Check lid and machine for foreign bodies and ensure that the RKB222 padlock is fitted to the crank handle cover.

Service B

Exterior

2.1 Scrape, brush, wash and examine machine cover and casting.

Interior (Motor should be isolated)

2.2 Clean interior of case.

2.3 Examine motor commutator all round using crank handle to turn the motor. The commutator should be a light coffee colour. Clean the commutator surface by hand cranking the machine and pressing a clean, lint-free cloth moistened with switch cleaner on to the commutator.

2.4 Examine motor brushes. The brushes should slide freely in their holders and seat fully on the commutator. Replace the brushes when worn to approximately 10 mm long.

2.5 Smear lithium based grease on intermediate gear cover retaining screws.

2.6 Clean snubbing contact (HW1000 only) normal and reverse detection contacts with clean, lint-free cloth moistened with switch cleaner.

2.7 With the contacts fully open, check that the 'U' shaped contact spring (3) (See Appendix A) bears against underside of adjusting screw (2). To adjust contact alignment, release locking tabs, loosen the two screws in each contact block assembly and adjust as required. Retighten screws after adjustment and turn up locking tabs. With the contacts fully closed, check with the appropriate gauge that the distance between the 'U' shaped contact spring (3) and the head of the adjusting screw (2) is 2 mm.

2.8 Clean clutch control contacts (HW2000 only) with a clean lint-free cloth moistened with switch cleaner. Check that the contact pressure on fully closed contacts is approximately 400 grammes. To increase pressure bend spring (3) (See Appendix B) outward and conversely to reduce pressure bend spring (3) inwards.

2.9 Check that contact (4) does not foul the rivet head (1) on spring (2) (See Appendix B), and ensure that a satisfactory contact is made.

2.10 Check that the distance between the contacts when open is at least 5 mm using an appropriate gauge.

2.11 Clean motor control contacts with a clean, lint-free cloth moistened with switch cleaner. The motor control contact opening should be at least 8 mm using the appropriate gauge when the related normal or reverse contact closes (See Appendix C). If necessary adjust the fixed motor control contact by loosening the screw on top of the contact and re-position the adjuster spring into the appropriate hole of the contact finger and re-tighten the screw (See Appendix C).

2.12 Examine crank handle cut-out contacts and clean with a lint-free cloth moistened with switch cleaner. Check that contacts breaks when the crank handle is inserted and that the contact remakes when cut-out is reset. Using the appropriate gauges the contact opening when crank handle is inserted should not be less than 6 mm and the contact pressure not less than 450 grammes.

POINTS, GEC-GS, TYPES HW1000 & HW2000 POINT MACHINES

2.13 Measure the motor operating current whilst operating the points normal to reverse and reverse to normal.

2.14 Place obstruction between point switch and stock rail and operate the points. Using the higher of the two operating currents, check that the clutch slip current is 25% – 50% in excess of the figure but does not exceed 15 amps.

2.15 Note, where applicable, overload protection takes 6 to 9 seconds to operate.

2.16 If necessary adjust clutch. Remove obstruction from the points.

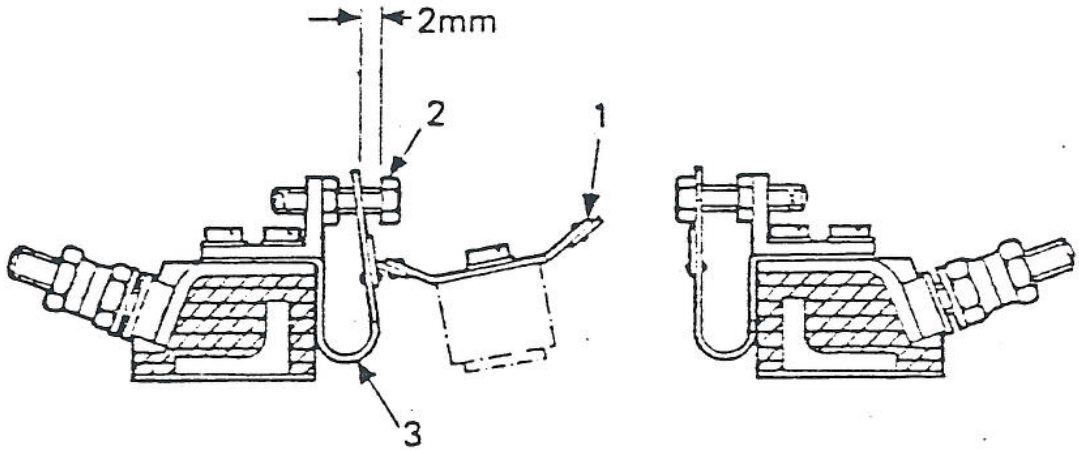
2.17 The dry plate clutch (HW1000 only) is adjustable mechanically by increasing or decreasing the clutch spring pressure by means of the four nuts on the clutch gear.

2.18 The electro-magnetic clutch (HW2000 only) is adjusted by means of a variable resistor and once set should require no further adjustment. This clutch cannot be adjusted mechanically.

POINTS, GEC-GS TYPES HW1000 & HW2000 POINT MACHINES

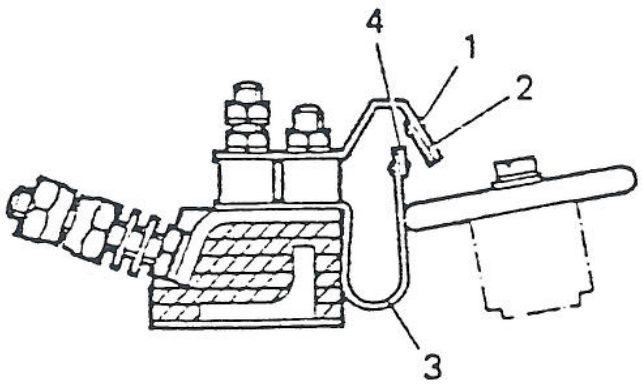
APPENDIX A, HW1000 and HW2000

Point Detector Contacts

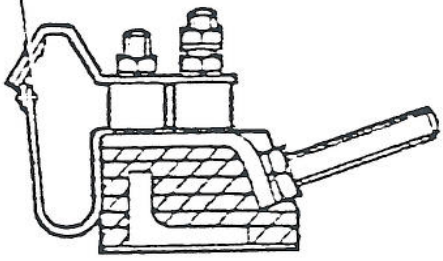


APPENDIX B, HW2000 ONLY

Clutch Control Contacts



Contact pressure should be 400 g (14 oz) approx.



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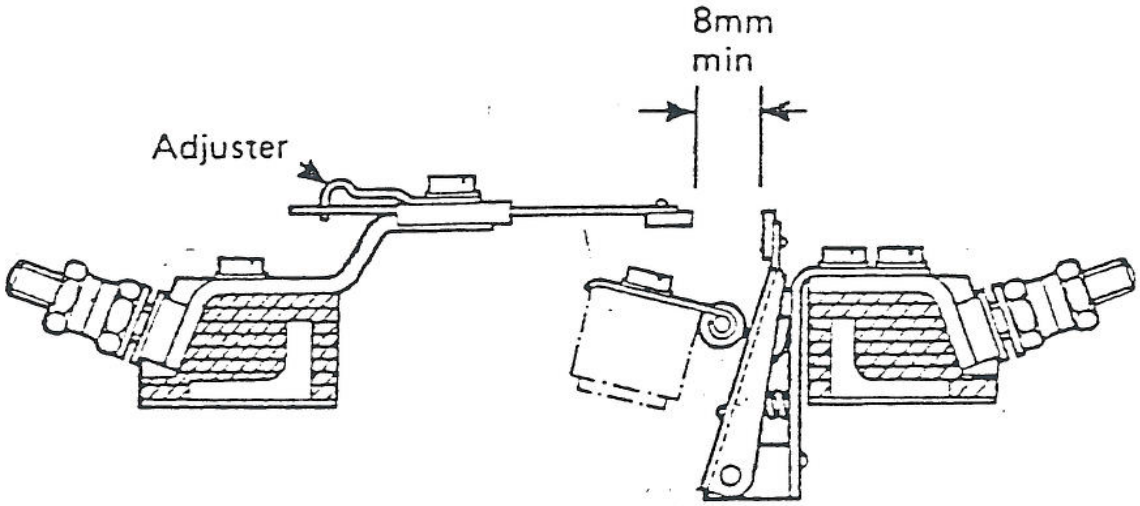
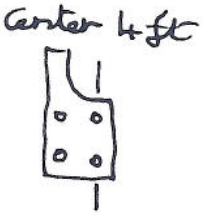
APPENDIX C

Motor Control Contacts

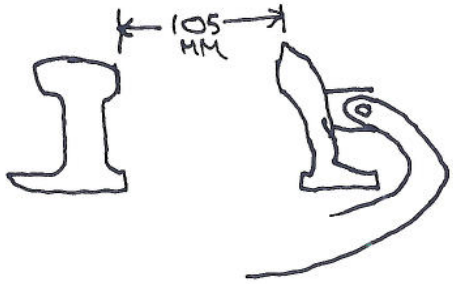


center thrust plate



Switch rail shims
Max 4 x 3mm + Wedge

Switch opening to
Lock Arm 105 mm
4 1/8"



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POINTS, DETECTION TEST, ELECTRICAL DETECTOR (EXCEPT RAIL CLAMP POINT LOCK)

01. Reference should also be made to the following specification when a FPL is fitted:-

PA21, POINTS, Facing Point Lock Test, Electric/Pneumatic Machines.

0.2 Reference should also be made to the following specification when a 4 ft mounted Facing Point Lock is fitted:-

PA23. POINTS, Facing Point Lock Test, Mechanical.

0.3 The last operation for all services is to test by operation from the signal box and to observe that the apparatus functions correctly.

Service A

1.1 Disconnect the detection on the outgoing KR lines to the signal box in the location and connect a voltmeter to the KR lines from the detector.

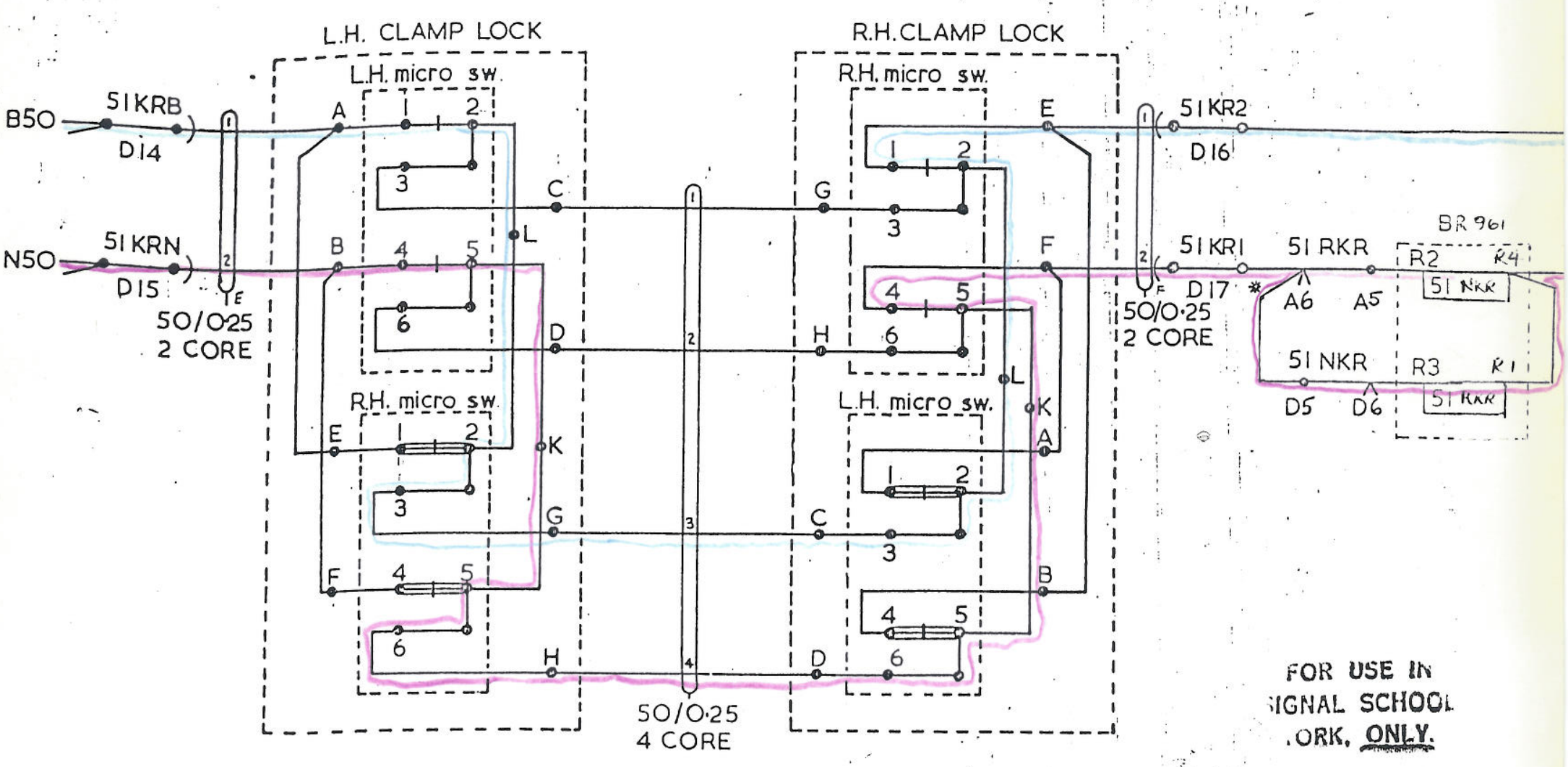
1.2 Disengage, where fitted, the Facing Point Lock Rod from the Lock Slide with the points in the unlocked position to enable the lock to be inserted with the gauge in the points.

1.3 With the 3.5mm end of the Point Checking Gauge placed between the switch and the stock rail at a point in line with the bolt securing the stock rail in the first slide chair, ensure that for both closed positions of the points with the lock, where fitted, in the appropriate lock notch the detection is made by referring to the meter, adjust as necessary.

1.4 Remove Gauge.

1.5 With the 5mm end of the Point Checking Gauge in the same position as 1.3 ensure that for both closed positions of the points with the lock, where fitted, in the appropriate lock notch the detection is broken by referring to the meter, adjust as necessary.

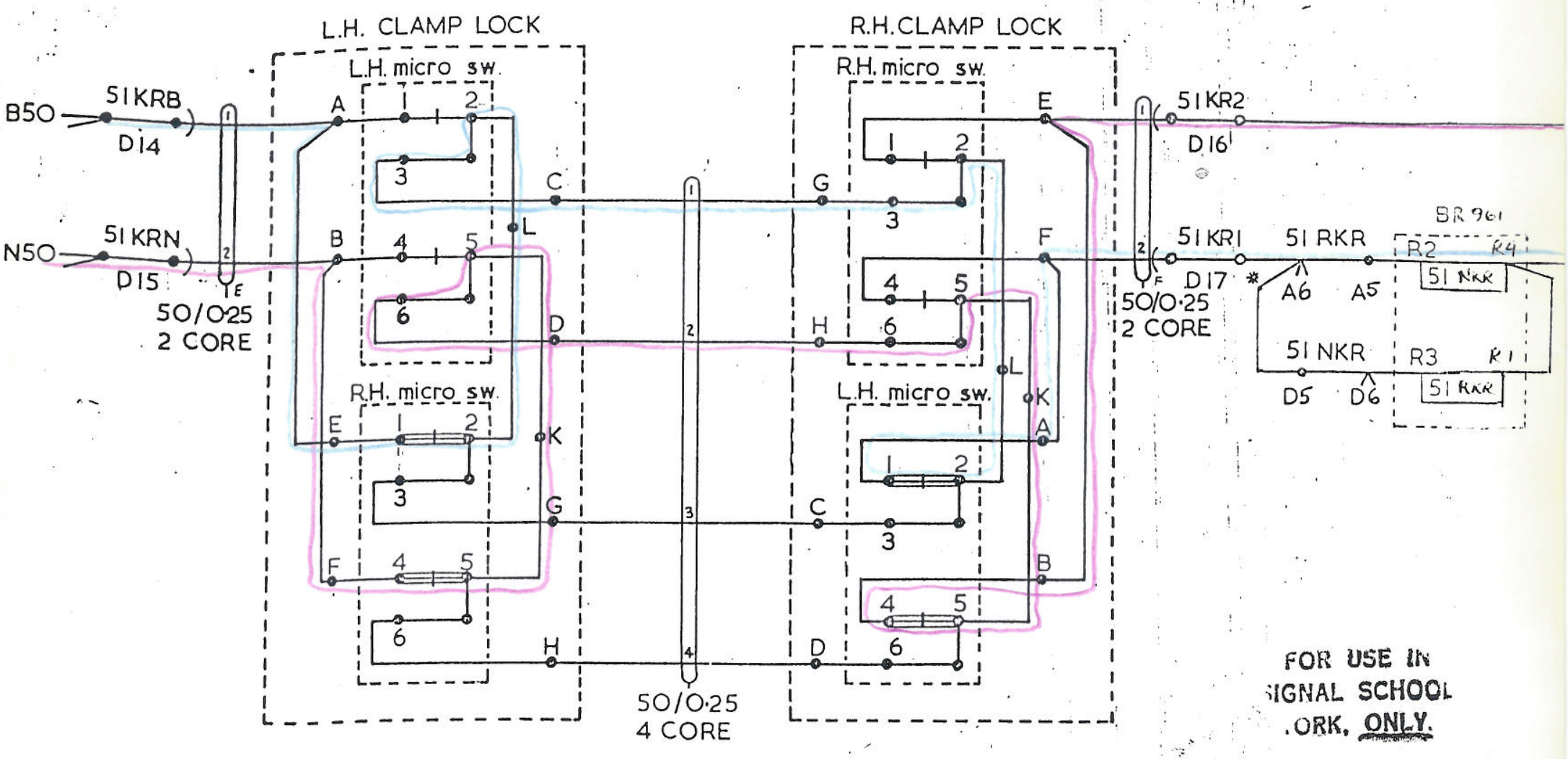
LEFT
~~RIGHT~~ HAND SWITCH NORMALLY CLOSED



FOR USE IN
SIGNAL SCHOOL
WORK, ONLY.

B50—
N50—

RIGHT HAND SWITCH NORMALLY CLOSED



FOR USE IN SIGNAL SCHOOL WORK, ONLY.

B50 —

N50 —

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POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

0.1 Reference should also be made to the following specifications:-

PA11. POINTS Joint S&T/CE Checks
PA51. POINTS Fittings

0.2 Parts that may need replacement are shown in Appendix D.

0.3 The machine should not be operated electrically until any adjustments made have been verified by operation with the hand pump to ensure that the machine is operating without undue strain on any of its parts.

0.4 The last operation for all services is to test by operation from the signal box and to observe that the apparatus functions correctly.

Service A

Isolate machine by turning to the 'Manual' position on the Hydraulic Power Unit.

FACING POINT TEST

1.1 Connect a meter on the correct voltage range across the outgoing KR lines.

1.2 With the 3.5mm end of the Point Checking Gauge placed between the switch and stock rail at a point in line with the bolt securing the stock rail in the first slide chair ensure that the lock arm does not engage and that the drive lock slide has stopped at least 30mm short of the end of the base plate. The padlock tab should be ignored when measuring the position of the drive lock slide.

1.3 Observe that detection is broken by referring to the meter.

1.4 Remove the gauge.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

1.5 With the 1.5mm gauge placed between the switch and stock rail at a point in line with the lock arm ensure that the lock arm fully engages and the drive lock slide completes its stroke.

1.6 Observe that the detection is made by referring to the meter.

1.7 Remove the gauge.

1.8 Repeat items 1.2 to 1.7 for the opposite point tongue.

1.9 Remove the meter and select the 'Power' position on the Hydraulic Power Unit.

1.10 If either lock fails to pass the tests in 1.2 to 1.7 adjustment and testing must be carried out in accordance with Service D and Appendix C.

1.11 Record the results and other details on the Facing Point Test Record Form.

Service B

Isolate the machine by turning to the 'Manual' position on the Hydraulic Power Unit.

CLAMP LOCK

2.1 Examine lock and detector mechanism assemblies, lock arm bracket assemblies, turned pins, split pins, fixing bolts including where fitted, heater mounting stud bolts as well as nuts, bolts, set screws and washers.

2.2 Examine the locating studs (fitted on 113A rail).

2.3 Clean exposed parts of all working surfaces on the lock arm, fixed cam, adjustable cam, locking piece and cam followers.

2.4 For both positions of the points wipe and examine exposed portion of the drive lock slide and slideways.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

2.5 With the points locked check that the lock arm and detection blade are free to slide on the pivot pin.

2.6 Lubrication should not be carried out on the cam follower pivot or the drive lock slide/drive lock bracket coupling.

2.7 Lubricate with mineral oil all working surfaces mentioned in item 2.3 and the lock arm pivot at the positions shown in Appendix A.

2.8 Liberally lubricate with mineral oil the drive lock slide, lock arm, detector blade, locking piece and lock arm for both positions of the points at the positions shown in Appendix A.

2.9 Examine cable entries, cable glands and ensure cables are not chafing.

2.10 Examine terminal and micro-switch assemblies. Clean and protect terminals as necessary.

2.11 Examine wiring.

2.12 Lubricate padlock.

2.13 Repeat item 2.1 to 2.12 for opposite clamp lock.

HYDRAULIC ACTUATORS

2.14 Examine centre thrust bracket, coupling bar, drive bracket, actuators, split pins, fixing bolts, nuts, bolts and washers.

2.15 Examine actuator hoses for chafing and security. If adjustment is necessary do not over tighten.

2.16 Check that the locking wires on the hose connectors are intact.

2.17 Examine and clean the drive lock slide/drive bracket coupling and the bottom of the lock arm.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

2.18 With the points closed ensure that a clearance of at least 8mm exists between the top of the drive lock coupling and the bottom of the lock arm.

HYDRAULIC POWER UNIT

2.19 Examine cable entry and ensure cable is not chafing.

2.20 Examine terminals and cover plate. Clean and protect terminals as necessary.

2.21 Examine wiring.

2.22 Check level of hydraulic fluid is visible in the filter cup. Top up as necessary.

2.23 Apply mineral oil lightly to the hand pump mechanism and, where applicable, to guides, pivots and joints of manual selection mechanism.

2.24 Check cover and unit for foreign bodies.

2.25 Lubricate padlocks.

2.26 Select the 'Power' position.

2.27 Ensure that the RKB222 padlock is fitted to the Local Control Hinged Lid.

GENERAL

2.28 Remove all fire risks and potential obstructions from or near equipment, e.g. oily waste, paper and ballast.

Service C

Isolate the machine by selecting the 'Manual' position on the Hydraulic Power Unit.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

CLAMP LOCK & HYDRAULIC ACTUATORS

3.1 Brush wash and examine covers.

3.2 Check that the cam follower tappet screws shown in Appendix D protrude no more than 25mm.

HYDRAULIC POWER UNIT

3.3 Clean, wash and examine casing.

3.4 Clean interior of power unit.

3.5 Examine power unit mounting, manual control selection mechanism, solenoid valve block, and hose connections. If adjustment to the hose connections is necessary do not over tighten.

3.6 Check where applicable, the motor commutator. The commutator should be a light coffee colour.

3.7 Clean, where applicable, the commutator surface with a lint free cloth moistened with cleaning fluid.

3.8 Examine, where applicable the motor brushes. The brushes should slide freely in their holders and seat fully on the commutator.

3.9 Flush carbon deposits clear of brush gear with cleaning fluid (aerosol).

3.10 Check that the locking wires on the hose connections are intact.

3.11 Select the 'Power' position.

3.12 Ensure that the RKB222 padlock is fitted to the local control hinged lid.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

Service D

DETECTION TEST

Isolate the machine by turning to 'Manual' position on the Hydraulic Power Unit and disconnect the outgoing KR lines to the signal box at the location.

Left and Right hand in connection with micro switches refers to the micro switch position when viewed from outside the track.

4.1 At the open switch check that the right hand micro switch plunger is clear of its cam follower tappet screw.

4.2 If incorrect carry out the FULL TEST in accordance with Appendix B.

4.3 If correct close and lock the switch.

4.4 Connect a volt meter across the outgoing KR lines.

4.5 Observe that the detection is made by referring to the meter.

4.6 Insert a 4 mm gauge between the point detector blade lug and the shoulder of the connecting eye and tighten nut.

4.7 Observe the meter reading.

4.8 If the detection is broken proceed to item 4.15.

4.9 If the detection remains made slacken the detector locking nut by 1/16th of a turn and whilst observing the meter turn the adjusting screw anti-clockwise until the detection breaks.

4.10 Tighten the detector locking nut and observe that the detection remains broken.

4.11 Remove the 4 mm gauge, insert the 2.5 mm gauge and tighten nut.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

4.12 Observe the meter reading.

4.13 If the detection remains broken, remove the 2.5 mm gauge tighten nut and carry out the FULL TEST in accordance with Appendix B.

4.14 If the detection is made proceed to item 4.22.

4.15 Remove the 4 mm gauge, insert the 2.5 mm gauge and tighten nut.

4.16 Observe the meter reading.

4.17 If the detection is made proceed to item 4.22.

4.18 If the detection remains broken slacken the detector locking nut by 1/16th of a turn and whilst observing the meter turn the adjusting screw clockwise until the detection makes.

4.19 Tighten the locking nut.

4.20 Observe the meter reading.

4.21 If the detection remains made remove the 2.5 mm gauge and proceed to item 4.6.

4.22 Remove the 2.5 mm gauge and tighten nut.

4.23 Insert the 1.5 mm gauge between the left hand micro switch plunger and the cam follower tappet screw.

4.24 Observe the meter reading.

4.25 If the detection is broken, remove the 1.5 mm gauge and carry out the FULL TEST in accordance with Appendix B.

4.26 If the detection remains made remove the 1.5 mm gauge and insert the 2 mm gauge.

4.27 Observe the meter reading.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

4.28 If the detection remains made, remove the 2 mm gauge and carry out the FULL TEST in accordance with Appendix B.

4.29 If the detection is broken remove the 2 mm gauge.

4.30 Transfer the meter to the outgoing KR lines of the open switch clamp lock mechanism.

4.31 At the open switch clamp lock mechanism insert the 1.5 mm gauge between the right hand micro switch plunger and the cam follower tappet screw using the 1.5 mm gauge as a lever, operate the right hand micro switch.

4.32 Observe the meter readling.

4.33 If the detection remains made investigate, for cause, repair and then carry out the FULL TEST in accordance with Appendix B.

4.34 If the detection breaks remove the 1.5 mm gauge.

4.35 Remove the meter from the outgoing KR lines.

4.36 Repeat items 4.1 to 4.35 for the opposite switch.

4.37 Reconnect the KR lines to the signal box and select the 'Power' positions on the Hydraulic Power Unit.

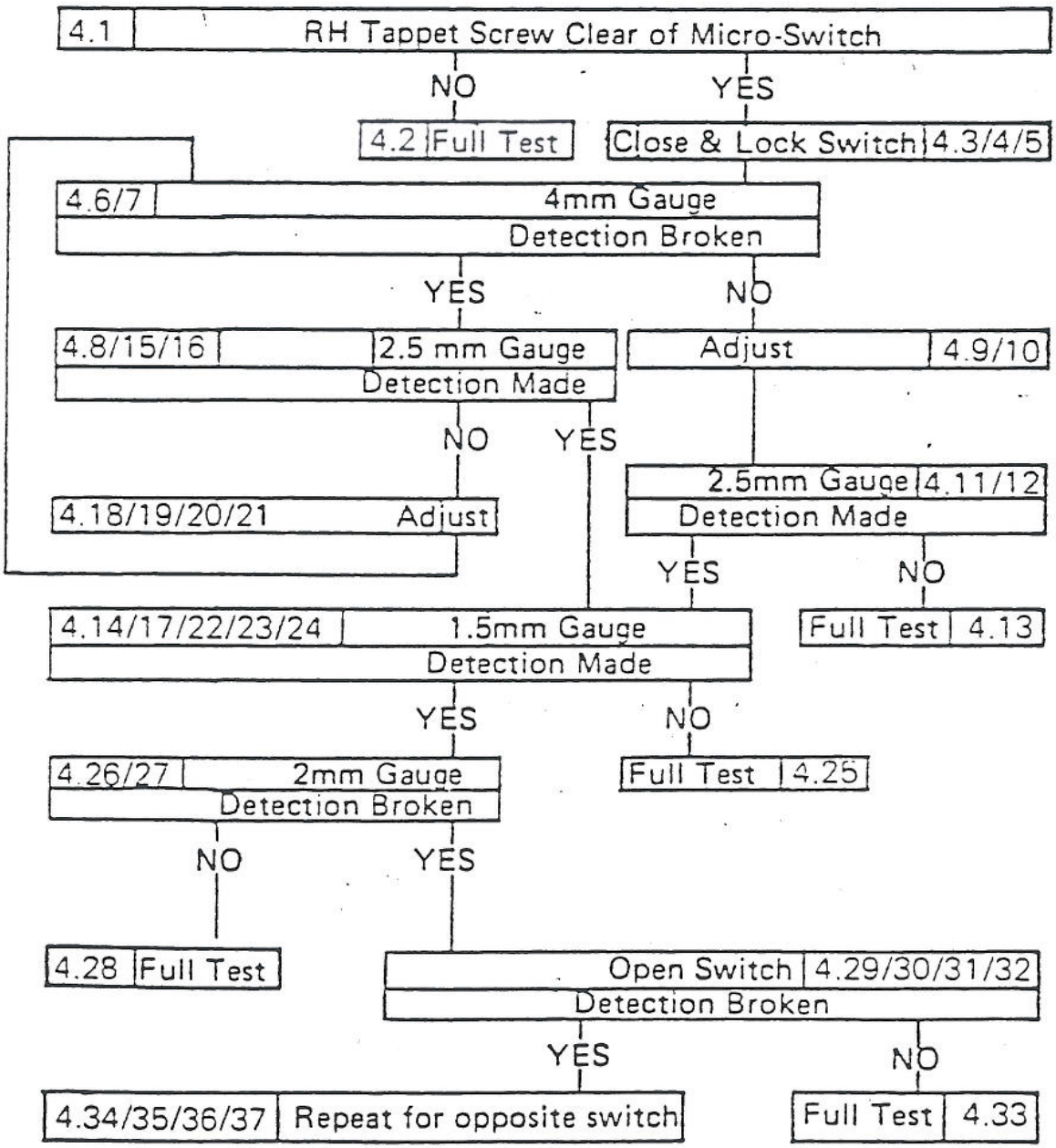
POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

Service D

Select 'Manual' position.

Disconnect KR lines to S.B. in location case.

At the open switch rail.



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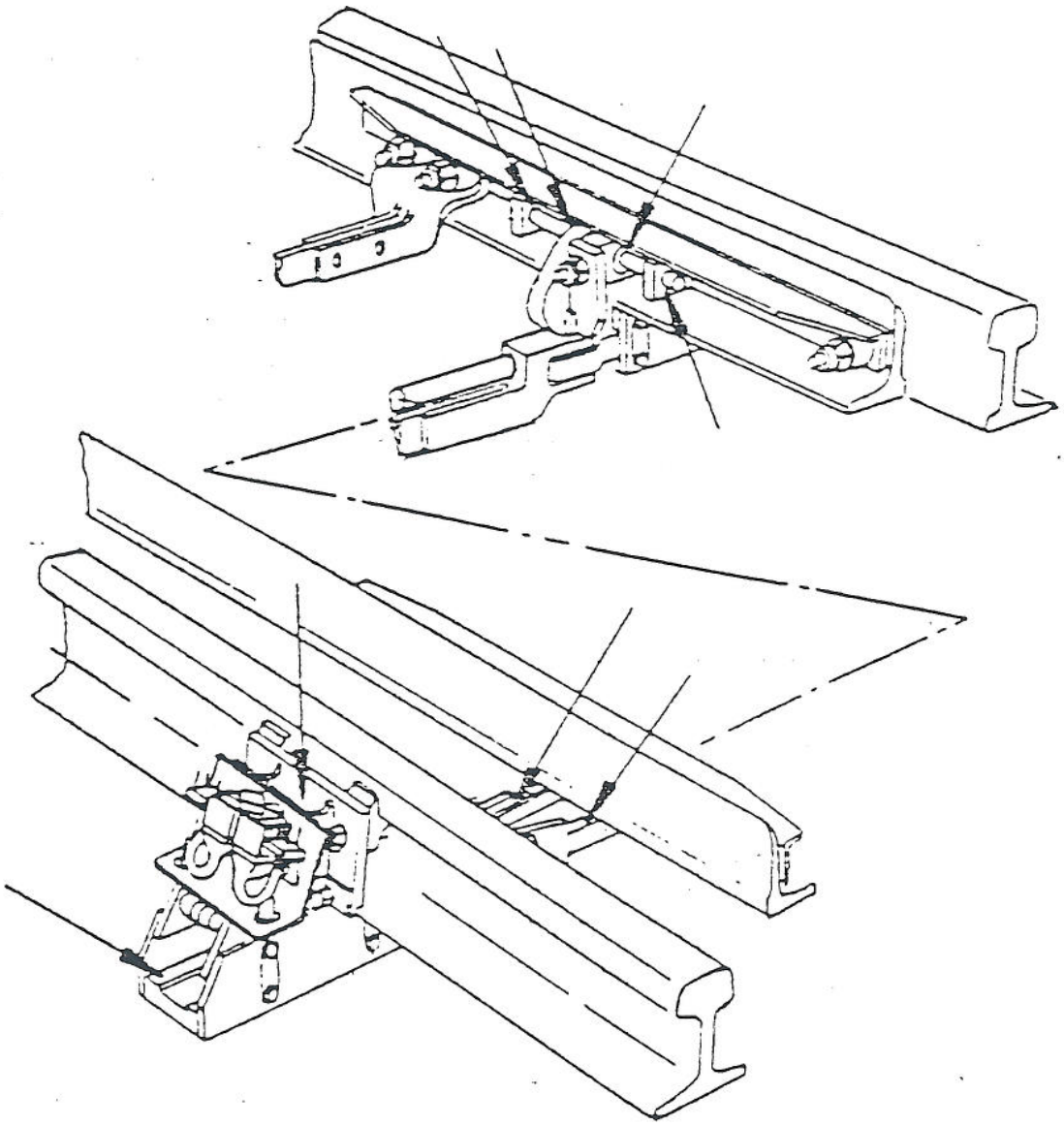
POINTS, RAIL CLAMP POINT LOCK, FITTINGS & TESTS

APPENDIX A. LUBRICATION POINTS



POINTS, RAIL CLAMP POINT LOCK, FITTINGS & TESTS

APPENDIX B

FULL TEST

LOCK AND DETECTION SETTING

Isolate the machine by turning to 'Manual' position on the Hydraulic Power Unit and disconnect the outgoing KR lines to the signal box at the location.

Left and Right hand in connection with micro switches refers to the micro switch position when viewed from outside the track.

B.1 Close and lock the switch rail.

B.2 Slacken the detector locking nut by 1/16th of a turn and turn the adjusting screw clockwise until the adjustable cam has reached the head of the adjusting screw.

B.3 Connect a meter on the correct voltage scale across the outgoing KR lines.

B.4 Insert the 2 mm gauge between the left hand micro-switch plunger and the cam follower tappet screw.

B.5 By referring to the meter, adjust the left hand tappet screw until the detection is broken. Tighten the lock nut.

B.6 Replace the 2 mm gauge with the 1.5 mm gauge and observe the meter reading.

B.7 If the detection is broken adjust the left hand tappet screw until the detection is made. Tighten the lock nut.

B.8 If an adjustment has been made in B.7 proceed to B.4.

B.9 If the detection is made remove the gauge.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS & TESTS

B.10 Insert the 4 mm gauge between the point detector blade lug and the shoulder of the connecting eye and tighten nut.

B.11 Whilst observing the meter turn the adjusting screw anti-clockwise until the detection is just broken. Tighten nut and observe that the detection remains broken.

B.12 Remove the 4 mm gauge. Insert the 2.5 mm gauge and tighten nut.

B.13 Observe the meter reading.

B.14 If the detection remains broken remove the 2.5 mm gauge and proceed to B.10.

B.15 If the detection is made remove the 2.5 mm gauge, tighten nut and observe that the detection is made.

B.16 Insert the 1.5 mm gauge between the left hand micro-switch plunger and the cam follower tappet screw.

B.17 Observe the meter reading.

B.18 If the detection is broken, do not adjust the tappet screw but proceed to B.10.

B.19 If the detection remains made replace the 1.5 mm gauge with the 2 mm gauge.

B.20 Observe the meter reading.

B.21 If the detection remains made, do not adjust the tappet screw but proceed to B.10.

B.22 If the detection is broken remove the 2 mm gauge.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

B.23 Open the closed switch to an opening of approximately 25 mm.

B.24 Observe that the right hand tappet screw is level with the left hand tappet screw. Adjust the right hand tappet screw as necessary. Tighten the lock nut.

B.25 With the switch rail fully open check that there is a gap between the right hand micro-switch plunger and its tappet screw.

B.26 Repeat B.1 to B.25 for the opposite switch.

B.27 Reconnect the KR lines to the signal box. Remove the meter and select the 'Power' position on the Hydraulic Power Unit.

B.28 Obstruct the points and ensure that the overload protection take 6 to 9 seconds to operate.

B.29 Carry out FACING POINT TEST in accordance with Service A.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

APPENDIX C

LOCK ADJUSTMENT

Isolate the machine by turning to 'Manual' position on the Hydraulic Power Unit.

C.1 There is provision for coarse and fine lock adjustment. If it is found on re-adjustment that more than a 0.6 mm shim is needed, a check must be made for damage to the switches. Points that have been run-through by a light vehicle may show little evidence of damage but the switches may exhibit the following signs:-

Crippled/Twisted Switch Rail.
Switch rail standing open in irregular formation.
Stretcher bar distortion.
Back of closed switch heavily scored and scuffed.

A run-through condition can be checked by gauging the thickness of an obstruction that can be inserted in the closed switch with the lock fully engaged. An estimate of this amount of opening can be made by levering open the closed switch rail with a crowbar inserted from the toe end between the webs of the switch and stock rails.

C.2 Coarse adjustment is effected by inserting packing plates between the lock arm bracket and the switch rail web. The amount of packing will vary with the type of planing of the points and also by reason of manufacturing tolerances. Packing plates 3 mm and 1.6 mm thick are available for this purpose. A total packing equivalent to four thick plates (12 mm) may be required in extreme cases.

C.3 Fine adjustment is effected by inserting shim plates behind the locking piece in the lock body unit. The total amount of fine adjustment shim packing shall not exceed a thickness of 4mm and when necessary additional packing may be inserted between the lock arm bracket and the switch rail web to avoid exceeding this.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

C.4 If coarse lock adjustment has been carried out the DETECTION TEST must be carried out in accordance with Service D.

C.5 Select 'Power' position on the Hydraulic Power Unit.

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

APPENDIX D

REPLACEMENT OF PARTS

D.1 Replacement due to wear.

DRG. NO. BRS – SM	DESCRIPTION	REQUIREMENT	CAT. NO.
	Shim packing for Locking Piece	To maintain correct Locking Arm engagement	
506/1	0.6 mm		86/32141
506/2	1.6 mm	(Maximum Total Thickness 4 mm)	86/32142
501/5	Locking Piece	To maintain correct Locking Arm engagement When more than maximum allowable packing is required	86/32135
526/10	Tab Washers	With each packing or locking piece replacement	86/32138
501/6	Special Screw	Only if damaged or lost in the ballast	86/32139
510/2	Locating Stud (Not Brass)	Excessive wear See item 2.18	86/32206

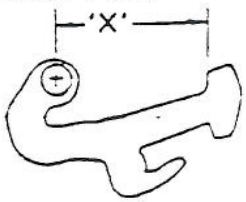
POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

D.2 Replacement due to damage, wear and malfunction.

PL = Plain Lead
SSL = Single Slip Lead
DSL = Double Slip Lead
SD = Switch Diamond

S.I. = Smiths Industries
V.S. = Vickers Systems (Formally Sperry Vickers)

Refer to :Schedule BRS – SM5500/7 for type of layout and relevant components.

DRG. NO. BRS – SM	DESCRIPTION			FAULT	CAT. NO.
	Lock Arm 'X' 			Following a run through	
	Type	'X' mm	Lead		
502/2	A	202	PL/SSL		86/32212
			DSL outer switch		86/32212
529	B	200	DSL inner switch		86/32369
517/3	C	233	1 : 7.5 or flatter		86/32238
519/3	D	260	SD 1 : 5.5 to 1 : 7		86/32253
545	Insulating Bushes (Pair)			Track Circuit Failure	55/27011
501/26	Coupling Bolt. Complete with S.L. M16 Nut				86/32191
	Crinkle Washer M16 S. Steel				3/189989
508/10	Special Washer				86/32011

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

DRG. NO. BRS – SM	DESCRIPTION	FAULT	CAT. NO.
542/1	Switch & Terminal Block Assembly	Malfunction of switch(es)	86/32165
501/10	Mounting Plate for BRS – SM 542/1		86/32162
501/21	Detector Mechanism Cover	Damaged	86/32180
501/22	Cover Pin	Damaged	86/32181
BR Spec 817	Actuator Packing Ring and Split Cotter to be replaced.	Actuator Spigot/ Thrust Socket sloppy fit	86/32012
	Split Cotter 6.3 x 50 corrosion resistant.		29/127210
BR Spec 817	Actuator (Complete with 2 Split Cotters 6.3 x 50 Corrosion Resist)	Cylinder or Ram damaged Oil Leakage	86/32500 29/127210
	Thrust Bracket Packings	As required when mechanism bodies or actuators are replaced	
525/1	6 mm		86/32266
525/2	3 mm		86/32267
BR Spec 817	Hydraulic Power unit Cover	When Damaged	
	S.I. } Covers are not V.S } interchangeable		86/32588 86/32010
BR Spec 817	Hydraulic Power unit S.I. & S.V units are interchangeable	Operational Failure	
	110V		86/32540
	50V		86/32520

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

DRG. NO. BRS – SM	DESCRIPTION	FAULT	CAT. NO.
542/1	Switch & Terminal Block Assembly	Malfunction of switch(es)	86/32165
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525/2	3 mm		86/32267
BR Spec 817	Hydraulic Power unit Cover	When Damaged	
	S.I. } Covers are not V.S } interchangeable		86/32588 86/32010
BR Spec 817	Hydraulic Power unit S.I. & S.V units are interchangeable	Operational Failure	
	110V		86/32540
	50V		86/32520

POINTS, RAIL CLAMP POINT LOCK, FITTINGS AND TESTS

DRG. NO. BRS—SM	DESCRIPTION	FAULT	CAT. NO.
	Power unit Motor Brushes	Worn Out.	
	S.I. 2 required		54/24999
	V.S 4 required		54/24514
	Hydraulic Hose (Union nut to be re-locked with locking wire)	Badly Abraded Hose or Fitting Leak	
541/1	3 m long		86/32600
541/2	4 m long		86/32610
541/3	6 m long		86/32620
541/4	7 m long		86/32630
	Tie Bar. Must be changed when mechanism body is replaced. Type | Lead	At relaying of P.W. OR When damaged	
521/1	A | PL/SSL/DSL		86/32002
521/2	B | SD		86/32026
501/27	Actuator Cover	Damaged	86/32193

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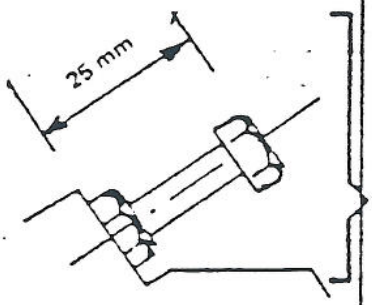
DRG. NO. BRS – SM	DESCRIPTION	FAULT	CAT. NO.
501	Lock and Detector Mechanism  BRS.SM 501/7	A. Damaged OR B. Worn to a condition that 1. The open switch detection is difficult to maintain. 2. The left hand cam follower tappet screw has been adjusted to 25 mm above cam face OR C. The mechanism having been installed a nominal ten years or longer depending on site conditions OR D. When the P.W. is relaid. OR E. When the coupling bar drive bracket at the open switch has at least 10 mm vertical free play.	86/32115

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DRG. NO. BRS – SM	DESCRIPTION			FAULT	CAT. NO.
	Lock & Detector Arm Assembly			As for Lock & Detector Mechanism Section C See note C above OR When the Pin is bent (possibly after a run through)	
	Lock Arm Type	Switch	Lead		
502	A	–	PL/SSL		86/32060
502		outer	DSL		
504	B	inner	DSL		86/32070
517/1	C	L.Hand	SD.1 1:7.5 to 1:17		86/32086
517/2		R. "			86/32100
519/1	D	L. "	SD.2 1:5.5 to 1:7		86/32103
519/2		R. "			86/32107
532/1	C	L. "	SD.3 Flatter than 1:17		86/32109
532/2		R. "			86/32112

E.R. APPENDIX 1 TO PB11 (MAY 1987)

RAIL CLAMP POINT LOCK : BODY FRACTURE TEST.

1. BODY CRACK EXAMINATION (4 WEEKLY)

1.1 Remove lock body cover.

1.2 Clean body framework if necessary.

1.3 Examine body framework for signs of cracks. (See Sketch for areas where cracks have been found).

1.4 Any defects found should be immediately reported to the Supervisor and arrangements made for replacement if required.

2. EXAMINATION TO BE CARRIED OUT AFTER DETECTION FAILURE (EDDY CURRENT METHOD)

If a clamp lock requires attention as a result of detection failure (permanent or intermittent) more than once within seven days and either

I) Detector toppets require adjustment
or
II) No cause of failure is found and no visible cracks are evident

then arrangements must be made with the Area Support Engineer for crack detection tests to be carried out. These tests should preferably be carried out immediately, but in any case should be carried out within 72 hours. On multiple-ended layouts, all clamp lock bodies concerned must be tested.

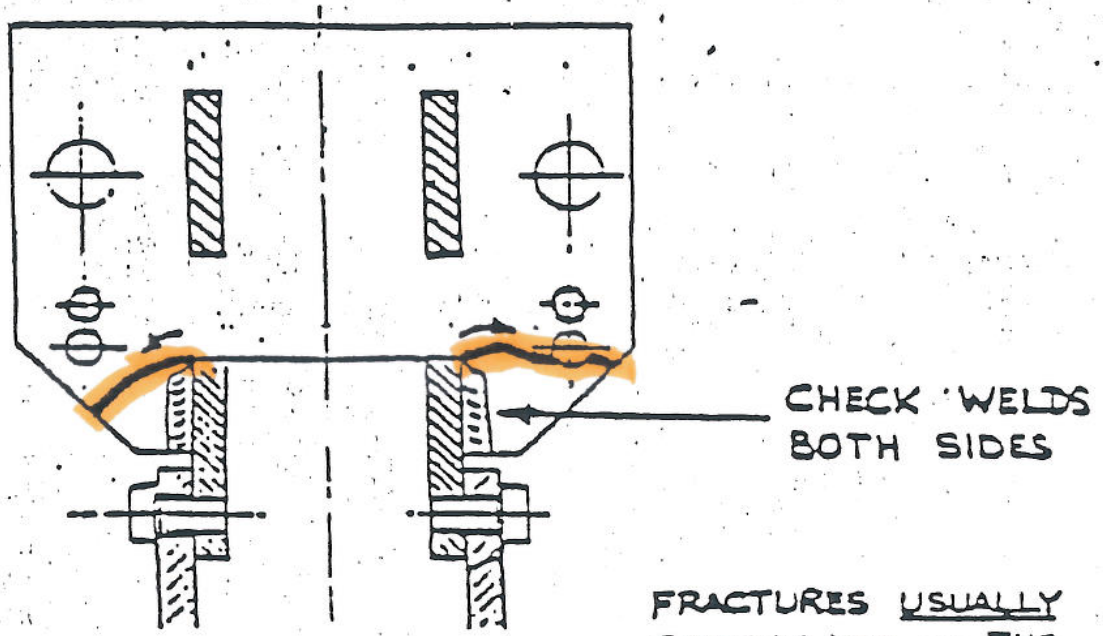
The body will then be tested by use of an Eddy Current Defect Meter, and any suspicions will be proved by use of Magnetic Particle Crack Inspection techniques.

Defects found should be reported immediately and arrangements made for replacement if required.

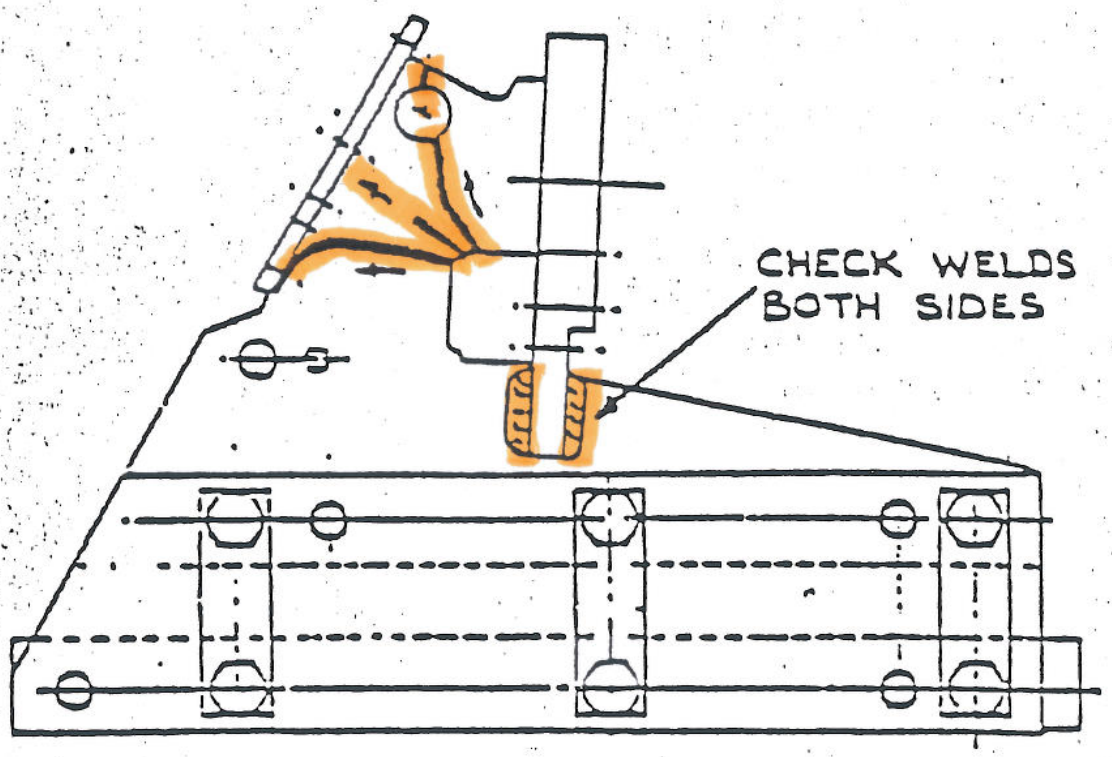
A form (CL10) is available to record site details for body units where cracks are detected.

E.R APPENDIX 1 TO P.B 11

BODY FRAME - LOCATION OF TYPICAL FRACTURES AND CRACKED WELDS



FRACTURES <u>USUALLY</u> PROPAGATE IN THE DIRECTION OF THE ARROWS SHOWN



CHECK ALL SIDE-PLATE BOLTS & SPIROL PINS

E.R. APPENDIX 2 TO PB11 (MAY 1987)

RAIL CLAMP POINT LOCK : COUPLING BOLT

TRACK CIRCUIT FAILURES

Track circuit failure can occur due to the spirol pin in the end of the locating bolt working loose and becoming trapped between the top of the drive bracket and underside of the lockarm. In this position it will short circuit the insulated joint between the drive bracket and drive lock slide.

Coupling bolt heads are fitted with a 6mm spirol pin or dowel which engages in a slot in the top section of the drive bracket, preventing the bolt from turning as its lock nut is tightened.

The length of the spirol pin or dowel is 16mm and its engagement into the bolt head between 10-11mm, leaving a protruding section of approximately 5mm.

Drive brackets in use have a variety of slots machined into them for this purpose, as illustrated overleaf.

When profiles A and B are used the slot is machined right through the casting and is straight sided, but Profile C is produced using a circular cutter and the result is an extra long parallel sided slot with a curved bottom.

Profile A ensures that the locating pin is completely captive; profile B permits some movement of the spirol pin but prevents anything approaching total disengagement, but profile C offers very little resistance to the spirol pin working out.

To avoid failures of this nature it is necessary during routine maintenance visits to check if the slot is cut as profile C and if so, that the dowel or spirol pin is correctly located. If pins are found not fully located they should be punched back into position.

E.R. APPENDIX 2 TO PB11