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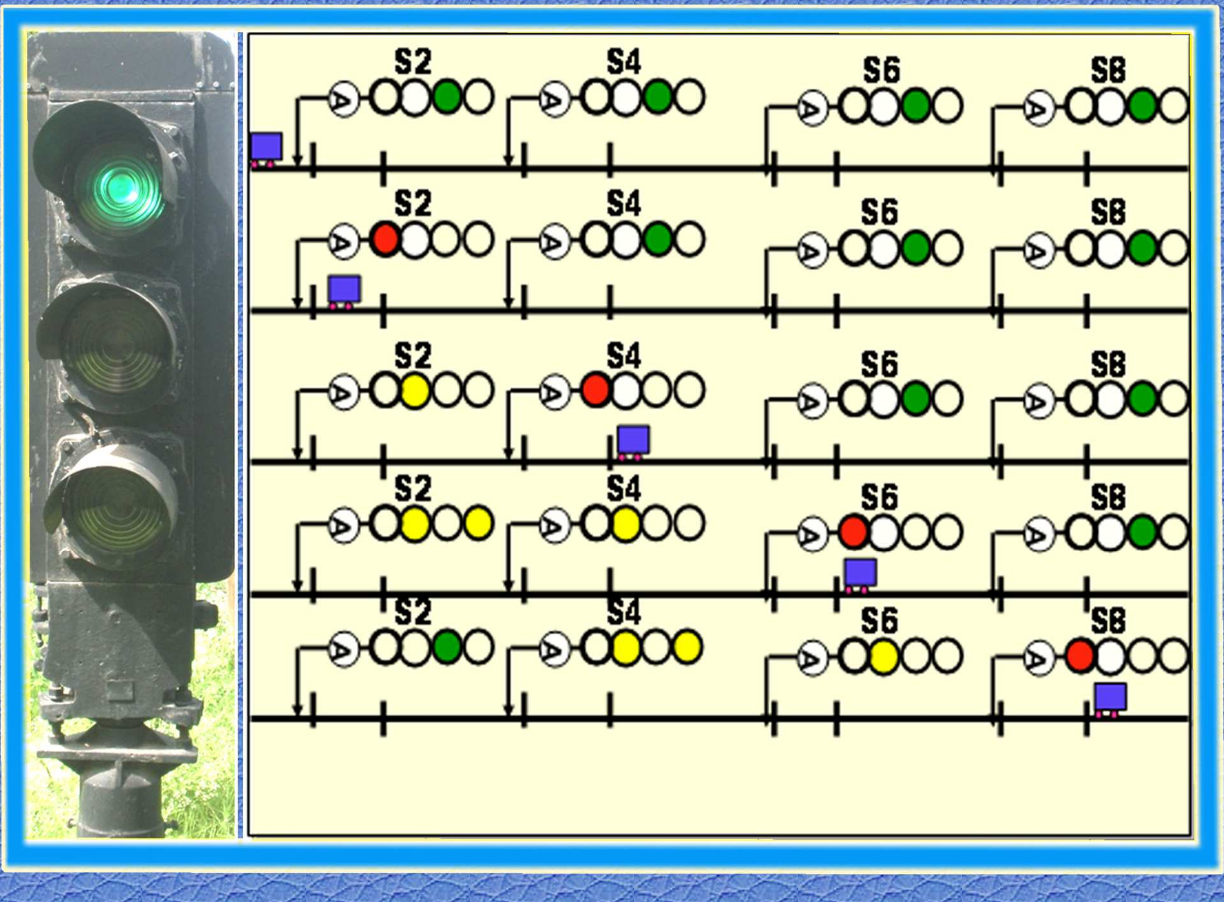
COLOUR LIGHT AND AUTOMATIC SIGNALLING



Indian Railways Institute of Signal Engineering and Telecommunications

SECUNDERABAD - 500 017

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INDIAN RAILWAYS INSTITUTE OF

SIGNAL ENGINEERING & TELECOMMUNICATIONS

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CHAPTER 1: MULTIPLE UNIT COLOUR LIGHT SIGNAL

1.1 Multi-unit Signals

Modern techniques used in colour-light signalling frequently necessitate having relays and equipment for the final aspect control close by the signals, so that the use of multi-unit signals, which have no moving parts, has become the general choice to utilise these relays to best advantage.

The light units are specifically designed to avoid "phantom" effects in sunlight, which otherwise might occur due to internal reflection and tend to give the impression of a cleared signal. Each light unit comprises a low voltage concentrated filament lamp at the focal centre of a double lens system in order to provide an efficient optical arrangement without the use of a reflector.

Colour Light Signals as the name implies give the different aspects both by day and night by colours corresponding to the night aspects of semaphore signals. The multi-unit type signals are of 2-unit, 3-unit or 4-unit type depending upon the number of aspects to be displayed. They are made of either cast iron or sheet metal. The 4-unit type is also derived by combining (2+2) units or (3+1) units.

The grouping of the light units is usually vertical with the Red aspect the lowest so as to be as close to the driver's eye level as possible. In the case of a 3-aspect signal the green is placed uppermost for the best sighting, whereas with a 4-aspect signal the two yellow aspects must be as widely separated as possible to give a clear "double yellow" indication at a distance. The order of the units is therefore generally as in the figure 1.1,3.2 and 3.4.

1.2 Advantages over Semaphore Signals

The following are the main advantages claimed by multiunit colour light signals over semaphore signals.

(a) The same aspect is displayed both by day and night.

(b) High intensity beams produced by these signals have great penetrating power. This is important when atmospheric conditions are unfavourable. This increases the range of visibility.

(c) No moving parts are used. Hence, maintenance required is less, No of failures is also less.

(d) As the structure is light and small, mounting is easier.

(e) Backgrounds such as trees and buildings etc., which are bad backgrounds for semaphore/signals, are good backgrounds for colour light signals.

(f) Aspects can be displayed at driver's eye level.

(g) Operation is very quick.

The disadvantages of colour light signals are: -

(a) Close up view is difficult.

(b) Glare at night.

(c) Limited visibility on curves.

(d) Lamp failures are frequent.

(e) However with latest technology like triple pole lamps, LED signals the above disadvantages can be minimised.

1.3 Description

In multi-unit type a separate light unit is provided for each aspect to be displayed. The main parts of a 3-unit type are shown in Fig.1.1(a & b). Multiple Unit Colour Light signal units are separated from each other and fitted one cast aluminium or a sheet metal case. The light units are generally arranged vertically about 3" apart green on top, yellow in the middle and red at the bottom, for 3-aspect signal. Each signal unit is provided with a shield for providing good background and each light unit with a hood to prevent sunlight falling directly on the lens. Below the units a compartment with two terminal blocks for the termination of cable and for internal connections is provided. Separate waterproof-hinged covers are provided for the light units and terminal box.

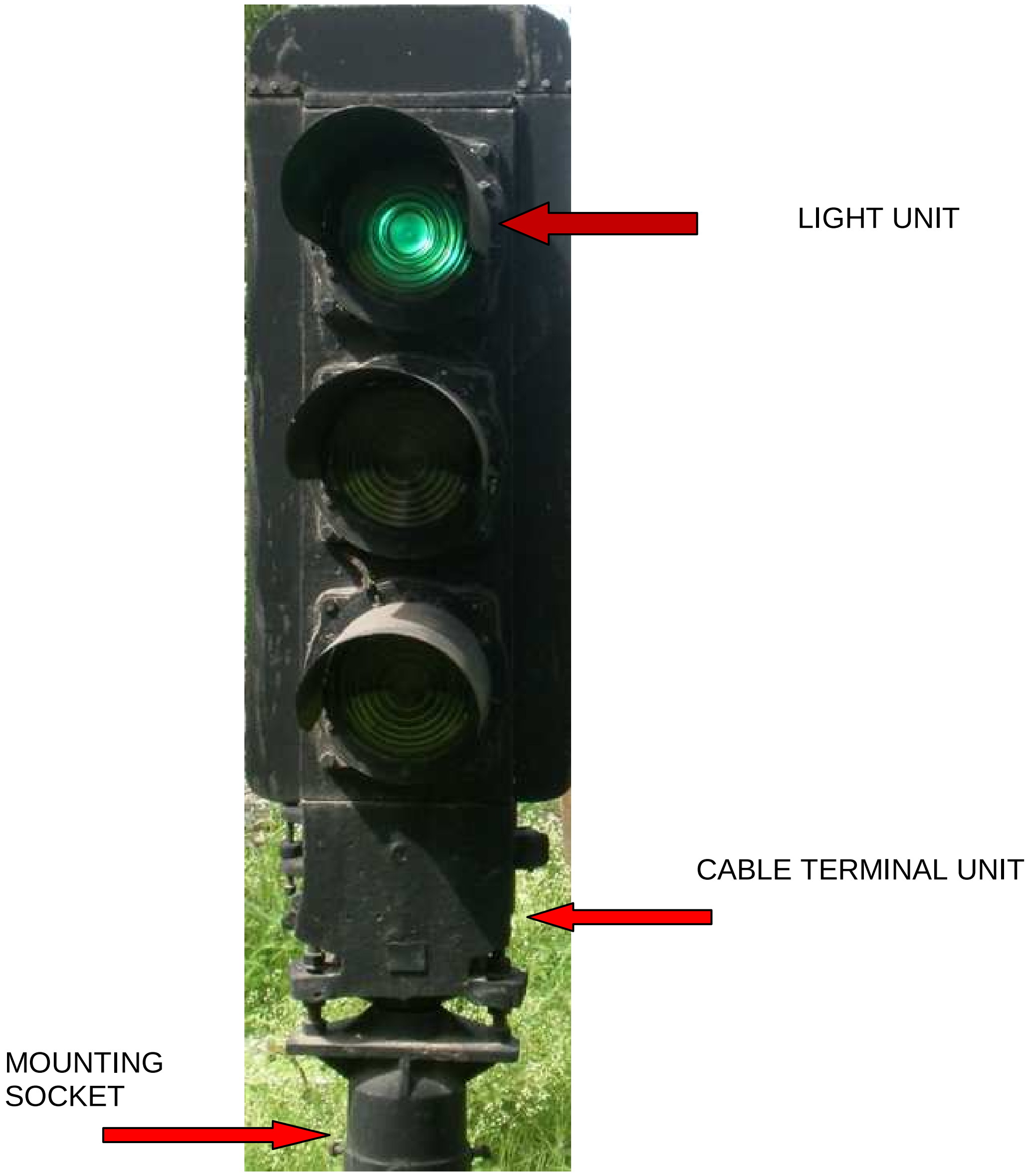


Fig.1.1 (a) 3-ASPECTS - MACLS UNIT

1. Clear outer Lens
2. Coloured inner Lens
3. Frame
4. Lamp Holder unit
5. Bracket
6. Lamp

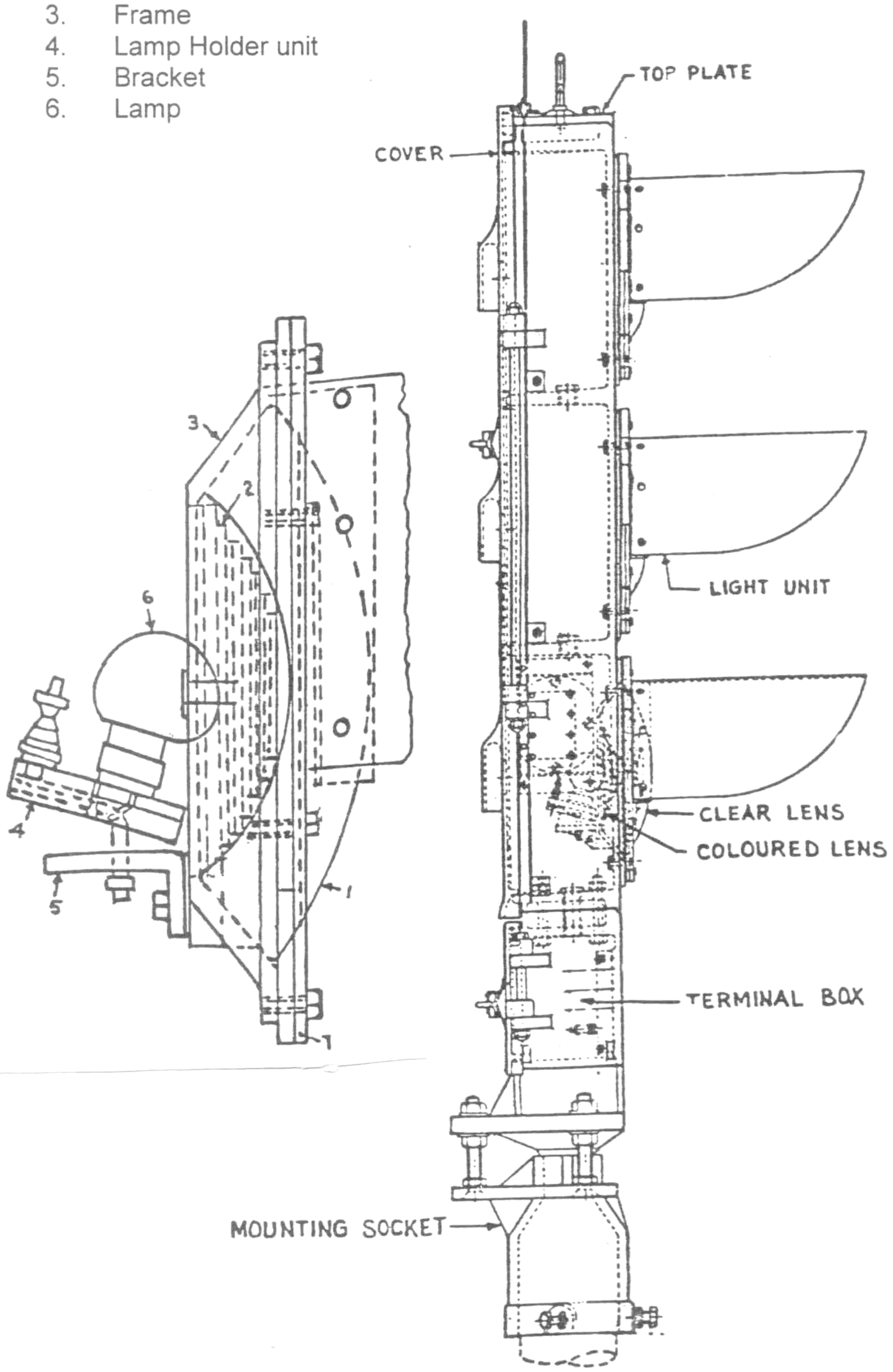


Fig.1.1(b) SIGNAL COLOUR LIGHT-MULTIUNIT TYPE

1.4 Normally the red aspect is kept at the lower compartment at driver's eye level. Breathing holes are also provided on the cover, one for each compartment to ensure ventilation. Suitable expanded metal netting may also be provided over the external lenses to prevent damage of the lenses. To increase the visibility, steel backgrounds are provided. Each aspect is normally provided with a hood to shield the lens unit from external light. Reflectors are not used in multiunit signals as it is necessary to ensure that outside light source such as that from an engine headlight or sunbeam are not reflected back, through the lens to give phantom indications to the drivers.

1.5 Focusing Arrangements

To ensure good visibility it is essential that the light unit is focussed to align the beam of light towards the driver. As the red aspect is more important, it is kept at driver's eye level. For the purpose of focussing all signals are fitted with lugs drilled with small apertures at the bottom of the unit to form an aperture sighting arrangement. These two holes are aligned in the direction of the approaching train. The mount socket (turn table) is fixed on the post with three bolts and by proper adjustment of these bolts, the entire unit can be titled either vertically or horizontally for correct alignment of the beam of light.

The complete CLS unit is fixed over the turntable. It is useful to turn the unit both horizontally and vertically for correct adjustment of the beam light.

For sighting a signal from a particular spot on the track, Sighting Apertures are provided on the right side of the signal units on terminal box (two numbers). These two holes are provided externally and aligned in the direction of the approaching train.

Signal Lamp Holder & Bracket: It will have slotted notches both in horizontal and vertical position. Bracket is fixed over the conical casting of the signal unit. Vertically it can be aligned, for vertical adjustment of focusing of the signal. In horizontal slotted notch, the lamp holder will be fixed for keeping the main filament exactly at the focal point of the lens combination.

Focus the aspect lamps as per the procedure explained below:

See that the signal post is in proper plumb and that all the fixing bolts of foundation base and unit base are tight.

See if the unit is properly aligned with aspects turned towards the track at the farthest Point where the signal should be sighted first. If the unit seems to be away from or closer to the track, loosen nuts on the turntable bolts and adjust its position. The curve or gradient within the signalling distance shall be taken into account while doing it. Unit may be tilted forward or backward, as necessary before fixing it.

Fix a sighting object at the point of maximum required visibility on track or place a man there with a walky-talky.

Perch yourself on the ladder behind and viewing through the lug aperture on the right hand bottom of the unit, turn the unit as required. Tighten the nuts of turntable bolts.

Now, for focussing of the lamp, loosen the fixing studs of lamp bracket, moving it gradually up and down, arrive at a position so that a complete round bright spot is formed at the middle of outer lens. Fix the bracket in that position by tightening its screw studs.

Loosen the nuts on holder bolts below bracket. Moving holder to and fro, bring it to a position at which the aspect is able to be sighted its brightest form from the maximum required visibility distance. Tighten the nuts.

Finally moving along the entire sighting distance, make sure that the signal can be sighted well and continuously for 200 m towards the signal from the farthest point of visibility.

Each CLS unit consists of

(a) Lens arrangement,

(b) Signal lamp, and

(c) Transformer.

1.5.1 Lens arrangement

Each aspect of a colour light signal is a complete light unit in it. Each unit comprises a concentrated filament electric lamp accurately focussed behind an efficient lens system, using a doublet combination of 2 lenses Fig.1.2 (a). These lenses are concave, convex, combination the inner lens being coloured, red, yellow or green and the outer clear lens being a plane lens. The 5½" (140 mm) dia x ½" focus inner lens is stepped outside whereas the outer lens is stepped inside and is of 8 ⅜" (213 mm) dia x ½" focus mounted on a conical casting of the unit.

The advantages of a step lens over a plane convex lens are:

(a) Reduced variation in thickness, which reduces the light absorption.

(b) The improved, accuracy of refracting surface.

(c) Saving in weight (about 1/7th of plane convex lens).

(d) Increased thermal endurance (max. safe tem. is about 100^{0}C as against 45^{0}C in case of plane convex).

(e) Flexibility in optical design, which enables better use of the light, emitted.

It would be impracticable to make a (213 mm x 100 mm) plane convex lens. The strongest lens of that dia is of 11 ½ " focus, which only collects 6% of the light from the source. A single step lens usually collects 20 to 25% of the light and the combination of 2 lenses are used in multi-unit signal, known as toric combination which may collect upto 50% of the light emitted due to reduction of focal distance by the combination of lenses.

Doublet lens is used on the unit because more beam candlepower is obtained by this arrangement than with a single optical lens.

The lens combination collects light from the lamp through a solid angle of 155^0 and refracts this into almost parallel beam of light. The amount of useful luminous flux cannot be increased by using reflectors due to the possibility of phantom indications from the reflected headlight of trains approaching on sunrays.

If accurately aligned and focussed, the clear visibility of these signals is more than 1000 m in bright sunlight. The visibility of the signal at close range is however poor on curves as the driver passes out off the beam as he approaches the signals. This can be however remedied by the use of spread light lens giving 8^0 or 16^0 or 32^0 angular deflection instead of the usual clear lens. The greater the deflection the less efficient is the main beam and care has to be taken to accurately align the signal for maximum sighting distance combined with good close range visibility.

A driver standing under or very near a signal cannot read the signal properly as he is out of the direct line of focus of the beam. To obviate such a situation, close up indications are provided on the signal. This may be sidelight or deflecting prism in the outer lens. Where sidelights are provided a separate side light lamp and optical system is used for each aspect so that there cannot be any phantom indication in the main lens. The side light lamp is connected in parallel with the main signal lamp. It consists of a lamp and a colour lens. The lamp rating is 12 V / 4 W (SL 5) or 12 V / 6 W (SL 8) 2-Pin single filament. The code SL 5 indicates Signal Lamp serial number five.

A deflecting prism (Fig.1.2 (a) & 1.2 (b)) is fitted to the outer lens which diverts a part of the light as subsidiary beam at an angle of 35^0 from the main beam. This should be carefully adjusted and kept either to the right or left of the track depending on the location of the signal to give the best possible effect to a driver on the foot plate of an engine or cab standing at the signal.

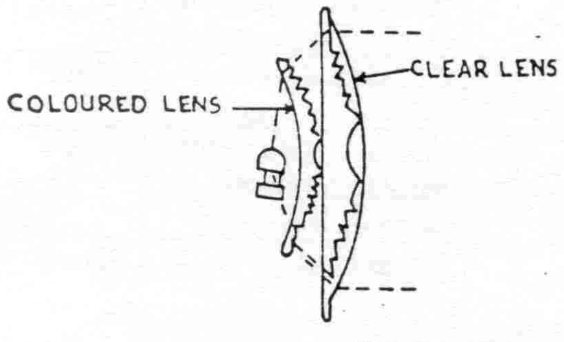


Fig: 1.2a SIDE VIEW OF STEPPED LENS

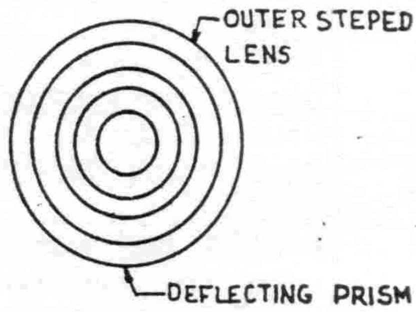


Fig: 1.2b FRONT VIEW OF LENS

The double lens unit used for long range signals has an outer lens of 8 ⅜" (213 mm) diameter with 4 inch (100 mm) focal length and an inner lens of 5 ½ " (140 mm) diameter where as that for short range signal the outer lens is 5" dia., and the inner coloured lens is 3.5/8" dia. The focal point of this lens combination is (½ ") at the back of the inner lens. Due to short focus of the 13 mm combination the lens collects 155^0 of effective light from the front of the lamp. The vazil rings and frame, which is hold the two lenses, are accurately machined so that when the signal unit is assembled the lenses will be held in their correct positions. The inner lens is coloured lens and stepped outside. Where as the outer lens is plane / clear lens and stepped inside. The stepped surfaces of the outer and inner lenses face each other. As both the lenses are concave convex, they help to throw a parallel beam of lights of high intensity.

Types of Multi-Unit Signals: -

Multi Unit colour light signals may be of short range or long-range type. The range of visibility of long-range signals is not less than 1000 m and for a short-range signal 350m. Doublet combination lens is used in both the cases but in short range type the outer clear lens is 160 mm (6 ⅜") dia against 213 mm (8 ⅜") clear lens used in long range signals. The coloured inner lens with outside step in either case is of 140 mm dia (5½ "). The short-range type is not generally used on Railways and the description given in this chapter pertains to long-range signals.

Sl. No	APPLICATION	DIAMETER AND COLOUR	TYPE	NOMINAL FOCAL LENGTH
1	Colour light signals multi unit type.	140 mm Red / green/ Yellow	Outside step	13 mm#
2	Colour light signals multi unit type (for stop signals only).	213 mm Clear	Inside step with spread light.	102 mm
3	Colour light signals, multi unit type (for stop signals only).	213 mm Clear	Inside step with moulded prism for close up indication	102 mm
4	Colour light signals multi unit type (for permissive signals only).	213 mm Clear	Inside step without moulded prism for close up indication	102 mm
5	Route indicator & Direction type indicator	92 mm Lunar white	Outside step	16 mm*
6	Route indicator & Direction type indicator	127 mm Clear.	Inside step with moulded prism for close up indication	70 mm

Sl. No	APPLICATION	DIAMETER AND COLOUR	TYPE	NOMINAL FOCAL LENGTH
7	Point & trap indicators, target type (clear only)	101 mm Red / Green / lunar white /Clear	Inside step	89 mm
8	Hand and temporary engg. Signal lamps, semaphore signal lamps (clear only)	136 mm Red, yellow, Green, and clear	Inside step	89 mm
9	Semaphore signal lamps	136 mm Clear	Inside step	89 mm
10	Calling "ON" colour light signal	136 mm Yellow	Inside step	89 mm
11	Position Light Shunt signal	101 mm Lunar white	Inside step	89 mm

* The focal length refers to doublet combination of the lens with 127 mm dia x 70 mm focal length inside step clear lens.

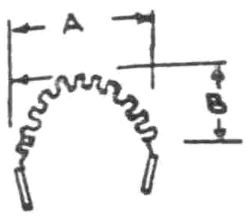
The focal length refers to doublet combination of the lens with 213 mm dia x 102 mm focal length inside step clear lens.

** The inside step clear lens, moulded out of polycarbonate material, shall confirm to Drg. No: S - 24845

1.6 Lamps Used for Colour Light Signals

A signal lamp consists of a helix of tungsten wire mounted within a sealed glass envelope. The tungsten wire or filament as it is called is so designed that it is raised to incandescence by the flow of electric current through it when voltage is impressed, across its terminals. The envelope is either evacuated or filled up with gas, which will not combine chemically with tungsten filament even at high temperature. Although rapid chemical decomposition of the filament is eliminated, the wire wears away gradually as the lamp "burns". This process is called "evaporation", atoms of incandescence, which condenses and forms a black deposit on the bulb.

During the life cycle the lumen output or candlepower of the lamp diminishes, partly on account of attenuation of the metal conductor, which reduces the wattage, consumed and partly as a result of black deposit of tungsten, which has evaporated. In common type of signalling lamps, the lumens output will have reduced to approximate, 15% just before the lamp fails.



The light output of a tungsten filament depends entirely upon the temperature at which it operates, which in turn depends on the voltage impressed. This relationship is illustrated in curve, of Fig. 1.3(a). The efficiency of the lamp as a light generating device also varies with the filament temperature and voltage. This is shown in Fig. 1.3(b) by curve 'P'.

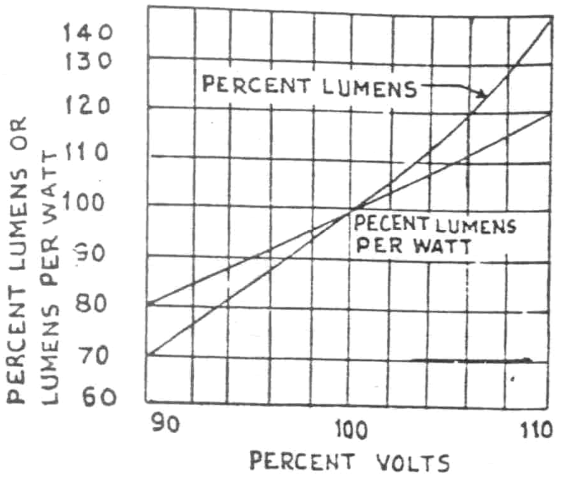


Fig: 1.3a LIGHT INTENSITY

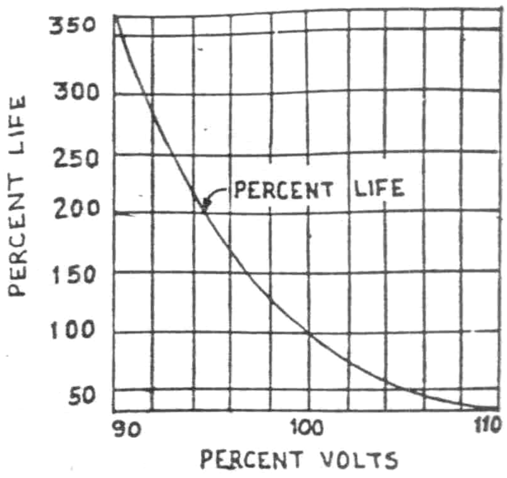


Fig: 1.3b LIFE OF LAMP

Light output and efficiency increase or decrease in proportion to the voltage impressed on the lamp, but the life of a lamp decreases as the light output and efficiency increases. The life, therefore, varies inversely with the voltage. It results from the fact that the rate of evaporation is determined by the operating temperature of the tungsten wire. With higher operating temperature, the rate of evaporation is greatly increased.

As the light output varies quite rapidly with variation in voltage, at 90% of the rated voltage, the C.P. of the lamp is reduced to about 70% of the value of full rated voltage. Consequently, care must be exercised in reducing the lamp voltage that the intensity of the beam is not reduced to a point where atmospheric conditions can affect the integrity of the signal aspect.

Lamps burned at less than 80% of the rated voltage may have their filament temperature reduced to a point where chromatic of the signal light colour will be affected. For colour light signals a low voltage lamp (12 V) is preferred. Low voltage lamps take higher currents and therefore, current density is higher. Higher current density gives higher temperature thereby increasing light output and efficiency. A high voltage lamp (110 V /33 W) has resistance of

$$\frac{110 \text{ X } 110}{33} = 367 \text{ Ohms and 300 milliamps.}$$

This would mean a long and thin filament, on the other hand a 12 V /33 W filament will have only 12 X 12 about 4.3 ohms, Current 2.75 Amps and therefore, the filament is sufficiently thick and short. A thick filament would technically strong. Especially for the colour light signals kept closer of the track and subjected to vibrations. A long filament will have most of its light outside the focal point and hence, the brilliance of the lamp will be effected.

LAMP No.	A	B
	MAX.	MAX.
SL 4 and 21	3.6	1.5
SL 13.16.24.28.32	4.8	2.4

Dimensions in mm.

The plane containing the filaments of a lamp No. SL 4.13 & 16 shall be normal to the axis of the cap pins. Over all dimensions of short bow filament for lamps SL 4, 13, 16, 23 to 28 inclusive 32.

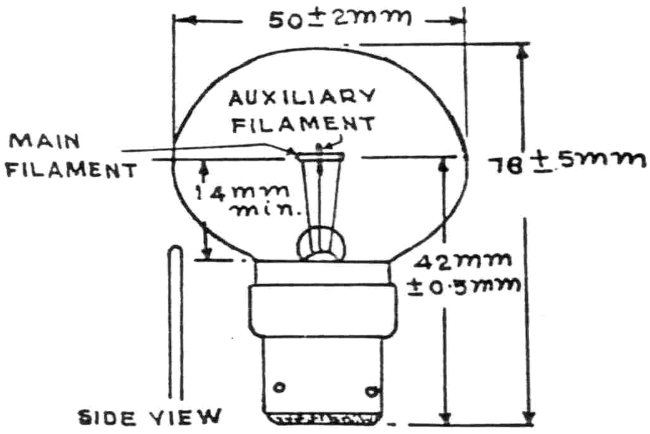


Fig: 1.3(c) FILAMENT CONNECTED IN PARALLEL

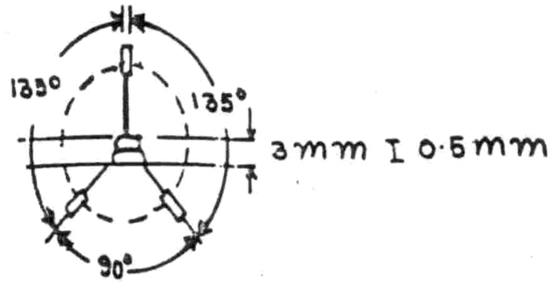


Fig: 1.3 c. ILLUSTRATIONS OF LAMPS NOS. SL 17, 21 and 22

The following three types of signal lamps are generally available for use on multiple aspect colour light Signals: -

Sl. No.	Type of Signal	Rating of filaments	Light output in lumens
1.	SL 17	Main filament 12 V / 16 W Auxiliary filament 16 V / 12 W	150 lumens
2.	SL 18	12 V / 24 W	275 lumens
3.	SL 21	Main filament 12 V / 24 W Auxiliary filament 16 V / 12 W	230 lumens

In the earlier installations of multiple aspect colour light signals, cascading arrangements (If an off aspect lamp fuses, then the Aspect becomes next most restrictive aspect) was not provided. Therefore, in those days and in such installations it was necessary to provide double filament signal lamps so that even in case of main filament failure, the auxiliary filament will be there to display the aspect though it may be very dim. This reduced the chances of drivers coming across blank signals. But some Railways continue to use double filament lamp even after (cascading) “Cutting-in” arrangement has been entered with the result that daily complaints are being received from the drivers and motor-men of signals displaying conflicting aspects such as Red and Yellow or Green and double Yellow etc. Because the lamp proving relays are not adjusted properly. If the signal is to function efficiently, the lamp proving relay, connected to the OFF aspect signal lamp should drop only when both the filaments have fused and the proving relay connected to the ‘ON’ aspect signal lamp should be capable of de-energising when any one of the filaments has fused for timely detection.

To overcome the problem, Railway has switched over to the use of single filament lamp (SL 18,12 V / 24 Watt) for the “OFF” aspects of colour light signal where ‘cutting-in’ is provided. If SL 18, 12 V / 24 W lamp is used where earlier SL 21, 12 V / 33 W lamp was in use for the “OFF” aspect, there may be complaints from the drivers and motor-men regarding impaired visibility of OFF aspect after the change-over. This argument is ill founded because it is evident from the specification of the lamp and which has been verified from actual use that the light output from the SL 18 lamp is much more than obtained from the SL 21 lamp. Even though the wattage is less by as much as 9 W, still the light output is more by 45 lumens because in the SL 18 lamp there is only one filament and the same is correctly focussed at the focal point of the lens whereas in the case of SL 21 there are two filaments and one of them have to be necessarily out of focus. It is therefore SL 18, 12 V / 24 W lamps for the OFF aspects of multiple aspect, colour light signals where “Cutting-in” arrangement is already catered in the design of circuitry.

Lamp failures with single filament lamps caused considerable traffic delays. This led in the first place to devising an arrangement with 2 similar single filament lamps, the second being normally comes in circuit by the failure of the first. As the second lamp will always be out of focus, the visibility was greatly reduced and hence, the later development has the 2 filaments known as "main" and "auxiliary" placed in the same envelope in the shape of double filament lamps. These are classified as two pole known as double pole (parallel burning) or triple pole (independent burning) as shown in Fig. 1.4(a).

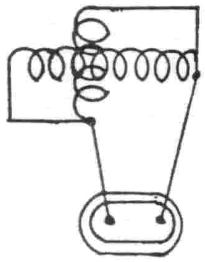
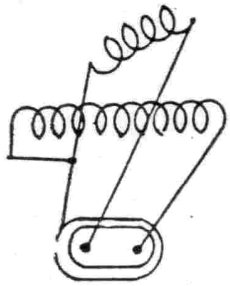


Fig : 1.4 a DOUBLE POLE



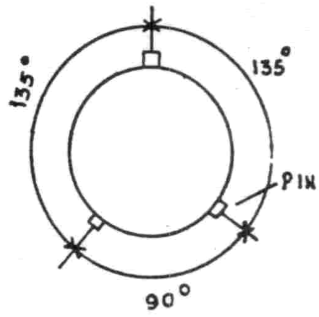


Fig : 1.4 b HOLDER PINS

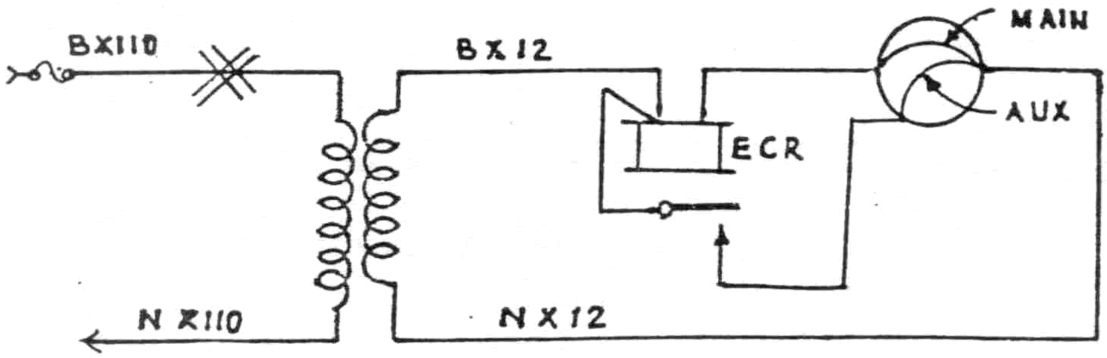


Fig: 1.4 c SCHEMATIC WIRING DIAGRAM

Double Pole Double Filament lamps may have centre contacts of 2-pin bayonet cap or triple pin type. As both the filaments are burning always, it is essential to maintain the auxiliary filament at a lower voltage to prevent its failure before the main filament fails. As an example, in the type SL 17 (12 V / 25 W) double filament double pole 3 pin lamps, main filament is rated at 12 V / 16 W and the auxiliary filament at 16 V / 12W. The other type of lamp used for multiunit type is SL 21 (12 V / 33 W) double filament, double pole, 3 pin in which the main filaments is rated at 12 V 24W and the auxiliary 16 V / 12 W. The main horizontal filament is placed at the focal point of the lens combination whereas the vertical auxiliary filament is slightly away. In order to ensure that the main filament is at the correct focal point 3-pin caps are used. As shown in Fig.1.4 (b), the three pins are not at 120 deg apart and hence, insertion of the lamps in any position other than the desired position is not possible. The lamp has 2 bases, the inner one is for sealing the envelope and the top one with the pins is used for rebasing to get the filaments in the correct position. In SL 21, one filament is horizontal in position and other filament is vertically placed. As the two filaments are burning simultaneously, at the place of crossing of the filaments, more heat is generated and the filament is fusing earlier. So the life of the lamp getting reduced. This is the hot spot problem. To overcome this problem, triple pole lamps came in existence. In these lamps, the common connection of the filaments is connected to the shell and the other end of each of the filament connected to the contact plate Fig.1.4(a). With triple pole lamps, a lamp-proving relay (MECR) is used in series with the main filament. When the main filament fails, the auxiliary filament is brought in circuit through the de-energised contact of the MECR Fig.1.4 c. As both the filaments are not burning together the auxiliary filament can also be rated at the same voltage (12 V) as that of the main filament.

In SL 35 Triple Pole, double filament and the main filament is horizontally located with the ratings of 12 V, 24 W and the auxiliary filament rating of 16 V, 12 W, vertically placed. In these lamps, when main filament fused, the auxiliary filament came into circuit, with a dim light, because of less wattage.

In SL 35A Triple Pole, double filament and both filaments are kept horizontally located with the ratings of 12V / 24 W both main and auxiliary filaments.

In SL 35B Triple Pole, double filament and both filaments are kept horizontally located with the ratings of 12 V / 33 W / 33 W for both main and auxiliary filaments.

Table-1 Dimensions of Signalling Lamps (B.S. Specification No.469)

Ref.	PURPOSE * Types Recommended By RDSO	Rating Volts	Watts	CAP	Fig No	Length	Tolerance On Length	Dia meter	Tolerance in dia ±mm	Light Centre Length mm	Tolerance On light centre length ±mm	Torsion Test	Remarks
*SL5	Signal and point Indication behind levers. Signal box diagrams, multi lamp route indicator with parallel connection	12	4	B.15d/17	-	32.5	2.5	18	1	-	-	10	V or Bow filament
SL8	Side light for colour light Signal Marker lights, Semaphore Signals.	12	6	B.15d/17	-	32.5	2.5	18	1	-	-	10	V or Bow filament
*SL16	Search light Signals, Point Indicator.	12	12	B.15d/17	1	56	4	38	2	32	0.5	10	V or Bow filament
*SL17	Multi Aspect Day CLS Marker lights.	12 Main	16	B.22	2	70	5	50	2	42	0.5	25	Double Pole
*SL21	Multi Aspect Day colour light Signal - Marker lights.	16 Aux. fil. 12 16	12 24 12	3 Pin	2	70	5	50	2	42	0.5	25	Double Pole
SL28	Search light Signals	12 Main fil. 16 Aux. fil.	12 16	B.15d/17 B.15d/17	1.3	5 56	4	38	2	32 32	0.5 0.5	10 10	Double Pole
*SL30	Illuminated diagrams and control panels.	12	1.2	-	5	-	-	-	-	-	-	-	V or Bow filament

Table-1 Dimensions of Signalling Lamps (B.S. Specification No.469)

Ref.	PURPOSE * Types Recommended By RDSO	Rating Volts	Watts	CAP	Fig. No	Length	Tolerance on length	Diameter	Tolerance in dia ±mm	Light centre length mm	Tolerance on light centre length ±mm	Torsion test	Remarks
SL 30	Illuminated diagrams and control panels.	24	24	-	5	-	-	-	-	-	-	-	Red end piece, Yellow end piece.
SL 32	Search light	12	12/16	B.15d/17	1.3	56	4	38	2	32	0.5	10	Triple Pole
***SL 33**	Position light junction	110	25	B.22/25x 26 (3 pin)	-	75	5	50	2	40	0.5	25	-
***SL 13**	Multi lamp type Route indicator with series connections	6	1.2	B.15d/17	1	56	4	38	2	32	0.5	10	V or Bow filament
***SL 18**	Multi Aspect colour light Signal	12	24	B.22/25x 26 (3 pin)	4	70	5	50	2	42	0.5	25	-
***SL 35A**	Multi Aspect colour light Signal	12	24-24	-	-	-	-	-	-	-	-	-	Triple pole 'OFF' Aspect
		12	33-33	B.22/25x 26 (3 pin)	-	77± 6	-	50± 2	-	42±0.5	-	-	Triple pole with filaments parallel 'ON' Aspect.

Sl. No.	Reference	RATING		AVERAGE INITIAL WATTS		Average initial efficiency L/W min.	Average initial Lumens min.	Coefficient of variation of initial efficiency (Max) %	Ageing period @ rated Volt hours	Specified line hours
		Volts	Watts	Maximum	Minimum					
1	SL 5	12	4	4.4	3.6	6.0	23	8	1	100
2		12	6	13.0	Sec BS 941	9.0	107	6	1	1000
3	SL 16	12	12	13.0	11.0	9.0	107	6	1	1000
4	SL 17	12	25	27.0	23.0	6.3	150	5	1	1000
5	SL 21	12	33	35.5	30.5	7.4	230	5	1	1000
6	SL 28	12	16	17.2	14.8	8.0	120	5	1	1000
7	SL 30	12	16	1.3	1.1	2.6	3	20	2	1000
8	SL 31	24	24				Sec BS 1050			
9	SL 32	12	12 16	13 17	11.0 14.8	9.3 12.5	106 178	6 6	1 1	1000 250
10	SL 33	110	25	26.5	22.5		130	6		500
11	SL 13	6	12	13	11	10.0	115			1000
12	SL 18	12	24	26.0	22.0	12.0	275	5	1	1000
13	SL 35	12	24/24							1000
14	SL 35A/ SL 35AL	12	24/24							1000/5000
15	SL 35B/ SL 35BL	–	–	–	–	–	–	–	–	1000/5000

Note: All Lamps except SL5 are Gas filled.

The following are the important instructions for the maintenance of signal lamps: -

(a) Lamps must be replaced with similar lamps.

(b) Lamps must be inspected every day or at intervals specified, by the maintainer to see

(i) That they are burning properly.

(c) Receptacle and base of lamp must be clear to ensure proper contact.

(d) Care must be exercised when replacing lamps to see that the pins in the base are turned to the end of the slots in the receptacle and forced into place by the contact spring.

(e) Applied voltage must not be more than the rated voltage of the lamps and should not be more than 90 % of the rated voltage (10.8 V). Not less than 80% percentage of the rated voltage (9.6 V)

(f) Lamps should be tested prior to or when installed to determine their fitness for use. To test lamps apply voltage of not less than 90% and not more than rated lamp voltage for a period of 10 minutes. If the filament burns excessively bright or after burning the filament has lost its shape or the bulb is discoloured the lamp should not be used.

(g) Lamps should be stored in clear dry place.

(h) Where practicable, signal lenses roundels and reflectors should be cleaned without removing the lamp.

(i) Voltage reading at lamp must be taken each time the lamp is replaced.

(j) Double filament lamps must be replaced when one filament fails.

(k) New lamps should be handled carefully and as little as possible before placing in service. Jerking should be avoided so that filament will not be distorted.

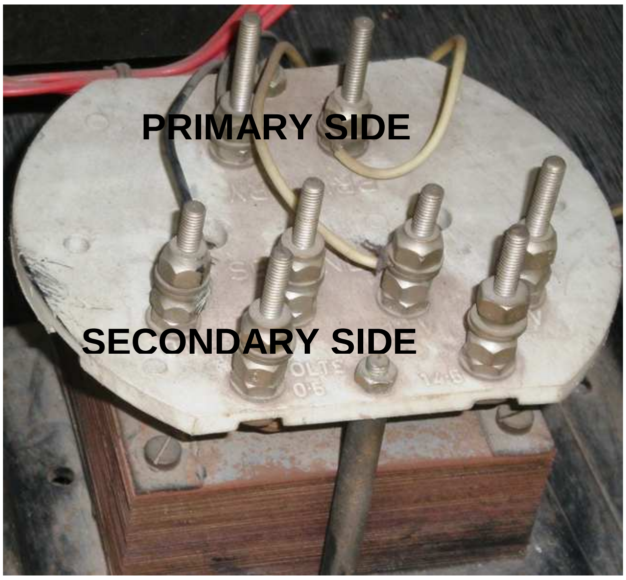
(l) Maintainers should not carry lamps in their toolboxes. A spare lamp should be stored in one apparatus case near every station.

1.7 Signal Transformer (IRS: S 59)

The rated voltage of colour light signal of multiunit type is either 110 V 50 C/S AC (high voltage) or 12 VDC / VAC (low voltage). Usually the high voltage is used for CLS. The low voltage type is preferred where the signal lamp is fed from a standby battery.

In the high voltage type a transformer 110 / 12 V / 40 VA 50 C/S is provided for each aspect in the respective unit. Without a transformer, if the lamp is directly connected to the cabin as the lamp current is about 3 A (for SL 21 12V / 33W), the voltage drop in cable will be very high. As an example, let us assume a cable resistance of say 10 ohms, the voltage drop being roughly 30 V. Hence, the voltage to be maintained at the cabin is about 42 V, and in this case, most of the power supplied is lost in the cable. Further, the voltages to be maintained at the cabin will have to be different for different signals, as all signals are not located at the same distance. Use of a transformer at the signal reduces the current in the cable to about 33 W / 110 V = 0.3 A.

Hence, the drop in voltage under the same condition will be only (0.3 A X 10 OHMS) about 3 V out of 110 V supplied. Hence, the voltage drop is negligible and the same 110 V supply can be used for all signals. Tapings are provided either on primary side or on secondary side of the transformer to get the specified voltage across the lamp irrespective of line drop and drop due to series repeating apparatus, in the figure 1.5.



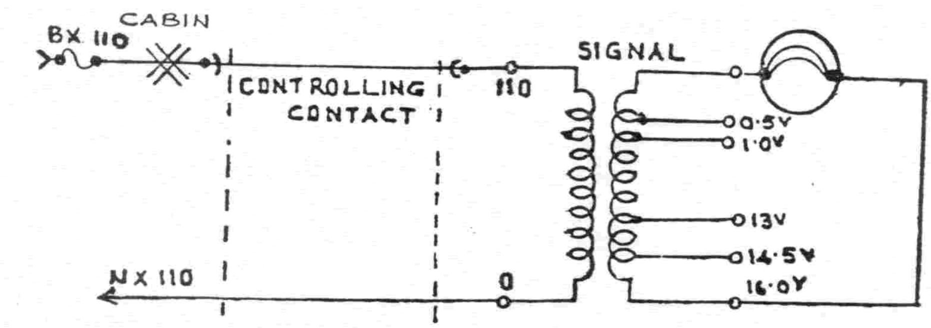


Fig: 1.5 SIGNAL TRANSFORMER

Transformer rating is 110 V / 12 VAC, 40 VA, 50Hz. Minimum capacity of the transformer is 40 VA continuous. No load current shall not be more than 15 ma.

$$\% \text{ Regulation} = \frac{\text{No load voltage} - \text{Full load voltage}}{\text{No load voltage}} \times 100$$

% Regulation measured on secondary side shall not be more than 15%. Signal Transformers are available in two types.

(a) IRS type (IRS: S-59). It is having tapping on secondary winding.

(b) Siemens type: It is having tapping on primary winding.

Voltages mentioned above on Transformer tapping are nominal voltages at “No Load”. Insulation Resistance shall not be less than 100 MΩ with 500 VDC Megger. It shall be measured between the core and each winding and also between the primary and secondary windings.

In AC RE area, to increase the range of operation of signals by direct feeding method 300 V/12 V Signal Transformers have been used.

NOTE: *As per Railway Board’s Letter No.96/Sig/M/4 dated 01.10.1997, 110 VAC feed system should be provided on all future colour light signal installations.*

CHAPTER 2: SIGNAL INDICATION CIRCUITS

2.1 INTRODUCTION

Repeating the aspects of multi-unit signal: As no backlight is provided on colour light signals, the aspects of the signals are repeated in the cabin when the signals are either manual or semi-automatic. Even though in lever controlled signals all the aspects are repeated individually, it is often considered sufficient to give only two indications, one for 'ON' and the other 'OFF' indication common for all 'OFF' aspects. As cabin indicator used for lever-controlled signals is designed as a single unit so arranged that additional units can be bolted to the top of it. Any number of units (2 or 3 or 4) can thus be used to form a multi-aspect indicator. The case is of black moulded insulation and the pull off door of the same material at the back of the case provides easy access to the lamp holder. For signal repeating, it is usual to have a coloured dome glass of about 1 1/4" dia, the colour corresponding to the aspect repeated. (The same indicator can be used for repeating point indications and in such case the coloured dome will be replaced by a ground glass with stencils N or R behind it). The lamp used is SL 5, 12 V / 4 W single filament bayonet cap 2-pin type.

2.2 The methods adopted for repeating signal aspects are

(a) Using potential drop method.

(b) Using current transformer method.

(c) Using signal proving relays method.

2.2.1 Potential drop method

In the potential drop method a resistance in series with each of the supply leads to the signal is connected and thereby a potential difference of about 12 V is obtained when the signal lamp is burning (Fig.2.1 (a). This potential drop is utilised to light the 12 V / 4 W (SL 5) indication lamp connected across the resistor. When the signal lamp fails, the signal transformer will work as a choke and draws only a no load current. This current will not produce enough voltage for burning the indication lamp.

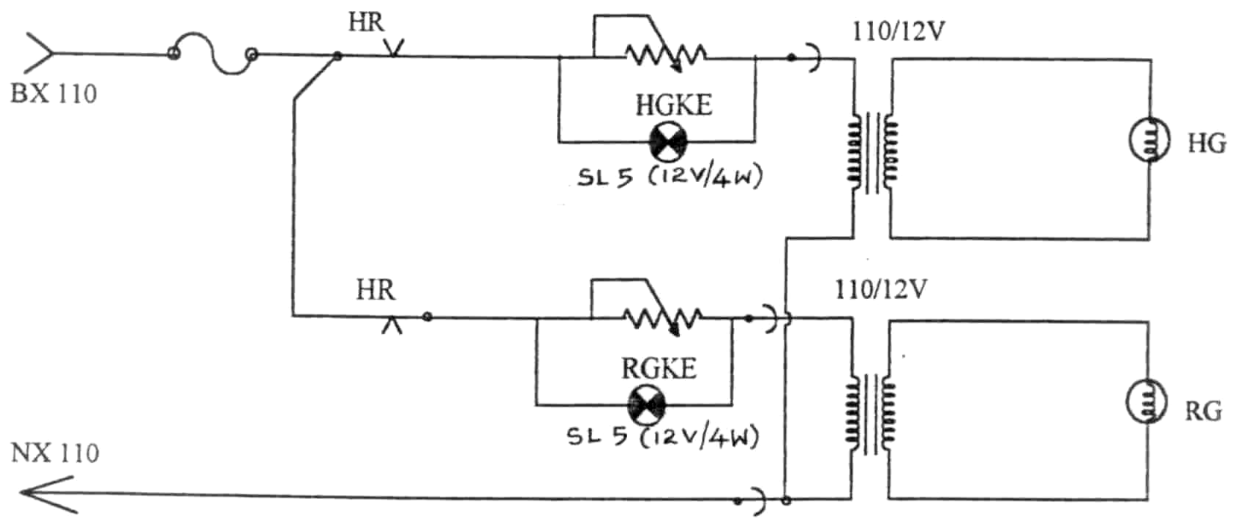


Fig: 2.1(a) POTENTIAL DROP METHOD

Drawbacks:

(a) There is an EXTRA VOLTAGE DROP across the resistance. So, we may not get sufficient voltage to lit the signal lamps of the signals which are far away from the cabin. Hence, this method is some times used only for nearer signals.

(b) There will be constant dissipation of power due to heating effect of the resistance.

(c) Cascading arrangement cannot be provided.

(d) If one filament of the signal lamp is fused, the remaining filament may draw the current, which may produce sufficient voltage drop across the resistance to glow the indication lamp.

(e) If more relay contact are available on the signal control relay (DR in this case) economical arrangement using only one resistance as shown in Fig.2.1(b) may be used. This method can be adopted in other cases of lamp repeating also. For the purpose of explanation the signal is assumed to have only 2 aspects. The same principal is extended to 3 and 4 aspect signals also.

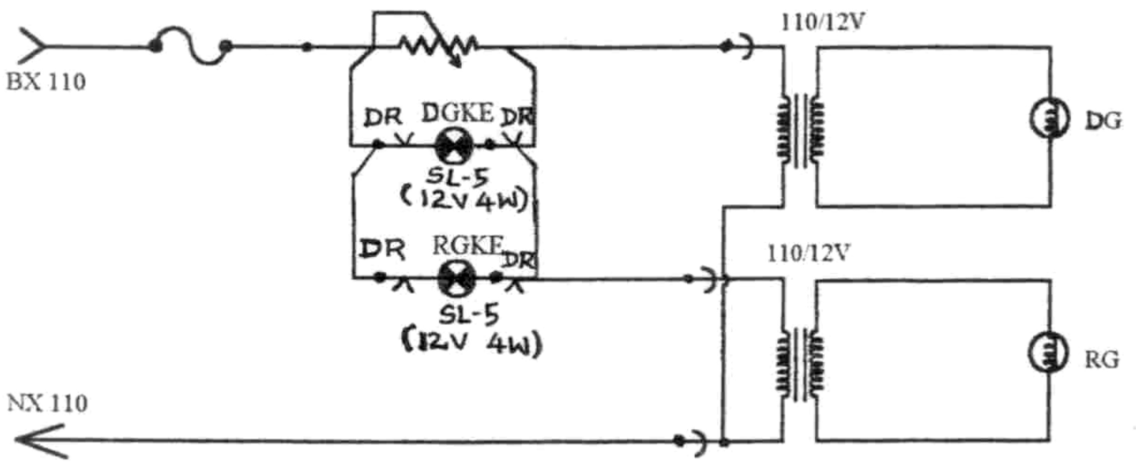


Fig: 2.1(b) POTENTIAL DROP METHOD BY USING (ONE RESISTANCE)

2.2.2 INDICATION TRANSFORMER METHOD

The second method uses a current transformer in lieu of the resistance (Fig.2.1(c). Current transformer is generally used in power engineering for the measurement of currents in high voltage circuits. The primary of this transformer is connected in series with the high voltage circuit and across the secondary having large number of turns, the ammeter is connected. In this arrangement large currents are measured. Further, the ammeter need not be insulated to the same high voltage. Transformers working with the same principle are used for indication purposes and hence, they are called indication transformers Fig. 2.1(c).

When the signal lamp is burning the current drawn by the signal transformer primary is large to compensate for the secondary load ampere-turns. Hence, the ampere turns produced in the primary and therefore, in the secondary of the current transformer are more which gives nearly 10 V for the indication lamps to light up. When the signal lamp is fused, the signal transformer draws less current and therefore, the current in the primary of current transformer is reduced. This reduces the secondary induced emf. And therefore, the lamp is dim. This current transformer having the indication lamp (12 V / 4 W SL 5) directly connected is known as I type. The primary current is in the range of 0.3 A, the voltage ratio primary to secondary is 10/7 volts + 5%. The secondary load is 2.5 VA at 7 V. If the cascading arrangement is to be provided, ECR methods are used.

Drawbacks:

(a) Dim glow indication may appear in case of signal lamp failures.

(b) Not suitable for cascading arrangement.

(c) Failure of the indication lamp affects the signal lamp voltage.

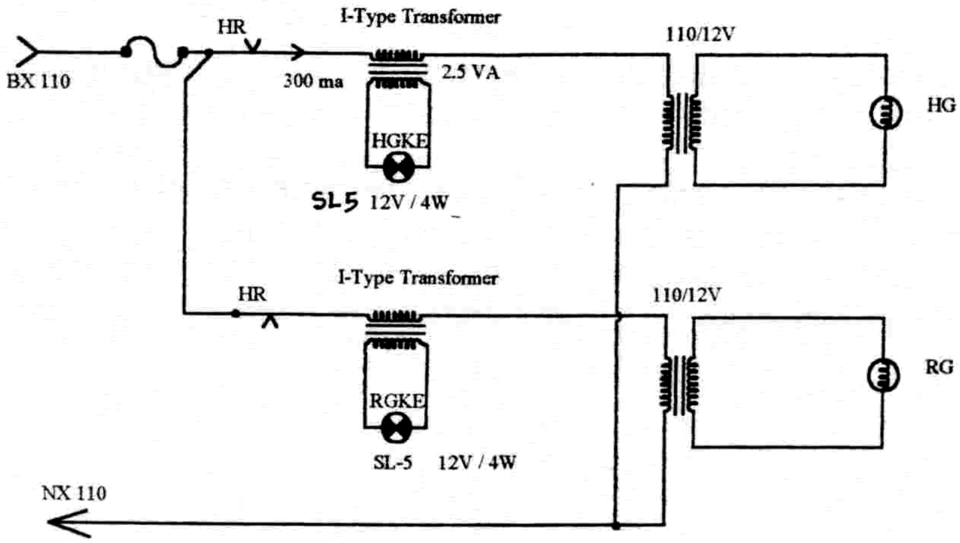


Fig: 2.2 INDICATION TRANSFORMER METHOD

2.2.3 ECR METHOD

(a) ECR METHOD USING SIGNAL LAMP PROVING RELAYS

There are 2 other types of current transformers used for energising lamp checking relays type H & type L. Where the volt drop is to be reduced to a negligible minimum and also aspect proving in other circuit is required the third method of using lamp-checking relay is preferred.

In this method a small amount of voltage is dropped across a resistance connected in series with the supply leads. This AC voltage drop is rectified by a bridge rectifier and the output DC voltage is made to operate a DC relay. The voltage required for the relay can be adjusted, by varying the resistance. When the Signal Lamp fails, the current through the resistance decreases and therefore, the voltage across the relay drops below the drop away value. The dropping of the ECR disconnects the indication lamps.

As already pointed out the main advantages are: -

(i) Less line voltage drop.

(ii) Failure of indication lamp does not affect the signal lamp voltage.

(iii) Contacts of ECR can be used for the circuits requiring the proving.

(iv) When the signal lamp fails, the supply for the indication lamp is completely cut off thus avoiding the dim glow.

The only drawback of this arrangement is that it is costly requiring the lamp proving unit and a separate 12 VAC indication supply. In RE area current transformers type L and type H are used to enable a 1000 ohms line relay to be used as ECR.

(b) ECR Method using ' L'-type Transformer

This method is suitable where the signal lamps are directly fed from the cabin, for DC RE areas, Non-RE areas and up to 605 M distance from the cabin in case of AC RE areas. Fig.2.3 (a & b).

In this, L-type current transformer is connected in series with lamp circuit (i.e., with primary of signal lamp transformer. L-type Transformer is suitable for low current in the range of 300 mA. on the primary; the secondary develops 9 V across it. The capacity of the L-type transformer is 0.09 VA. The voltage ratio is 0.5 V / 9V, +5%.

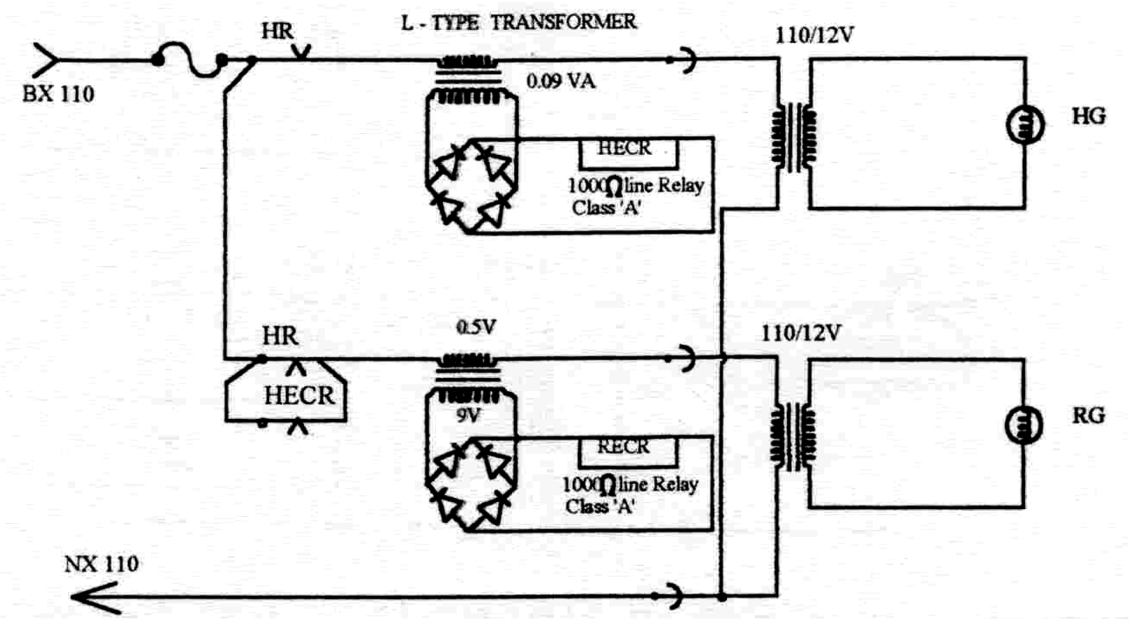


Fig: 2.3(a) ECR METHOD BY L - TYPE TRANSFORMER

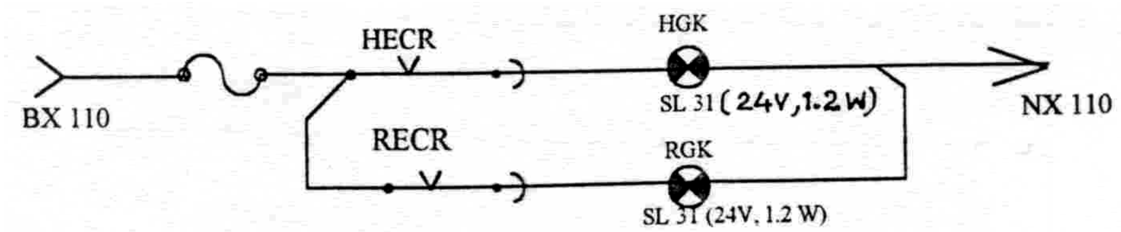


Fig: 2.3(b) INDICATION CIRCUIT

The Selenium bridge rectifier is connected across the secondary of the L-type current transformer. 'Class-A' line relay (BSS 165a) having 1000 Ω coil resistance, called as ECR, is connected to the output of the rectifier.

If the signal lamp lits, then the ECR picks up; and if the signal lamp is fused or not, lits, then the ECR drops. Concerned indications will appears on the panel through ECR contacts.

(c) ECR Method using 'H'-type Transformer

This method is normally used in AC RE areas, where direct feeding of the signals are not possible for long range of operation signals from the cabin.

In this, H-type current transformer is connected in series with the secondary side of the signal lamp transformer. H-type current transformer is suitable for high current in the range of 2.5 A on primary; the secondary develops 9 V across it. The capacity of the H-type transformer is 0.09 VA. The voltage ratio is 0.3 V / 9 V; +5%. The Selenium Bridge is connected across the secondary of H-type current transformer. Class-A line relay (BSS1659) having a coil resistance of 1000 Ω, called as ECR, is connected to the output of the rectifier. When the signal lamp is litting, the concerned ECR picks up. Then, its repeater relay picks up in the cabin. When the signal lamp is fused or not litting, the concerned ECR drops. Then, its repeater relay also drops. Signal lamp indications in the cabin is given through the contacts of ECPRs. Fig 2.4 (a,b and c).

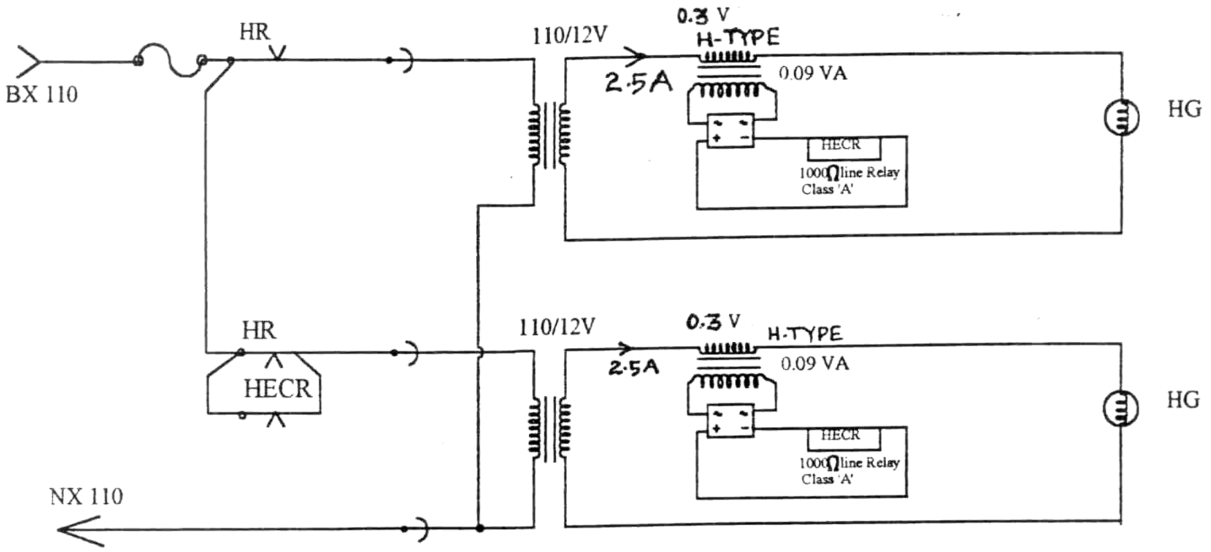


Fig: 2.4(a) ECR METHOD BY H - TYPE TRANSFORMER

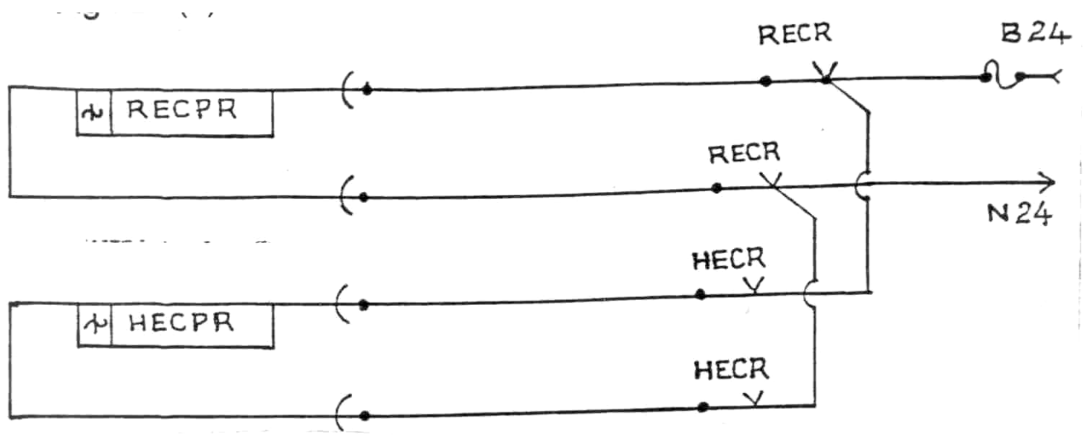


Fig: 2.4(b) ECR REPEATERS CIRCUIT

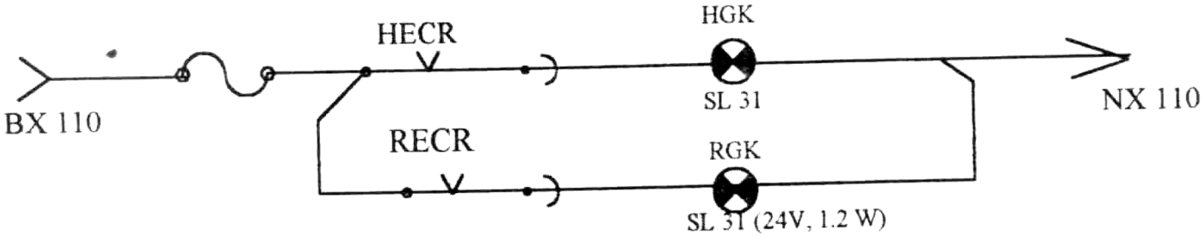


Fig: 2.4(c) INDICATION CIRCUIT

Advantages of ECR Methods:

(i) Less line voltage drop.

(ii) Failure of indication lamp does not affect the signal lamp voltage.

(iii) Contacts of ECR can be used for the circuits requiring the proving. When the signal lamp fails, the supply for the indication lamp is completely cut off thus avoiding the dim glow.

Drawback:

It is costly, since lamp proving unit and separate 24 VAC or 12 VAC indication supply is required.

CHAPTER 3: SIGNAL ASPECT CONTROL CIRCUITS

3.1 Introduction

In CLS, a Signal Control Relay must always control the signal. Without a control relay, the signal may have no aspect, when the signal lever is left in a mid-position. To make the circuit simplicity, signal aspect control relays are introduced. For 2-aspect signal, one control relay is required. Similarly, for 3-aspect signal, two control relays; and for 4-aspect signal, three control relays are required.

3.2 Two-Aspect Colour Light Signal Control Circuit

The relay HR or DR is controlled through the selection circuit proving all the conditions including signal/lever/button-operated contacts. The energisation of this relay connects "OFF" Aspect YELLOW or GREEN as the case may be. If any one or more conditions required to take off the signal is not fulfilled HR/DR is de-energized and the signal is maintained at "ON" Aspect. A 2-Aspect Signal Lamp Control Circuit is given in Fig.3.1.

TWO-ASPECT CONTROL TABLE

S.No	RELAY CONDITION	ASPECT
1	HR ↑ (or) DR ↑	HG (or) DG
2	HR ↓ (or) DR ↓	RG

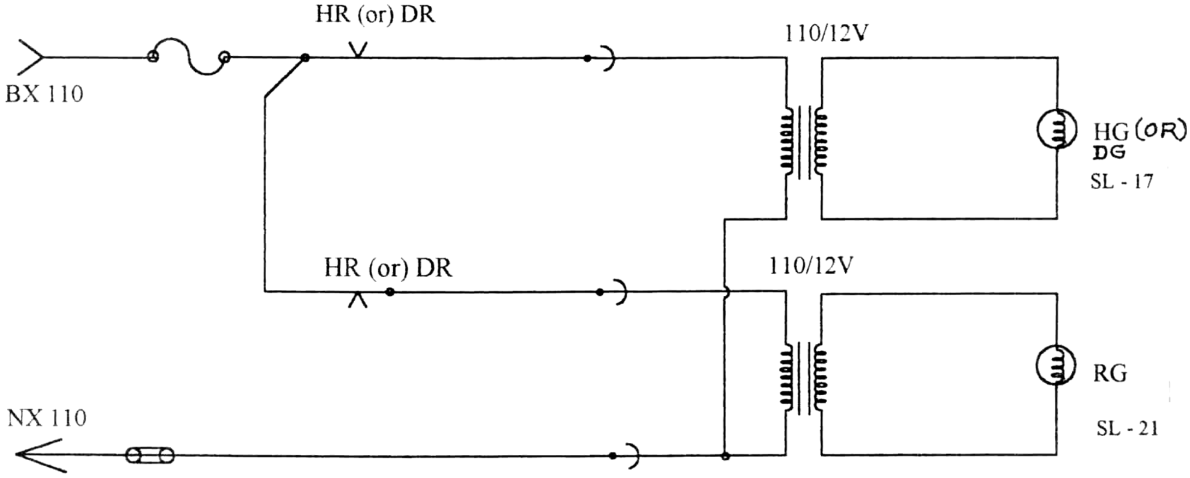


Fig 3.1 TWO-ASPECT CLS CONTROL CIRCUIT

3.3.1 Three-Aspect Colour Light Signal Control Circuit (STOP SIGNAL)

In this circuit HR, DR control relays are used. Where, HR is a Yellow/OFF Aspect control relay. DR is a Green Aspect control relay. HR relay is energized proving the conditions required up to next signal and overlap in advance of it. DR relay is controlled by the off aspect (Y or G) of the 3-Aspect Signal in advance. When HR itself is not energized, the signal is maintained at Red Aspect irrespective of the Signal Aspect ahead. When HR is energized (Yellow or Green) Aspect is selected through DR relay back contacts.

A front contact of DR relay is used for green aspect lamp circuit. A back contact of DR relay in yellow lamp circuit is used to prevent both yellow and green lamps lighting up when DR picks up. The control circuit for 3-aspect stop signal is shown in Fig.3.2.

THREE-ASPECT CONTROL TABLE

S.No	RELAY CONDITION	ASPECT
1	HR ↑ + DR ↑	DG
2	HR ↑ + DR ↓	HG
3	HR ↓	RG

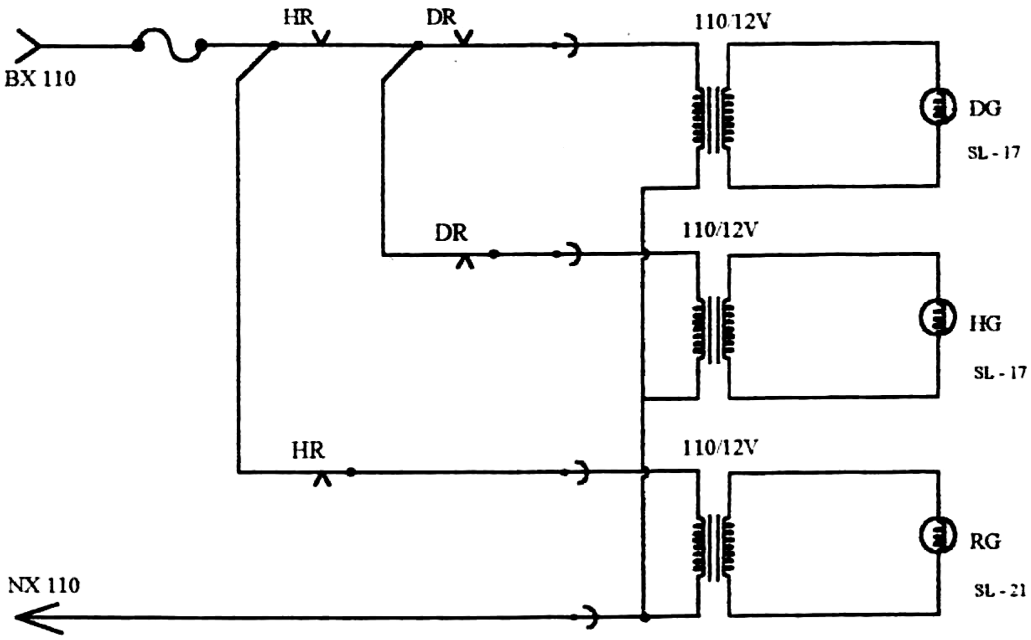


Fig. 3.2 THREE-ASPECT CLS CONTROL CIRUIT (STOP SIGNAL)

THREE ASPECT CONTROL

3.3.2 Three-Aspect Distant Signal Control Circuit (PERMISSIVE SIGNAL)

In this case, the green aspect-controlling relay of the distant (1D DR) is controlled through 5 NWKR and any of the 2 off aspect proving relays of the home signals (The method of connection and operation and operation of lamp checking relays, ECRS, are explained in the following paragraphs). The attention aspect controlling relay 1D HHR is energized whenever the Home Signal is OFF irrespective of whether the route is set for the straight or turnout. Normally, the distant signal displays yellow through 1HHR, HR back contact. When 1HHR energizes the signal displays double yellow and the bottom yellow lamp is now lit through HHR front DR back and another front contact of HHR. Another front contact of HHR is used to prevent the top yellow burning in parallel with bottom yellow when HHR is de-energized. The green aspect is displayed through HHR and DR front contacts. The control circuit for a 3-Aspect distant signal is given in Fig.3.3.

THREE-ASPECT CONTROL TABLE

S.No	RELAY CONDITION	ASPECT
1	HHR ↑ + DR ↓	HHG
2	HHR ↑ + DR ↑	DG
3	HHR ↑ + DR ↓	HG
4	HHR ↓	RG

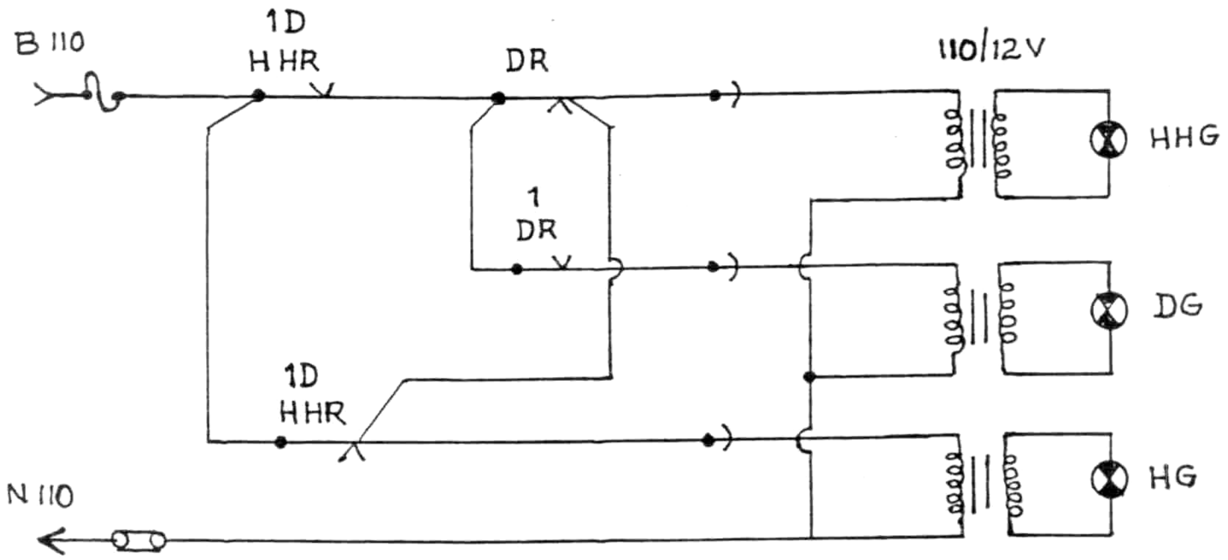
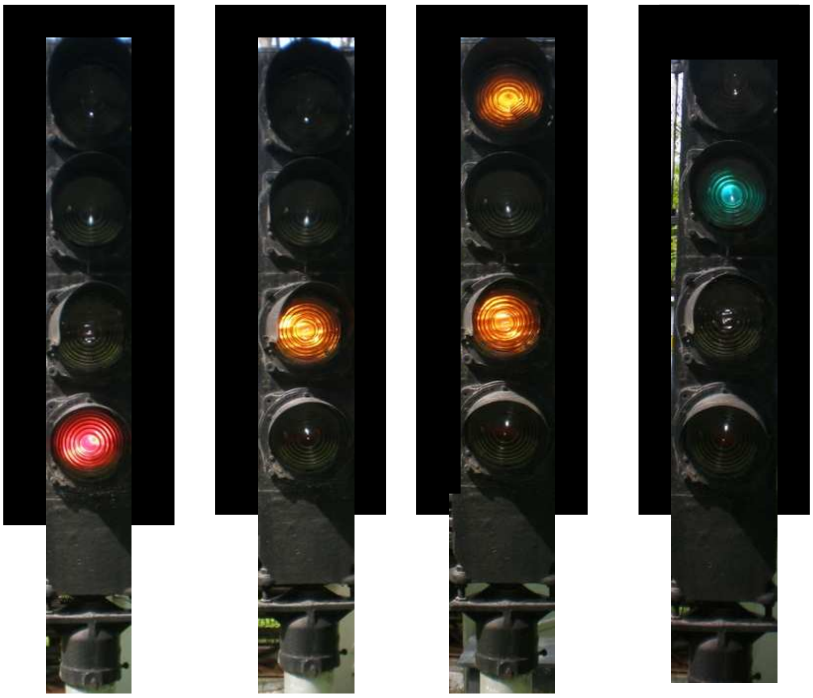


Fig. 3.3 THREE-ASPECT CLS CONTROL CIRUIT (PERMISSIVE SIGNAL)

3.4 Four-Aspect Colour light Signal Control Circuit: They are two methods

3.4.1 First Method

When HR is de-energized the signal shows red aspect. When HR alone is energized and the next signal is at "ON", the signal displays YELLOW aspect through DR back contact. When HHR is energized in addition to HR and the next signal is showing Yellow, the signal displays attention (Double Yellow) aspect. When DR is energized in addition to HR & HHR and the next signal is showing attention (Double Yellow) or proceed (Green), the signal displays GREEN aspect shown in Fig 3.4.



FOUR-ASPECT CONTROL

FOUR-ASPECT CONTROL TABLE

S.No	RELAY CONDITION	ASPECT
1	HR ↑ + HHR ↑ + DR ↓	HHG
2	HR ↑ + HHR ↑ + DR ↑	DG
3	HR ↑ + DR ↓	HG
4	HR ↓	RG

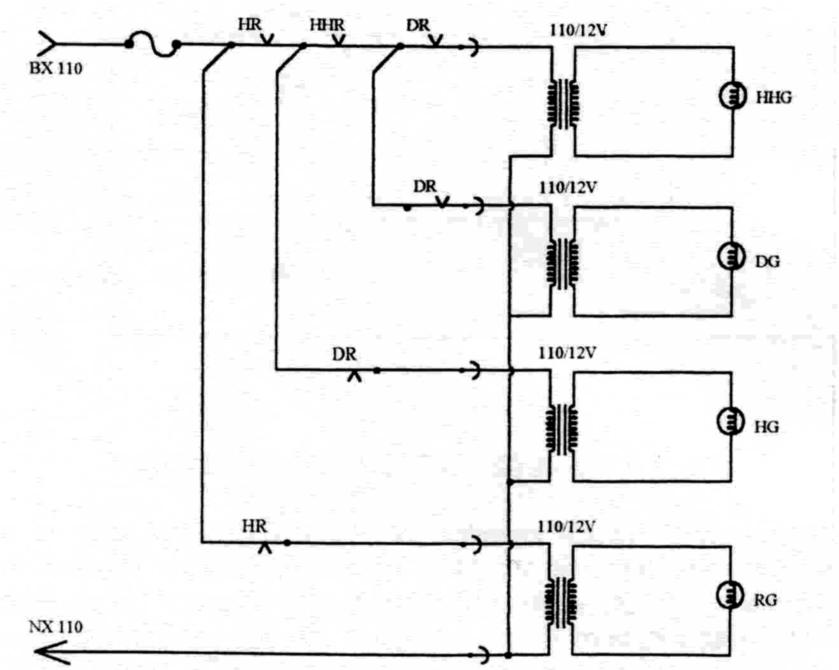


Fig. 3.4 FOUR-ASPECT CLS CONTROL CIRUIT

3.4.2 Second Method

In this case, both HHR & DR are not allowed to energize at a time. HHR picks up only when the signal in advance displays Yellow aspect. DR picks up only when the signal in advance displays Double Yellow or Green aspect. When HR is up, the bottom Yellow is brought in circuit, which is maintained to given double Yellow aspect when HHR picks up. When DR is up, this Yellow lamp is disconnected and Green lamp is connected through HR-Front and DR-Front Contacts. This is shown in Fig 3.5.

FOUR-ASPECT CONTROL TABLE

S.No	RELAY CONDITION	ASPECT
1	HR ↑ + HHR ↑+ DR ↓	HHG
2	HR ↑ + HHR ↓ + DR ↑	DG
3	HR ↑ + DR ↓	HG
4	HR ↓	RG

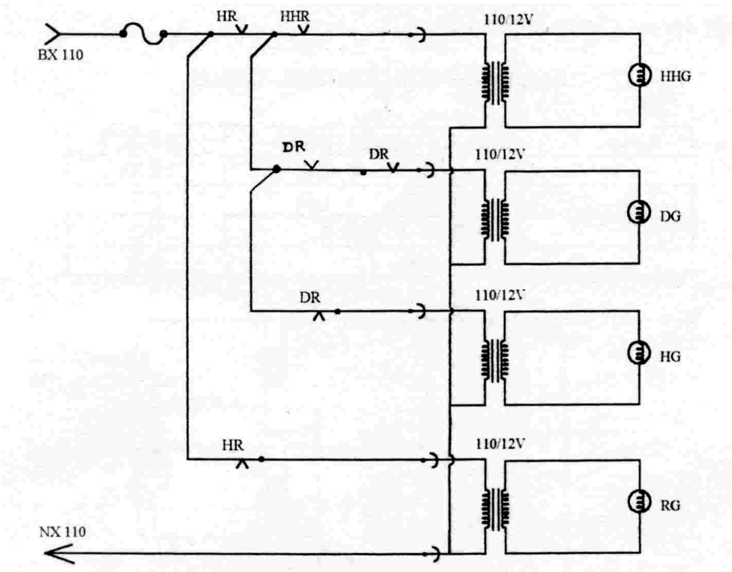


Fig. 3.5 FOUR-ASPECT CLS CONTROL CIRUIT

3.5 Typical Home signal control circuit

The Home Signal HR relay is controlled by the selection circuits. For main line with the Main Home Signal Lever reverse, the HR is directly energised. For loop line, the UR is first energised by the selection circuit. Energisation of UR, lights the direction route indicator lamps through a current transformer, whose secondary is connected to the route indicator lamp checking relay, UECR, with UECR pp, the HR is energised in this case.

The red aspect on the Home Signal is-normally maintain by HR back contact. The aspect control circuit has the feature for cutting into a more restrictive aspect. In case of lamp failures of less restrictive aspects. The conventional methods(described in the chapter-6 on automatic signalling) has the drawback of giving confusing indication to the driver in case one of the double filaments of less restrictive aspect lamp fails, For example, if one of the two filaments of green lamp fails, the driver will get a dull green and a bright yellow. This drawback is overcome by the use of DSR relay. The DSR relay is initially picked up through HR back contact. This relay sticks through Home HDECR front contact, when the Home Signal displays an OFF aspect. With DSR relay, in case one of the filaments of green lamp fails, HDECR relay drops. Dropping of HDECR releases DSR and its repeater DSPR. DSPR diverts the green lamp feed to yellow lamp, thus completely cutting off the supply to green lamp. In this circuit facility is not provided to cut in red lamp in case of yellow lamp failure. DSR relay is made slow to release to prevent its dropping during the period of the signal aspects change.

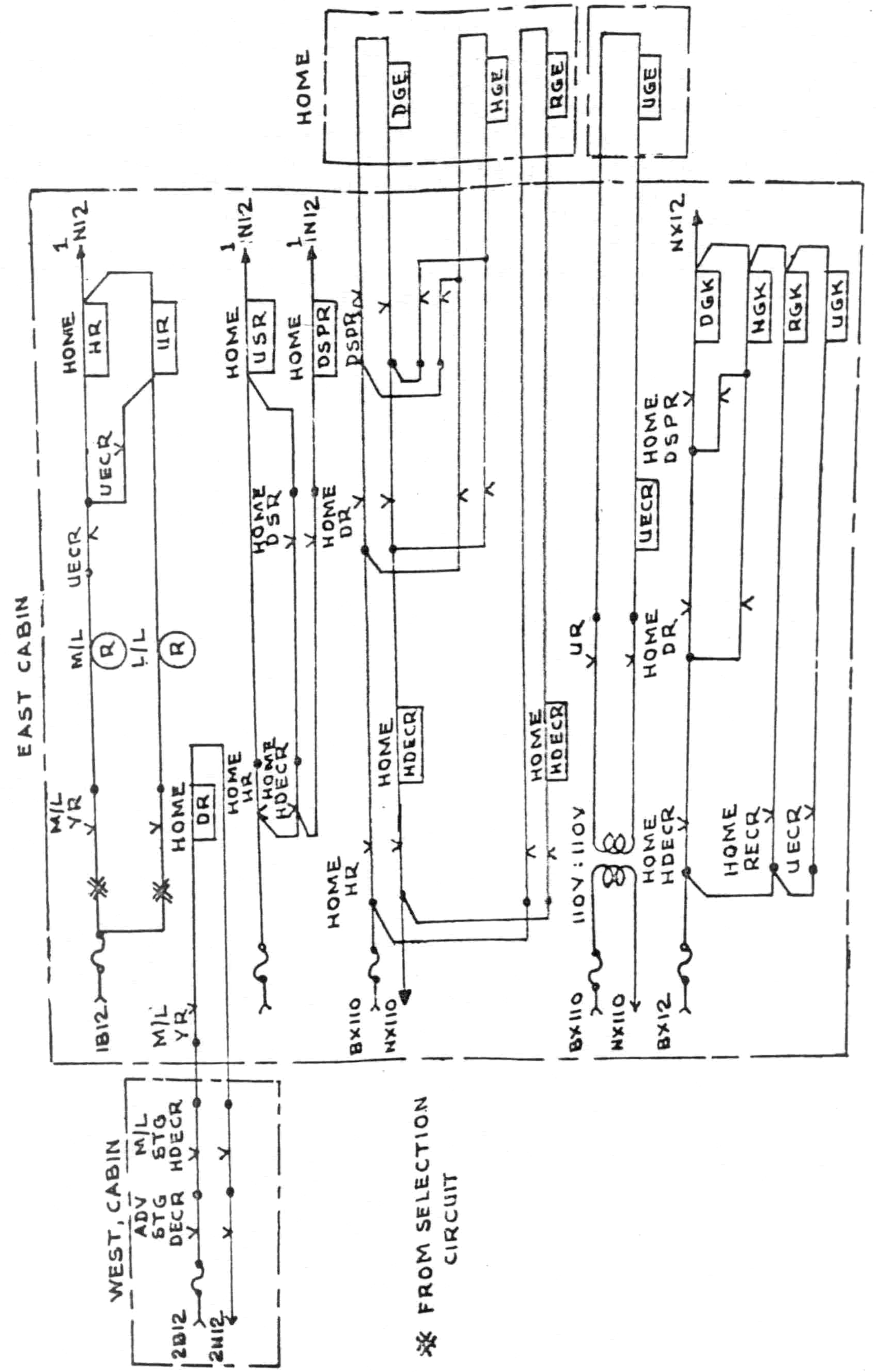


Fig 3.6 TYPICAL HOME SIGNAL CIRCIUT

CHAPTER 4: TRIPLE POLE LAMPS

4.1 Introduction

Measures are being taken to improve the safety & punctuality of railway traffics. Signalling system plays a vital role in running the trains at higher speed with utmost safety to passengers & carrying materials in goods. One step in the direction of improving the punctuality of the train is the signalling arrangements. In signalling arrangements liting, of signalling lamps are the main tools for giving proper communication to driver through the indication in non-verbal fashion. 15 to 20 percent of the signalling failures causes due to no light of signalling lamps on account of lamp fusing or any other causes. This is hampering the punctuality of the train running. To extend better liting of signalling lamp & giving continuous glow of signalling lamps without failure, revisions of the system are still continuing.

In colour light Signalling, where there is no cutting-in arrangement, lamps SL 21, 12 V / 33 W double filaments 3-pin are used. In case of cutting in arrangement single filament 2-pole 3-pin lamps SL 18, 12 V / 24 W used for OFF aspect. But in this system there is a chance of signal going blank if ON aspect also fuses. The fusing of signal lamps failures contributes failure on account of signal. To arrest the failure due to the signal lamp fusing the schedule of replacement of signal lamp is fixed according to the aspects. (Forty-five days or thousand hours for ON aspects & 180 days for OFF aspects. It is varied railway-to-railway, division-to-division with local orders.

4.2 Problems with 2-filament and 2-pole lamps (Fig 4.1 (a))

(a) The main problem is that both the filaments lit at the same time & on fusing of main filament, ECR drops & even when the signal is lighted at the sight. Therefore the incidences of signal failures & detention of the train on approach are more in the existing system.

(b) Lamps are schedule to be placed periodically hence it doesn't only involve the up keeping of records but also large number of signalling lamps required annually.

(c) To have better reliability these lamps are required to be pre-stressed for a given period before using them on site. This also bears additional burden over the signal staff.

4.3 Introduction of triple pole lamps

It was decided that above mentioned anomalies of conventional lamps must be removed & a more reliable signal lighting arrangement with lesser inputs is required. This decision gave a birth to the concept of "TRIPLE POLE LAMP" Fig 4.1 (b).

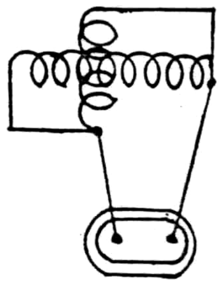


Fig 4.1(a) DOUBLE POLE LAMP

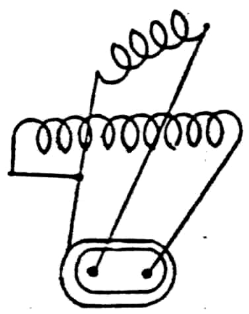


Fig 4.1(b) TRIPLE POLE LAMPS

As the name suggests in this lamp, in place of 2-poles of conventional type there is an additional third pole, which is used to prevent the disconnection of lamp circuits, when the main filament fused. There are 2-filaments in this lamp. These filaments are connected to third pole with one common pole for the both the filaments. As such when the signal is lighted, auxiliary filament, which is connected to the 3rd, remains idle. The auxiliary filament lighted as soon as the main filament is fused. Simultaneously an indication regarding the fusing of the main filament is given in the cabin so that lamp can be replaced before the failure of auxiliary filament; this prevents the signal becoming no light. With these arrangements, the chances of signal becoming no light due to lamp fusing are drastically reduced.

TRIPLE POLE LAMP WITH HOLDER

4.4 Triple Pole Lamps

In Triple pole lamps, there are two filaments of equal wattage. The main filament lits normally and the auxiliary filament serves as a standby, to be switch ON when main filament fuses. Since both the filaments have the same ratings and lumen output, the visibility of CLS is not so affected when the main filament is fused and the auxiliary filament is switched ON. The new design of the lamp has been developed with RDSO in which the two filaments are provided in parallel configuration to avoid possibilities of hot-spot formation.

The circuit arrangement for triple pole lamp is shown as per RDSO Drg.No.SDO/RRI-263. In this H-type transformer is used as per IRS: S62 with certain modifications in the secondary side of the signal transformer MECR unit can be connected to the signal lamp circuit.

MECR unit shall be fixed inside the signal unit or in the signal location box. This MECR unit basically consists of one H-type current transformer and the transformer secondary output voltage is rectified and the rectified out voltage is connected to one miniature relay (MECR). This relay gives the condition of main filament of the triple pole lamp.

This relay picks up when the main filament is burning. It drops when the main filament is fused. Then through the back contact of this relay auxiliary filament lits. In the auxiliary filament circuit path 1 Ohm, 15 W resistance is provided in series with the MECR back contact, to bring the main filament first in circuit when the aspect is switched ON.

In the new installations and in the old installations wherever possible, the railways may cater for the additional conductors required for providing the individual "Signal MECR" indication shall be provided.

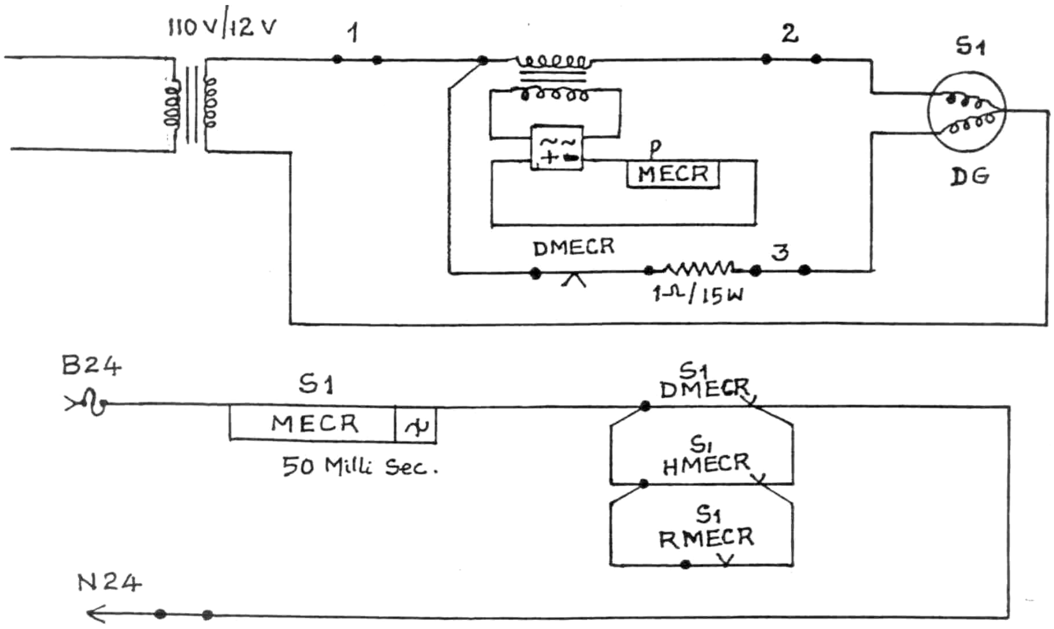


Fig. 4.2 RDSO TRIPLE POLE LAMP CIRCUIT WITH MECR

S1 MECR is normally up and made slow to release to avoid wrong indication at the time of aspect changing. S1 MECR down indicates that main filament is fused for its aspect burning at that time. In the existing installations due to shortage of available conductors, railways may decide, to give a common indication to the maintenance staff by suitable grouping of signals.

Signal lamp main filament checking (MECR) indication and alarm circuit using triple pole signal lamp is shown in Fig.4.2

The following are the triple pole lamps used in our Indian Railways:

Bulb No.	Rating	Life	Applications
SL 35A	12 V / 24 W, 24 W	1000 hours	Normally used for OFF Aspect in CLS, with or without cascading arrangement.
SL 35AL (Longer life)	12 V / 24 W, 24 W	5000 hours	Normally used for OFF Aspect in CLS, with or without cascading arrangement.
SL 35B	12 V / 33 W, 33 W	1000 hours	Normally used for ON Aspect.
SL 35BL (Longer life)	12 V / 33 W, 33 W	5000 hours	Normally used for ON Aspect.

4.5 Inputs required

4.5.1 Materials

(a) Triple pole double filament lamps SL 35 A - 12 V / 24 W & SL 35 B - 12 V / 33 W.

(b) Triple pole lamp holder with base.

(c) Switching unit (MECR).

(d) Push button switch.

(e) Buzzer, indication lamps.

(f) PVC wire.

(g) ARA terminals & other accessories.

4.5.2. Additional requirements

(a) 2- Spare core from, signal location to relay room for MECR is required.

(b) 1-extra core for each aspect in tail cable form location to signal post.

(c) If there is no space in the location for providing RMECR, HMECR, DMECR relay & indication transformers then extra location is also required.

4.6 Advantages

(a) Reduction in number of signal failures due to lamp fusing.

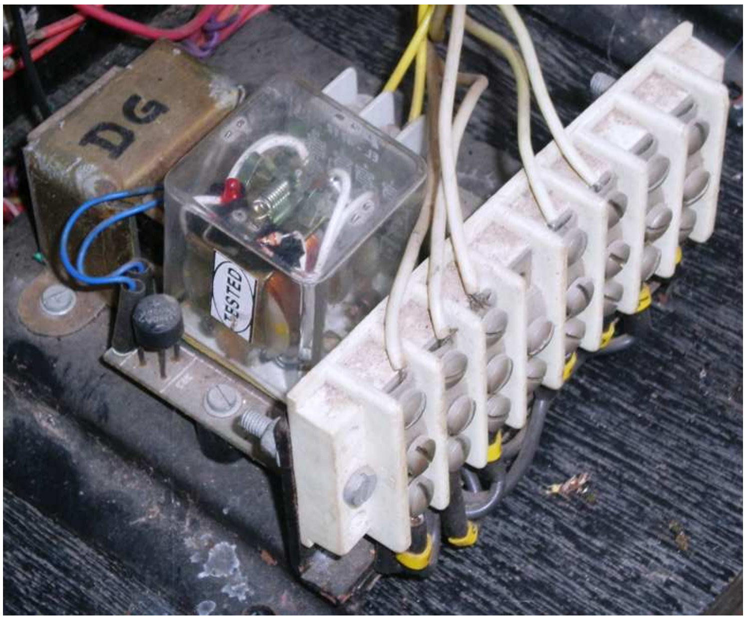
(b) No detention of trains even when the main filament is fused.

(c) Reduction in maintenance staff.

(d) Reduction in the duration of failures as indication of main filament fusing appears in the cabin immediately.

(e) Periodical replacement of lamp avoided, there by effecting saving / economy of lamp.

(f) No pre-stressing of lamp is required.



MECR

Alarm circuit (Fig No.4.3): Signal Lamp filament Proving Relay (GXPR) is normally up. If the main filament is fused, then the concerned aspect MECR drops. The result is that the concerned signal/signals group MECR in the cabin drops. In this circuit UPMECR drops. Dropping of UPMECR drops GXPR. Through GXPR back contact and ACKNR (Failure Acknowledgement Relay) back contact BELL rings and failure indication lit. BELL stops only after pressing the ACK.PB (Acknowledgement Push Button), since ACKNR picks up through UPMECR-B and ACK.PB pressed contact path. After replacing the signal lamp UPMECR picks up, results ACKNR drops. Through GXPR-B and ACKNR-B contact BELL rings again for acknowledgement of failure rectification. After pressing ACKPB through ACKPB-pressed contact, GXPR picks up. Picking up of GXPR disconnects the supply to BELL and indication.

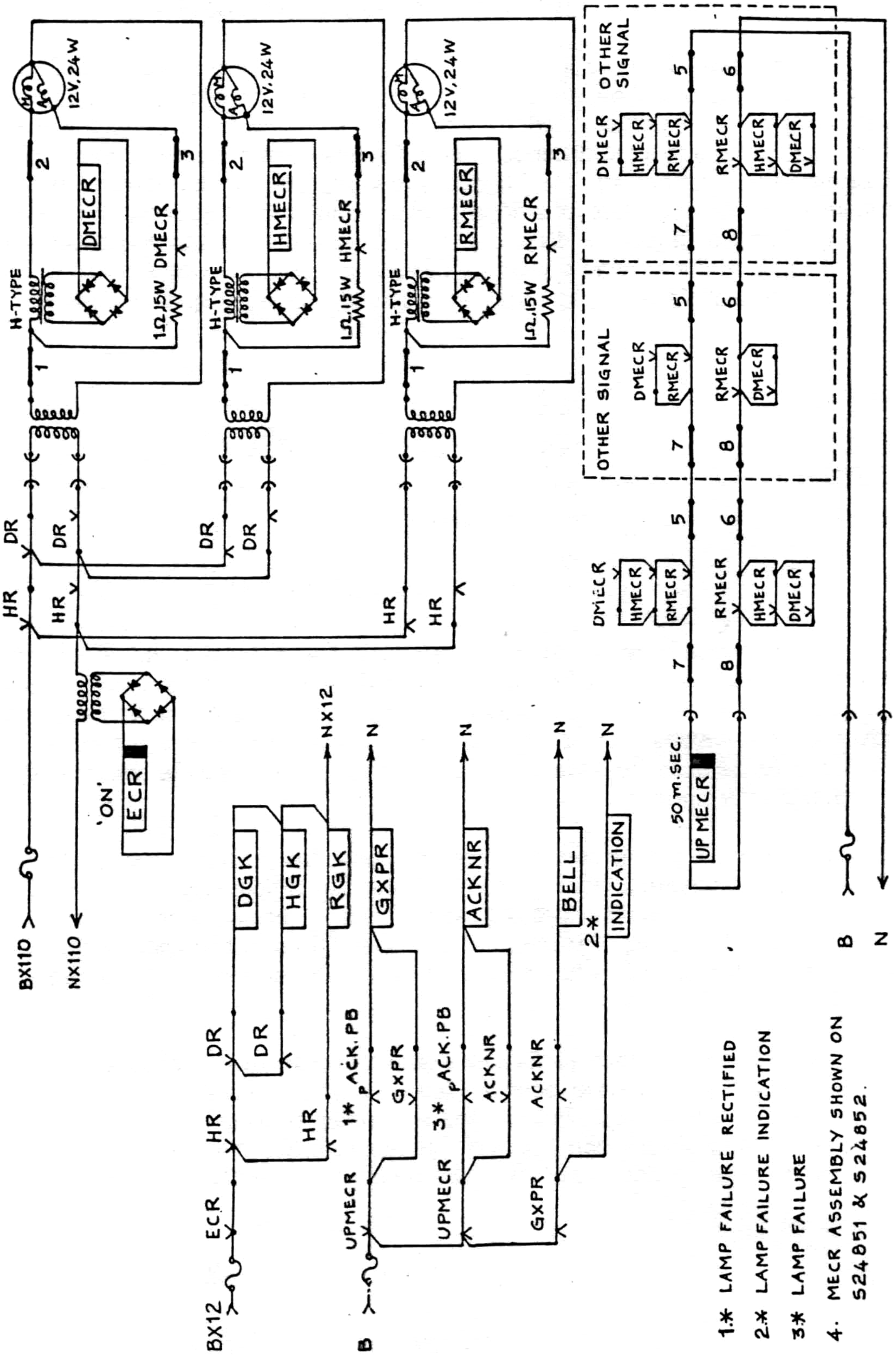


Fig 4.3 TYPICAL SIGNAL LAMP CHECKING & ALARM CIRCUIT BY TRIPPLE POLE LAMP

CHAPTER 5: INNER DISTANT SIGNAL

5.1 Introduction

In a multiple aspect colour light signalling system (MACLS), the driver of a train is warned of the approaching stop signal by a permissive signal. This signal, called the distant signal, is located at an adequate distance in rear of the stop signal, the aspect of which it pre-warns. An adequate distance of **one Km** has been normally adopted by Indian Railways. This distance, together with the distance at which the warning board is located in rear of the distant signal, is adequate for a driver to stop his train at the stop signal in case it is at ON. The braking distance (adequate distance) is reckoned from the warning board and not from the distant signal in the existing system of multiple aspect colour light signalling. This arrangement is considered satisfactory upto certain speeds and haulage capacity of trains.

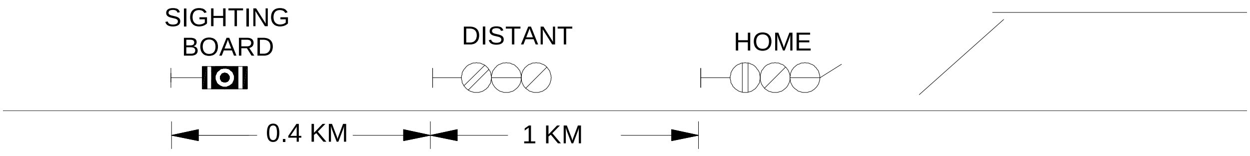


Fig. 5.1 DISTANT SIGNAL

5.2 With increase in speed and haulage capacity of passenger and goods trains, the above mentioned distance is not sufficient, which brings out the braking distances required for some of the loads and speeds. **General rules (GR) 3.07(6)** stipulates that *"Wherever necessary more than one distant signal may be provided. In such a case the outer most signal, to be located at an adequate distance from the first stop signal shall be called the distant and the other called the inner distant signal".*

From the above, it can be seen that even though in the present system of MACLS the distant signal can be placed at adequate distance in the rear of home signal, placing it more than 1 Km where higher adequate distances are required is not recommended by GR. In such cases, the GR recommends placing of second distant signal. This may be to enable the driver not to forget the aspect of the signal he has picked up in case of too much distance between subsequent signals.

5.3 Provision of a second distant signal

Comprehensive instructions regarding placing of second distant signals have been issued by Railway Board/RDSO. According to this, the existing distant signal shall continue and an additional distant signal shall be placed at 1 Km from the existing distant signal in rear. The warning board in such cases shall be dispensed with. This provides a distance of 2 km, which may not be sufficient in certain cases.

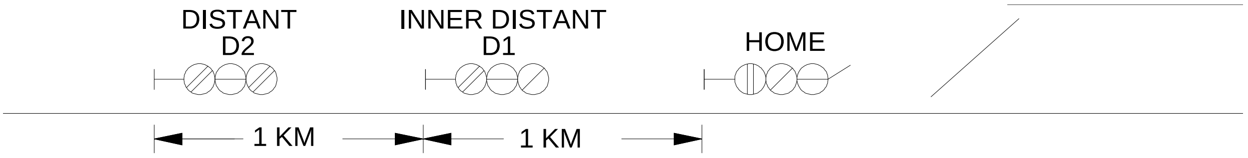


Fig 5.2 INNER DISTANT SIGNAL

The IB signals are also provided with second distant signals. Interlocked level crossing gates which are also provided with second distant signals. With the new signalling arrangement drivers encounter a signal in the block section at every 1.5 to 2 Km approximately. At some locations, the signals such as Advanced starter and IB home signal had to be combined with the second distant signal.

5.4 Aspect Control Chart

Sl. No	Indication to Driver	Distant Signal	Inner Distant Signal	Home Signal	Main line starter	Adv. Starter
1	May stop at home	Double yellow	Yellow	RED	-	-
2	May stop at main line starter	Green	Double yellow	Yellow	RED	-
3	To run through	Green	Green	Green	Green	Green
4	To stop at loop starter (or) pass via loop	Double yellow	Double Yellow	Yellow with Route Indicator	-	-

5.5 Advantages

(a) Driver can know the information of the signals ahead well in advance (1 Km in advance).

(b) Confidence in the driver is increased since he is having sufficient breaking distance for high speeds.

(c) Sectional average speed is improved.

(d) Goods warning board is not required.

5.6 Inner distant signal control circuit (Fig 5.3)

INR, DIST, DR & INR DIST HHR are controlled directly by the Home Signal aspects. INR DIST HHR picks tip when Home Signal is displaying yellow, through Home HDECR front and Home DR back contacts normally and through Home DR front and Home DSPR back contacts in case of Home Signal green lamp failure. Inner distant DR picks up only when Home Signal is, displaying green aspect (controlled by Home HDECR, Home DR & Home DSPR front contacts).

As there are 2 yellow lamps in this signal for the display of double yellow aspect, provision is made to switch over to the top yellow when the bottom yellow lamp fails. Inner-distance signal is normally displaying yellow aspect through INR DIST DR back and INR DIST HECR stick contact. In case this lamp fails INR DIST DR back & INR DIST HECR back contacts. As the feed for bottom yellow is completely cut off, there is no possibility of getting unsafe failure of double yellow aspect.

When INR DIST HHR is picked up, both the yellow lamps are brought in circuit. INR DIST DSR works similar to Home Signal DSR. It picks up initially through INR DIST DR back contact remains stuck through INR DIST HHDECR front when the signal displays on OFF aspect. If the green lamp is fused, the signal is made to display double yellow aspect, the top and bottom yellow lamps both being lit by INR DIST DR front and INR DIST DSPR back contacts.

When the signal is restored to ON after displaying Green aspect by dropping DR & HHR relays, the bottom yellow lamp will not light up as the INR DIST HECR stick contact has already dropped. To overcome this drawback, a slow to INR DIST HECR drops which disconnects the feed to the bottom yellow lamp and energises the top yellow lamp through release repeating relay DPR is used. When DR drops, DPR is held for some more time due to slow release feature and hence, provides a pick up path for INR DIST HECR by shunting INR DIST HECR stick contact. The indication circuit is similar to the aspect control circuit. The DSR relay is made slow to release to prevent its release during the periods the signal aspects changeover.

5.7 Distant Signal Control Circuit (Fig 5.4)

The normal aspect of this signal is double yellow. The bottom yellow lamp is lit through DIST DR back contact. Distant signal is having at least one yellow lamp lit. This is proved by the INR DIST HECR & INR DIST HHDECR front contacts in parallel. The DIST DR picks up only when the train is either received on main line or run through on main line. HOME UECR back, INR DIST HECR front & INR DIST HHDECR front contacts prove that the inner distant signal is displaying double yellow and the train is being received on the main line. Home UECR back, INR DIST DPR front & INR DIST HHDECR front prove that the INR distant is displaying green aspect and the train is running through the station.

The DIST DSR relay serves the same purpose as that of the DSR relays used for Inner Distant Signals. When the distant signal green lamp fails DIST HHDECR relay drops, which drops DIST DSR in turn. DIST DSR dropping, it disconnects green lamp feed and brings in both top and bottom yellow lamps in circuit. An I - type transformer is used for lighting the ON aspect indication lamp in the cabin. Other indication lamps are controlled in the same way as the signal lamps.

5.8 The scenario from the foot plate

With the commissioning of the second distant signal the driver encounters the following scenario.

A signal at every 1.5 to 2 Km in the block section.

Combination of signals

New aspect of signals

Absence of Warning Board.

Visibility of the D2 (First Signal) = 400 m.

Visibility of the D1 (First Signal) = 200 m.

In a typical signal layout at a station the distant signal is located at 1 Km. From Home signal and a sighting board is provided at 1.4 Km. From Home signal. With introduction of super fast services like Rajdhani Express, Shatabadi Express etc. the speed of passenger trains have gone upto 130 / 140 KMPH and of goods upto 72 KMPH requiring breaking distance of approx. 1.5 Km. Therefore, to enable the driver to control his train well in time while approaching the Home Signal, a Second Distant Signal is being provided at 2 KM from Home Signal on sections with maximum permissible speed of 120 KMPH and above.

The provision of Second Distant Signal has given more confidence to driver to run his train at maximum permissible speed thereby improving punctuality, along with enhanced level of safety in train operation.

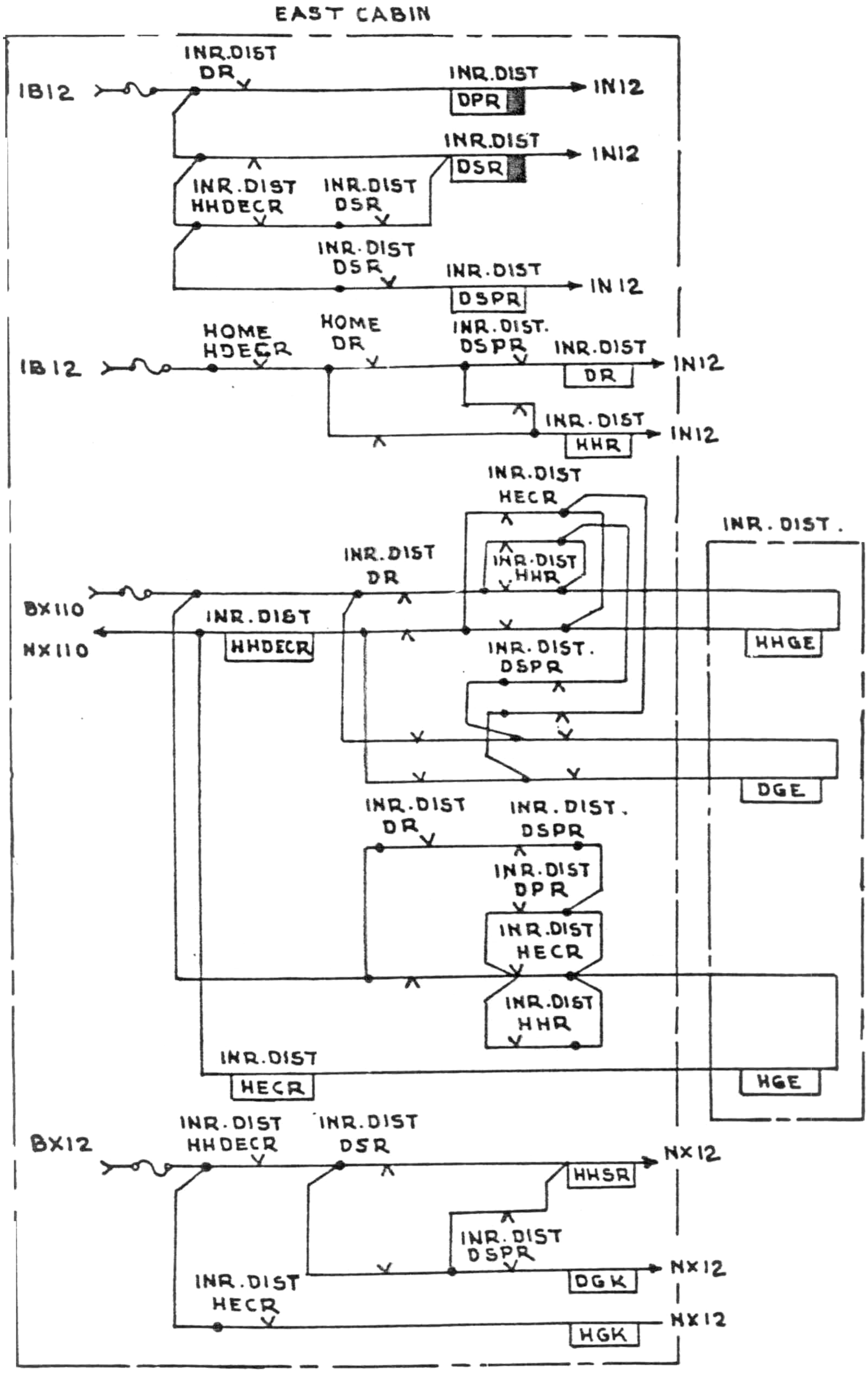


Fig 5.3 TYPICAL INNER DISTANT SIGNAL CIRCUIT

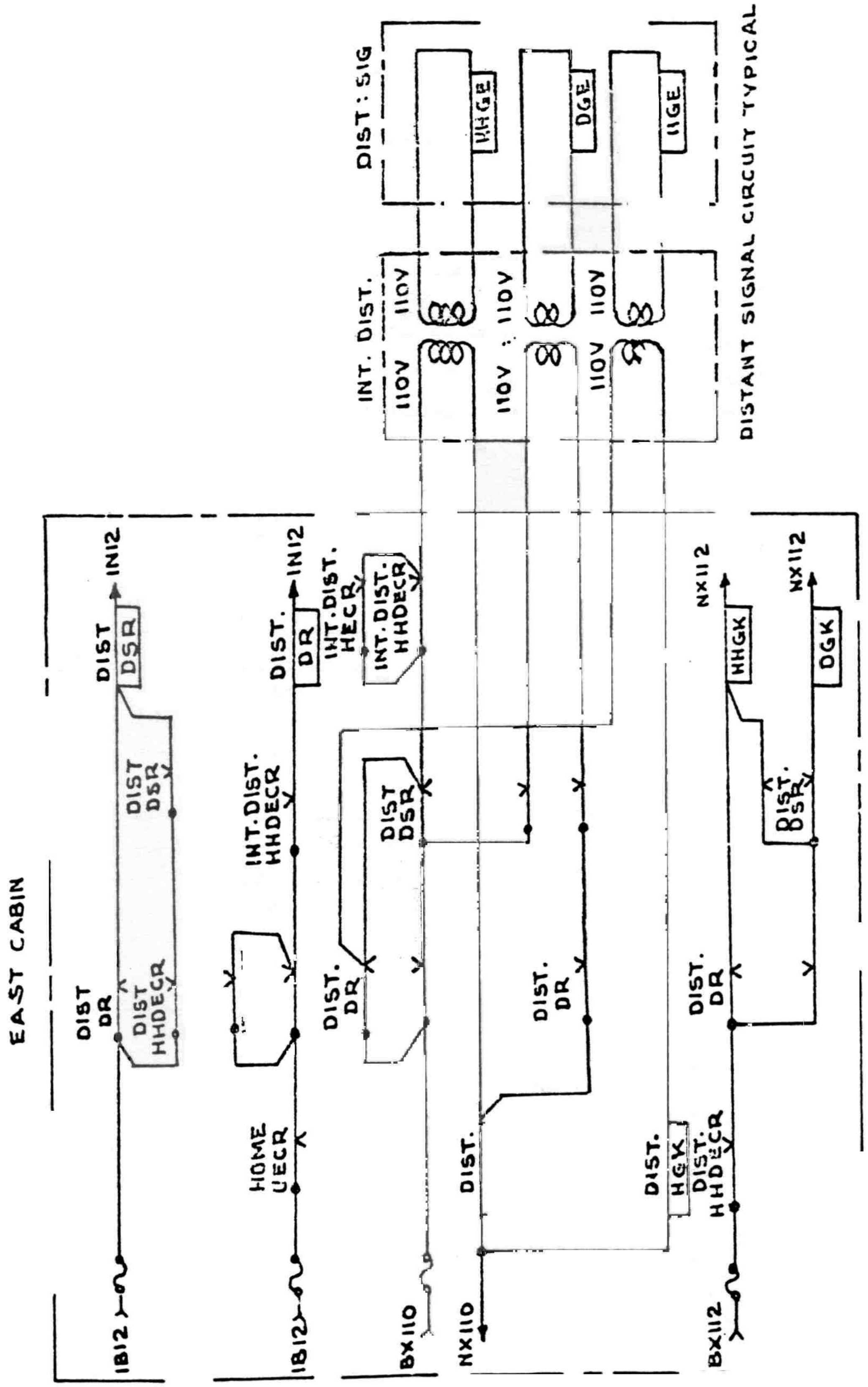


Fig 5.4 TYPICAL DISTANT SIGNAL CIRCUIT

CHAPTER 6: AUTOMATIC COLOUR LIGHT SIGNALLING

6.0 Introduction

Automatic Block Working is a system of train working in which movement of the trains is controlled by the automatic stop signals. These signals are operated automatically by the passage of trains into through and out of the automatic signalling sections. The following are the essentials of Automatic Block System.

Where trains are worked on Automatic Block System: -

(a) The line is track circuited throughout its length and divided into a series of automatic signalling sections each of which is governed by an Automatic Stop Signal.

(b) The movement of trains is controlled by stop signals, which are operated automatically by the passage of trains past the signals.

(c) No Automatic Signal assumes 'OFF' unless the line is clear not only upto the stop signal ahead, but also an adequate distance beyond it.

6.1 Adequate Distance or Overlap

The adequate distance referred to above, which may also be termed 'overlap' shall not be less than 120 metres unless otherwise directed by approved special instructions.

The first para of the essentials require the entire length of track to be track circuited for providing automatic block working and divided into sections (as shown in Fig.6.1a) which are called the Automatic Signalling Sections:-

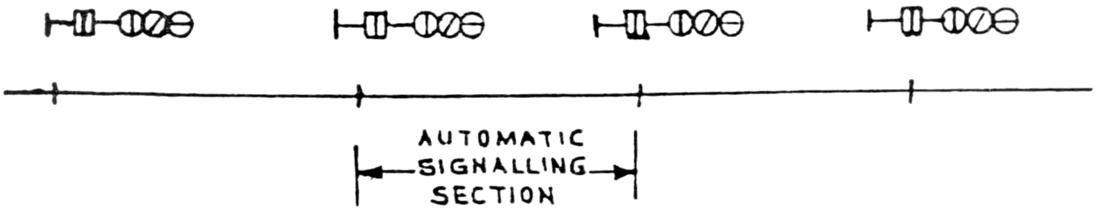


Fig: 6.1 a AUTOMATIC SIGNALLING SECTIONS

The automatic Signalling Section is defined as the portion of the running road between any two consecutive automatic stop signals and each of these sections is protected by an automatic stop signal. These automatic stop signals control the movement of trains into the sections and operate automatically by the passage of train past the signals are per para (b) of the essentials.

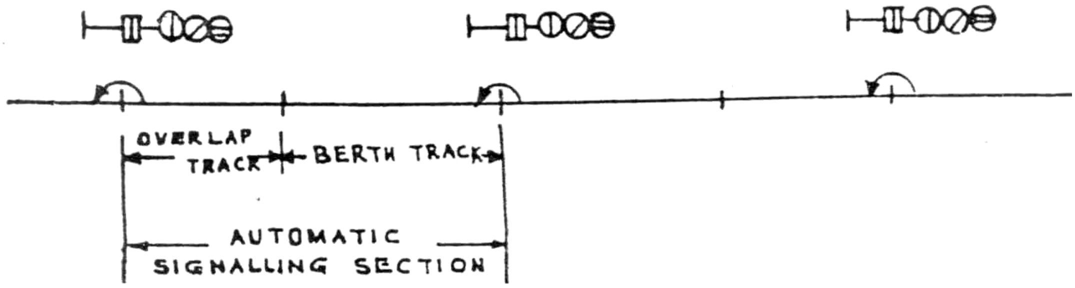


Fig: 6.1 b OVERLAP AND BERTHING TRACKS

The para (c) stipulates that an Automatic Stop Signal can assume OFF aspect only when the line is clear not only upto the next signal but also an adequate distance beyond it. This defines an overlap of 120 metres (minimum) in advance of every Automatic Signal to be clear before the signal in rear can change its aspect from 'ON' to 'OFF' in addition to the distance between the two signals. So it becomes necessary to define the end of overlap in advances of every automatic stop signal and hence, the track circuit is bifurcated at 120 metres from the signal as shown below and this 120 metres track is called the "overlap track" and the remaining track length is called the "Berth Track" in each signalling section.

6.2 Automatic Stop Signal

General Description and numbering: Automatic Stop Signals are multiple aspect colour light signals and are either 3-aspect or 4-aspect as the case may be. These signals are numbered serially, ODD numbers in one direction and even numbers in the other direction, for UP and DOWN lines or vice versa (Fig. 6.2(a). There is an attempt at numbering the automatic signals according to their location with respect to the kilometrage. This requires a code consisting of a group of digits in which the last two digits indicate the telegraph or traction pole and the first group of digits indicating the kilometres at which the signal is located. For example 2611 means the automatic signal located at 11th telegraph or traction pole between 26th and 27th kilometre. For distinguishing UP and DN signals the last digit can be made ODD in one direction and EVEN in the other approximate to the nearest telegraph or traction poles.

The method of numbering helps in easy identification and location of signal by maintenance staff in case of failure without referring to a layout plan. But this numbering becomes cumbersome for track circuit which are to be numbered according to the Automatic Signal governing that section. An example is illustrated in Fig. 6.3 (b). In quadruple line as there are 2 UP and DOWN lines, it becomes essential to identify each line by suffixing or prefixing alphabet to indicate 'Local' or 'through' and 'slow' or 'Fast' lines. This is in addition to the convention of using odd numbers for one direction of traffic and even numbers for the other direction. An example is given in Fig.6.2 (c). If the lines extend to two different destinations, alphabets corresponding to the first letter of the destination station or the name of the section may be used.

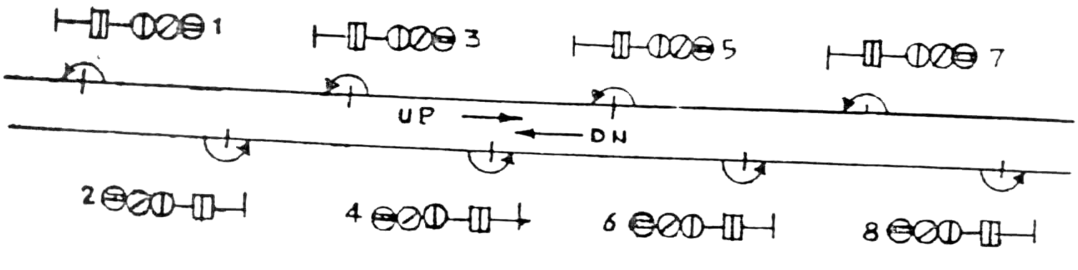


FIG : 6.2(a)

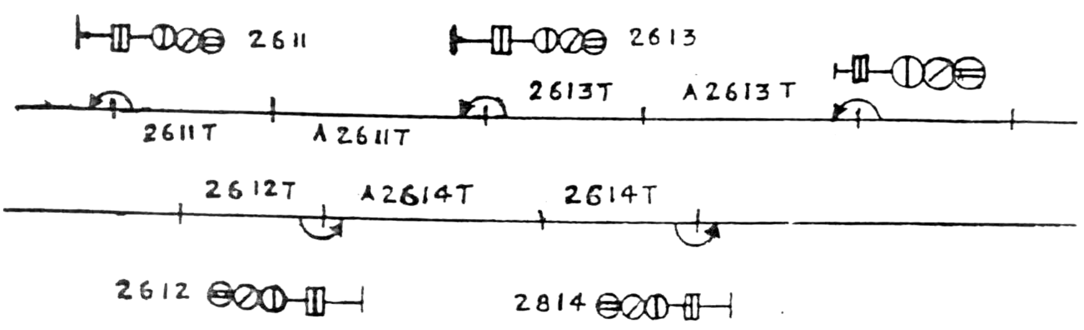


FIG : 6.2(b)

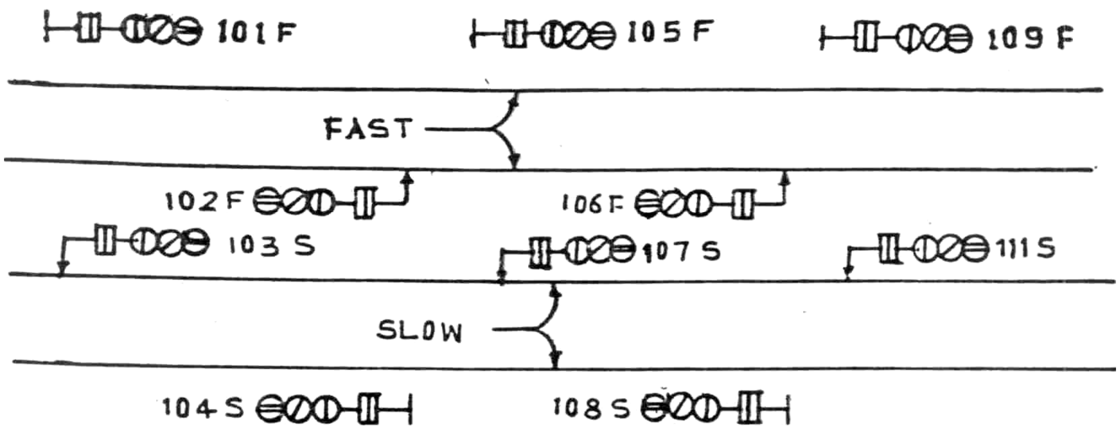


Fig: 6.2 C NUMBERING OF AUTOMATIC SIGNALS

6.3 Track Circuits

Arrangements and Numbering: The track circuiting between any two automatic signals follows the principle of "Overlap" and "berth track" as explained earlier. The overlap track circuit is normally of 120 meters length. Since this track is included in the control of the automatic signal in rear, its condition has to be repeated at the location of the rear signal. This requires a repeating relay and a pair of a cable conductors between the signals but in actual practice, these can be avoided by making use of the "cut section" principle between the overlap and rear berth track as shown in Fig.6.3. (a).

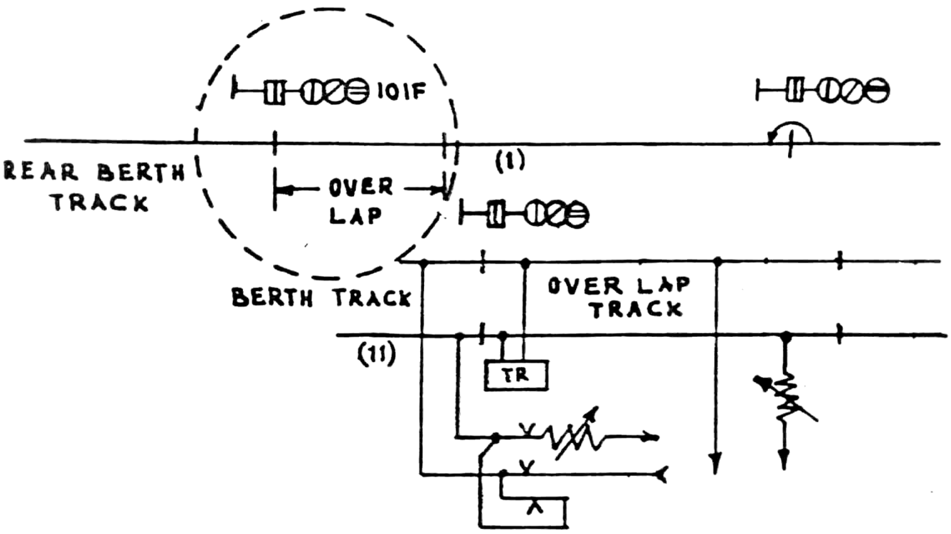


Fig: 6.3 (a) CUT SECTION ARRANGEMENT

By this arrangement, the overlap track controls the feed for the rear berth track in such a way that unless overlap is clear the berth track is not energised such that if berth track relay is picked up it proves not only berth track is clear, but also the overlap in advance of it. The back contact is provided for cross protection.

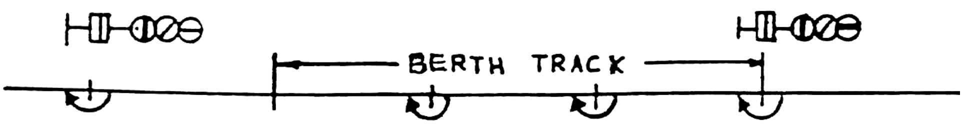


Fig: 6.3 (b) BERTH TRACK CIRCUIT

The length of berth track depends upon the distance between two automatic signals. If it cannot be made into one track circuit, it can be divided into two or more track circuits as the case may be and cut section arrangements provided to eliminate the need for repeating the track relays in the rear signal locations. (Fig.6.3 (b). The type of track circuits can be DC (Neutral or Polarised) or AC and single rail or double rail (with 2 or 3 position) relay as the case may be to suit the local conditions taking into consideration the type of electric traction if present. In case of DC traction arise, double rail AC track circuits with 50 cycles per second supply can be used including impedance bonds for traction return. In case of AC 25 KV electrification, one of the following types of tracks circuits can be used:-

(a) DC single rail track circuits.

(b) Electronic track circuits like JEUMONT, specially where the track circuits have to be compatible for both DC and AC traction with impedance bonds.

(c) Jointless track circuits(AFTC)

The second is preferred now-a-days as it eliminates the use of impedance bonds, and is economical.

The track circuits within the automatic signalling section carry the number of the Automatic Signal governing the movements over them. But to differentiate between the track number of each track in the berth section, e.g., A,B,C, etc., as shown in Fig.6.3. (c).

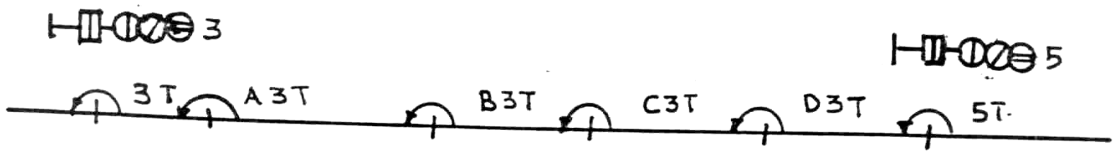


Fig 6.3 (c) TRACK CIRCUITING NUMBERING BY ALPHABICAL ORDER

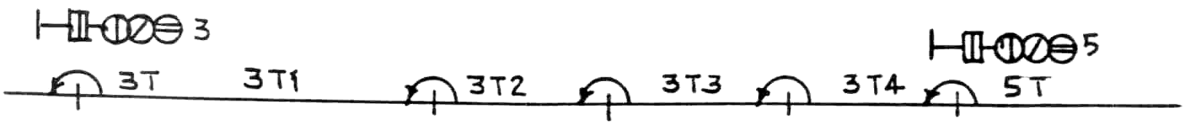


Fig 6.3 (d) TRACK CIRCUITING NUMBERING BY NUMARICAL ORDER

Instead of using the alphabetical prefixes, tracks can also be numbered serially 1,2,3 etc, as shown in Fig.6.3.(d).

6.4 Automatic Signal Control Circuits

The following layout illustrates the arrangement of track circuits and automatic stop signals of three consecutive sections in one direction. Each of the signalling sections having one overlap track and atleast one berth track. (Fig.6.4 (a)).

Normally when the entire section is clear all the automatic signals will display clear aspect (Green). When a train passes a signal (say signal 1), the signal is replaced to danger (red) automatically. After the train clears the section upto the next signal (Signal 3) and an overlap 3T) in advance of its, the signal will change its aspect automatically from danger (Red) to caution (yellow) and as the train clears two sections ahead (upto signals 5) and the overlap (5T), the signal (No.1) will change its aspect from caution (yellow) to clear (green) automatically.

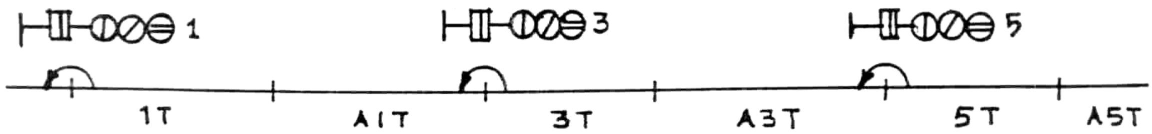


Fig 6.4 (a)

TRAIN ON	1TR	A1TR	3TR	A3TR	5TR	A5TR	SIGNAL NO.1	SIGNAL NO.2	SIGNAL NO-3
① 1T	↓	↑	↑	↑	↑	↑	R	G	G
② 1T & A1T	↓	↓	↑	↑	↑	↑	R	G	G
③ A1T	↑	↓	↑	↑	↑	↑	R	G	G
④ A1T & 3T	↑	↓	↓	↑	↑	↑	R	R	G
⑤ 3T	↑	↑	↓	↑	↑	↑	R	R	G
⑥ 3T & A3T	↑	↑	↓	↓	↑	↑	R	R	G
⑦ A3T	↑	↑	↑	↓	↑	↑	Y	R	G
⑧ A3T & 5T	↑	↑	↑	↓	↓	↑	Y	R	R
⑨ 5T	↑	↑	↑	↑	↓	↑	Y	R	R
⑩ 5T & A5T	↑	↑	↑	↓	↓	↓	Y	R	R
⑪ A5T	↑	↑	↑	↑	↑	↓	G	Y	R

Fig 6.4 (b)

The same principles are illustrated by the table and the diagrams in which the sequence of track occupation and change of aspects with the movement of train is indicated in the order in which they occur. From the table Fig.6.4 (b) and diagram Fig. 6.4 (c), it is clear that when the tracks 1T. A1T and 3T are clear, signal No.1 will display caution and if tracks 1T, A1T, 3T, A3T and 5T are clear, then signal No.1 will display clear aspect.

The same sequence will follow for other signals also. But at the same time if track 3T, A3T and 5T are clear, signal No.3 will display caution and hence, if signal No.3 is displaying caution, then signal No.1 can display clear aspect provided 1T, A1T are clear. If signal No.3 changes from caution to clear aspect then also signal No.1 must display clear aspect provided 1T and A1T are clear.

So, the aspect control of Signal No.1 will be as follows: -

If,

(a) 1TR and A1TR picked up, then signal No.1 displays caution if signal No.3 is displaying Red.

(b) Signal No.3 is displaying caution or clear then signal No.1 displays clear (A1TR pick up proving not only A1TR is clear, but also 3T is clear by means of the cut section arrangement between 3T and A1T.

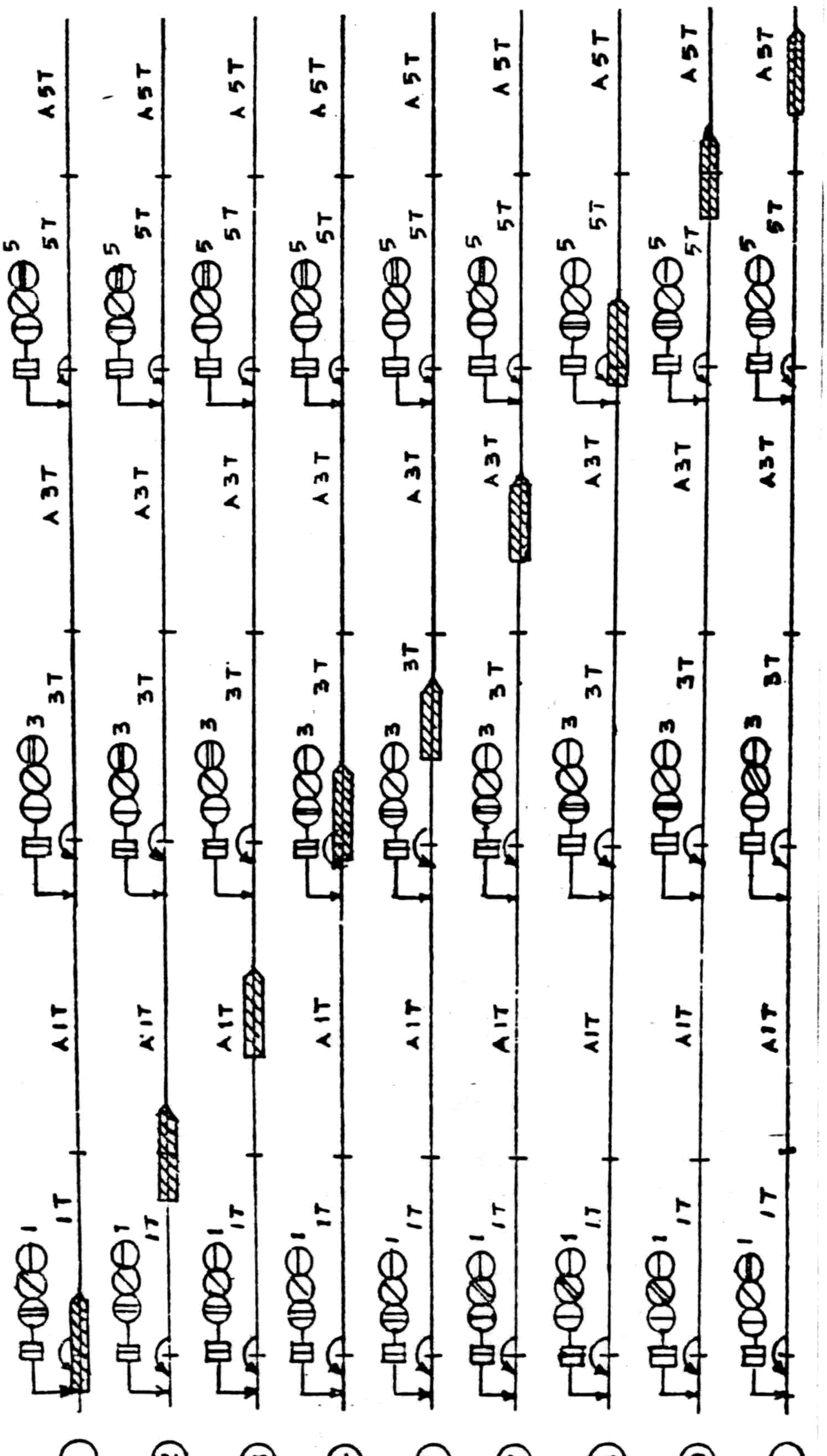


Fig: 6.4 (c)

6.5 Aspect Control Circuits for Signal No.1 as shown in fig 6.5 (a)

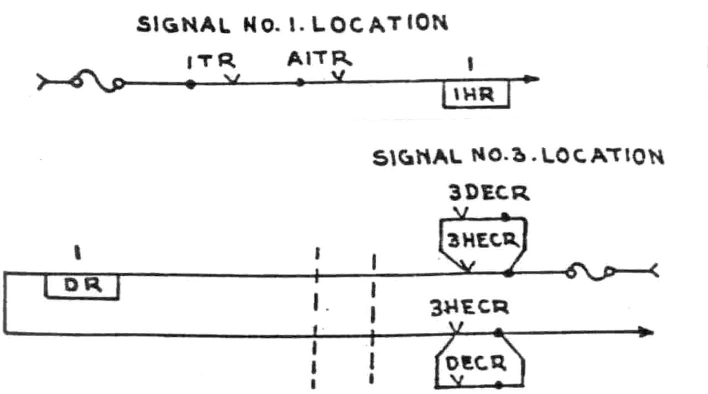


Fig 6.5 (b)

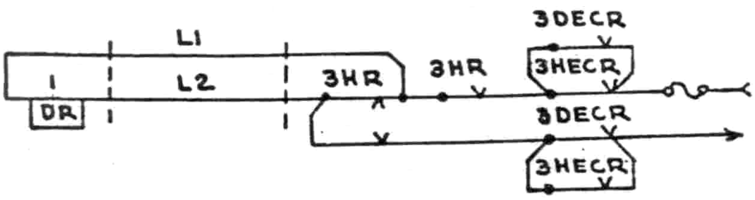


Fig 6.5 (b)

Sometimes 3 HR front contact is used in 1 DR circuit as a direct proof that 3 TR and A3TR are in pick up condition in addition to the 3 HECR and 3 DECR contacts as shown in Fig. 6.5(b).

6.6 Lamp Control or Lighting Circuit for Signal No.1

The two relays 1HR and 1 DR are used for controlling the 3 aspects of signal No.1 as follows:-

Control Relay		Signal No.1
HR	-	Red (Danger)
HR & DR	-	Yellow (Caution)
HR & DR	-	Green (Clear)

and the circuit is given in Fig. 6.6 (a).

The aspect control and lamp control circuits for all signals are same as for signal No.1.

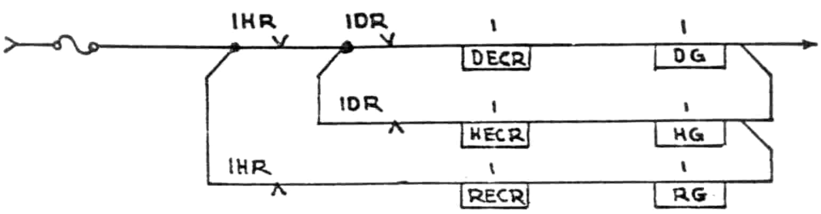


Fig 6.6 (a)

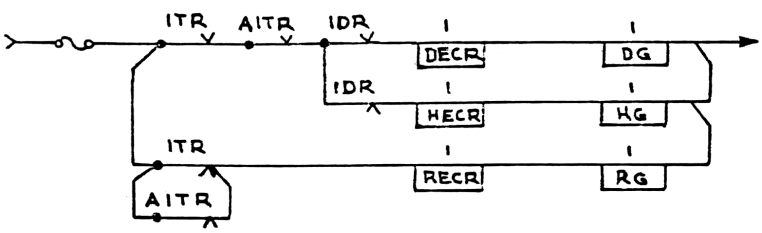


Fig 6.6 (b)

Sometimes, it is customary to eliminate the control relay HR making use of the track relays directly in the lamp control circuit as shown in Fig. 6.6 (b).

The use of track relay contacts is considered more safe as their percentage release is high 68% compared to their repeater relay HR (percentage release (60%)). In addition, this circuit results in saving of one line relay for each signal but may cause signal to go blank when AC track circuits with AC vane relays are used. When a train occupies a track circuit, it may so happen that the track relay might open the front contact but does not make the back contact specially if the train shunt is such that it does not reduce the torque on the vane to cause it to restore to the energised position. Under these circumstances, the automatic signal will remain blank since the danger aspect will be lit only if the back contact of the track relay is available. This defect can be eliminated by making use of the HR relay. Since this relay is operated through the front contacts of the track relays, it will drop the moment front contacts of track relays are open and the back contact of HR restores the danger aspect irrespective of the track relays back contacts are made or not.

But in case of DC track circuits using DC track relays of tractive type armature the back contacts will make positively when the front contacts are open due to increasing air gap which reduces the torque on the armature progressively. Hence, it is quite in order if track relays are used in the lamp control circuits of automatic signals in DC track circuited areas, but it is preferable to use HR in case of AC track sections.

6.7 CASCADING (Cutting in) Arrangements

Whenever the lamp fuses with the signal displaying a particular aspect, then it is likely that the signal becomes blank and there is a chance that the driver may miss the signal and overshoot. Even if the driver observes the signal, the signal with no light has to be treated as a defective signal and General Rules 3.74 will have to be observed. This will have a deleterious effect on capacity, so if a lamp of clear aspect fuses the signal should display a more restrictive aspect than no light which is equivalent to 'Red'. To avoid these conditions, an arrangement in the lamp control circuit can be adopted in such a way that if a lamp fuses the signal can be restored to a more restrictive aspect. For example if green lamp fuses (when signal is displaying clear aspect) then the more restrictive yellow lamp can be lit or if yellow lamp fuses (when signal is displaying caution) then red lamp can be lit. This arrangement is called the "cascading (cutting-in) arrangement" (Fig 6.7 (a)). The wiring shown in dotted lines in the figure is used for cutting in arrangement. When the signal is displaying green with 1 HR and 1 DR being energised, if the green lamp fuses then 1 DECR will drop. As soon as 1 DECR back contact is made the current supplied to green lamp is diverted to yellow lamp via the back contact of DECR, thus lighting the yellow aspect. Similarly, if yellow lamp fuses when the signal is displaying caution aspect the current supplied to yellow lamp is diverted to Red lamp via 1 HECR back contact and 1 HR front contact.

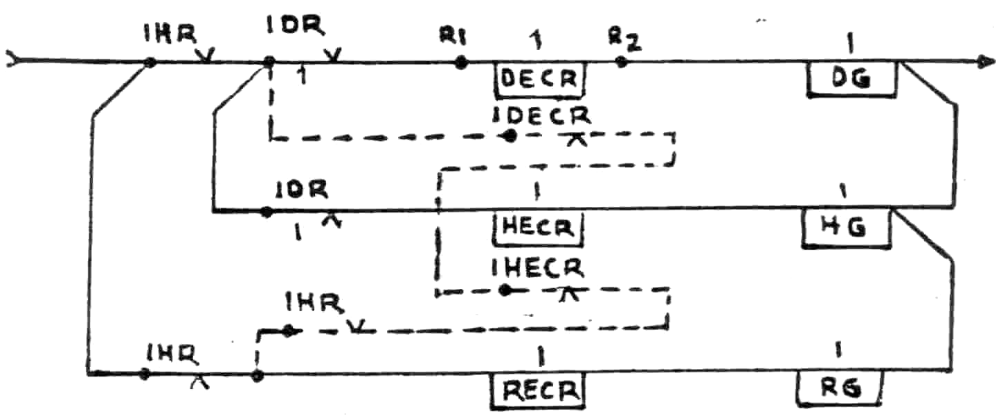


Fig 6.7 (a)

While providing for this cutting in arrangement, the circuitry should be so arranged that a less restrictive aspect or a confusing aspect should not result when the signal shall display a more restrictive aspect. In the above circuit, 1 HR front contact is included in the looping between yellow to Red. If this is not included a flashing yellow will result with a steady red aspect of the signal. Similarly, if the looping between green and yellow is taken from 1 DECR relay R1 terminal instead of 1 DR armature contact flashing green will result with a steady yellow aspect of the signal thus the flashing aspects of the signal may cause great confusion to the drivers and as such they should be avoided at all costs.

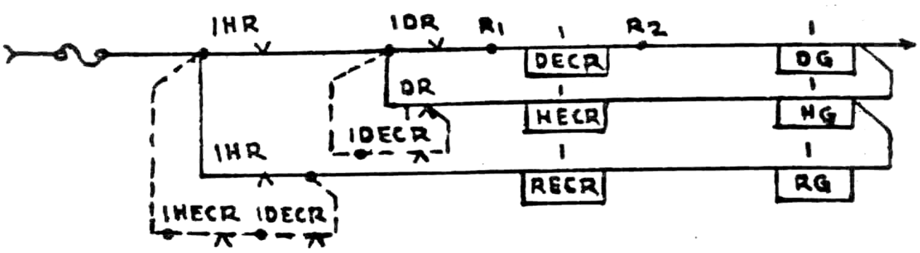


Fig 6.7 (b)

The cutting in arrangements can also be provided by bypassing the control relay contacts by the lamp checking relay contacts as shown in Fig.6.7 (b). This arrangement looks much simple, but requires more number of contacts for the ECRs.

6.8 Protection for Red Lamp Failure

The above 'cascading' arrangements are safeguarding the signal from going blank when the lamp for green or yellow aspect fuses by automatically restoring the signal to a more restrictive aspect. But when red lamp in the automatic signal fails, the cutting in arrangement cannot restore the signal to a more restrictive aspect, as there is no other restrictive aspect than Red in the signal. Hence, the signal goes blank aspects not in a position to protect the automatic signal section especially when a train occupies this section.

Under these conditions, the usual practice is to force the rear signal to danger so that it assumes the protection of not only its section, but also the section in advance and as a result the rear signal will remain at red till the train clears two sections ahead. The circuit arrangements required for this can be provided in three different methods.

6.8.1 First Method (Fig. 6.8 (a))

In this method, the red lamp checking relay 3 RECR front contact is included in series with the 3TR front contact in the 'cut section' arrangement between 3TR and A1TR that if automatic signal No.3 is not displaying red with the train in section due to red lamp failure, then the feed to the track A1T is disconnected at the 3 RECR front contact causing A1TR to drop. A1TR dropping in turn causes automatic signal No.1 to display Red aspect in lieu of automatic signal No.3.

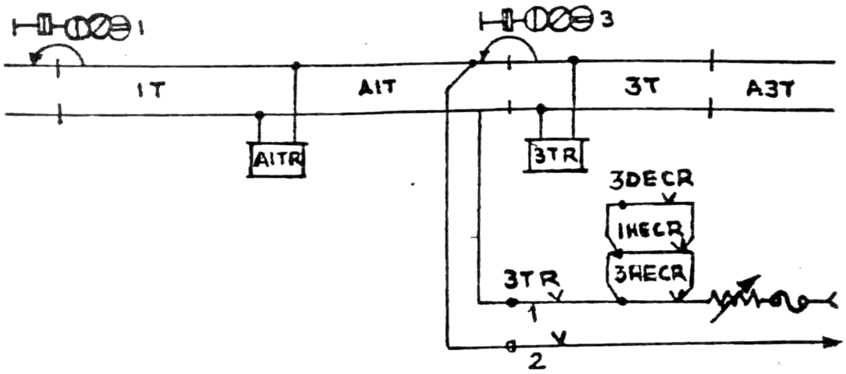


Fig 6.8 (a)

But when the section is clear and the automatic signal is displaying yellow or green then the signal in rear can also display green. So, 3 HECR and 3 DECR front contacts are provided to bypass 3 RECR contact so that when signal No.3 is displaying any OFF aspect, the track feed to A1TR is connected through 3 HECR or 3 DECR contacts and A1TR remains energised causing signal No.1 to display green aspect.

This arrangement is repeated at every cut section between the overlap and rear berth tracks of all automatic signalling sections. This method, in addition to providing protection for red lamp failure is also proving indirectly that the lamps in the automatic signal are in tact by virtue of the signal displaying different aspects with the train movement since the lamp check relay contacts are provided in series with the cut section arrangement. But this arrangement has a defect that when a signal in advance is changing its aspect from red to yellow or yellow to green the signal in rear is momentarily replaced to danger because when the signal changes its aspects, red is extinguished first then yellow is lit or yellow is extinguished first and then green is lit. As such, whenever the aspect changes in an automatic signal, it becomes blank for very short period during which all ECRs may drop causing the disconnection of feed to the rear berth track thus replacing the rear signal to danger automatically. This undesirable effect can be eliminated if ECRs are made slow to release.

6.9 Four-Aspect Automatic Signalling

Generally when the automatic signals are provided with distance between the signals not less than B.D. then 3-aspect signals will serve the purpose. But if the distance between two consecutive signals is less than B.D. on account of stations being very close or to improve the section capacity by reducing the headway between trains and reducing the automatic signalling sections, then the automatic signals have to be provided with 4 aspects. In this case, the sequence of aspects, when a train passes a signal is Red, Yellow double Yellow and Green as the train occupies the section after passing a signal and clearing one section, two sections and 3 sections ahead of the signal respectively. The arrangement of signalling is shown in Fig.6.9 (a).

When a train passes signal No.7 and is occupying the section A7T then signal No.7 displays Red (danger) and the signals in rear display the aspects as indicated below: -

Signal No.5	-	Yellow (Caution)
Signal No.3	-	Double Yellow (Attention)
Signal No.1	-	Green (Clear)

As these signals have one, two and three sections ahead clear. In this system of 4 aspect signalling, it is customary to ensure that the distance between the signal displaying red and a signal displaying double yellow is at least equal to B.D. If this distance is not available then, the double yellow aspects are repeated in rear signals till the last signal displaying double yellow is at a breaking distance in rear of the signal displaying Red. Shown in Fig 6.9 (b)

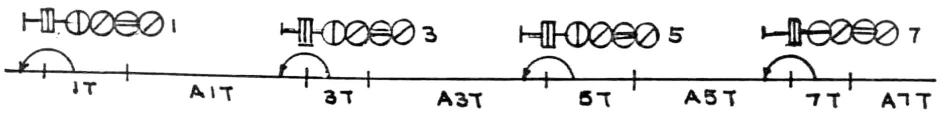


Fig 6.9 (a)

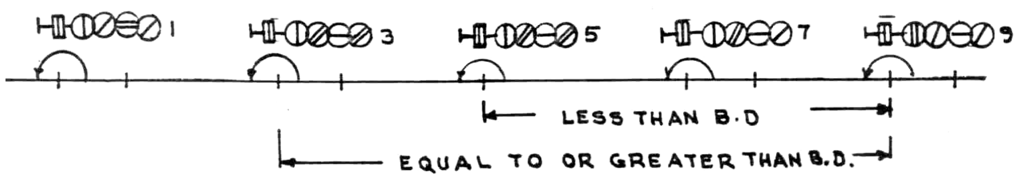


Fig 6.9 (b)

6.10 Aspect control of Four - aspect automatic signals

There are two methods for controlling the 4 aspects of an automatic signal.

6.10.1 First method

In first method shown in Fig 6.10.1(a) all three controlling relays viz., 1/HR, 1/HHR & 1/DR remain picked up when the entire section is clear. As soon as a train passes, signal No.1 HR will drop and replaces the signal No.1 to danger. When train clears one section ahead including overlap, 1 HR will pick up but 1 HHR and 1 DR will drop as the signal No.3 in advance displays red. Through HR picked up the signal No.1 will change its aspect from Red to Yellow. When the signal No.3 in advance changes its aspect to yellow, then 1 HHR will pick up in Signal No.1 location and changes the signal No.1 aspect from Yellow to double Yellow through 1 HR and 1 HHR pick up contacts. Similarly, if the Signal No.3 in advance changes from Yellow to double yellow and subsequently to Green, then 1 DR will operate in rear signal location and changes its aspect to Green through 1 HR, 1 HHR and 1 DR pick up contacts. Thus it is seen that when a signal is displaying Green, all the control relays are kept energised.

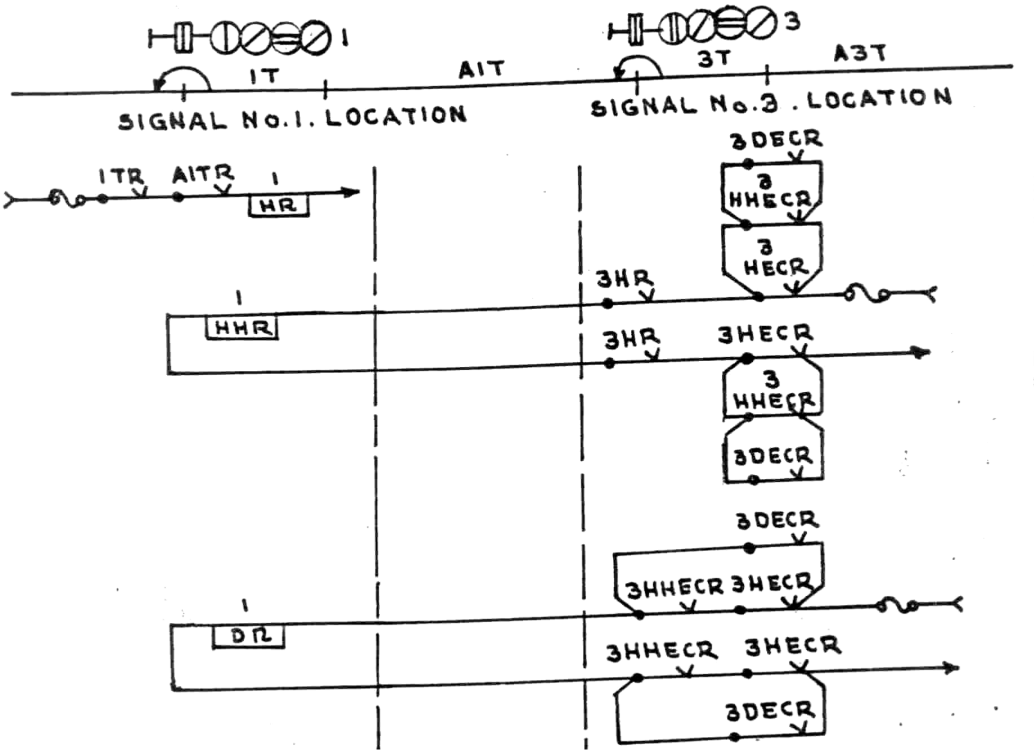


Fig 6.10.1 (a)

Lamp Control Circuits: The three relays 1 HR, 1 HHR and 1 DR will control the 4 aspects of signal No.1 as shown by the circuit diagram in Fig.6.10.1 (b).

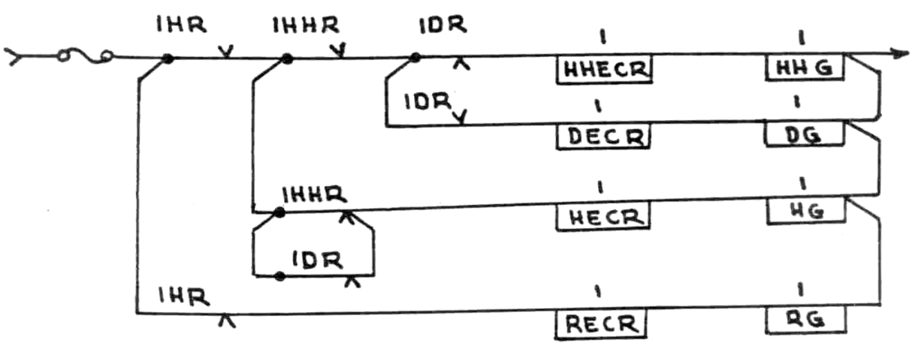


Fig 6.10.1 (b)

Cutting in Arrangement Fig.6.10.1 (c):

In 4-aspect automatic signalling arrangements can be provided to restore the signal to a more restrictive aspect when a less restrictive aspect fails due to lamp fusing etc. The circuit shown in dotted line shows the "cutting-in" arrangements in such a way that when Green lamp fuses, the signal is restored to double yellow, when one yellow fails, the other will remain in case of attention and if both yellows of attention or single yellow of caution fails, the signal is restored to danger. The protection for Red lamp failure is same as for the 3-aspect automatic signal as discussed earlier.

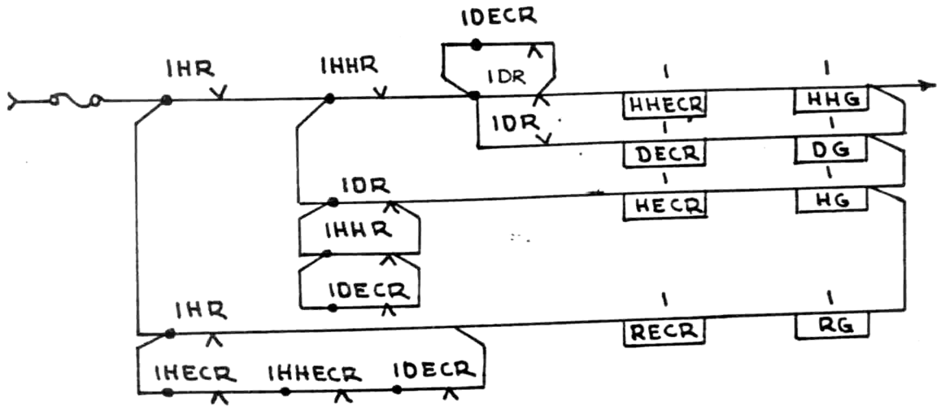


Fig 6.10.1 (c)

6.10.2 Second Method

In this method, instead of keeping all the control relays energised normally one of the two relays viz., HHR or DR is energised at a time. Thus, when the signal ahead is displaying caution HHR operates in rear signal location and if the signal ahead is displaying attention or clear DR operates in the rear signal location. The aspect control circuits are as shown in Fig.6.10.2 (a). The three relays 1 HR, 1 HHR and 1 DR will control the 4-aspects of signal No.1 as shown in Fig.6.10.2 (b). In the circuit cutting in arrangements can also be provided to restore the signal to a more restrictive aspect when a less restrictive aspect lamp fails. The dotted line shown the cutting in arrangement in the circuit drawn in Fig.6.10.2(c).

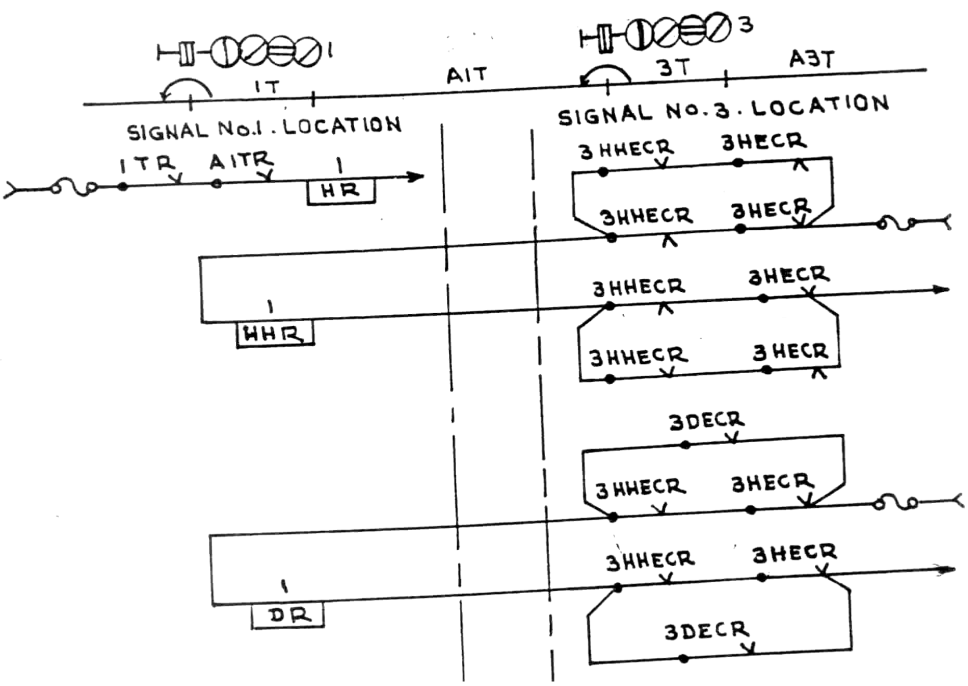


Fig 6.10.2 (a)

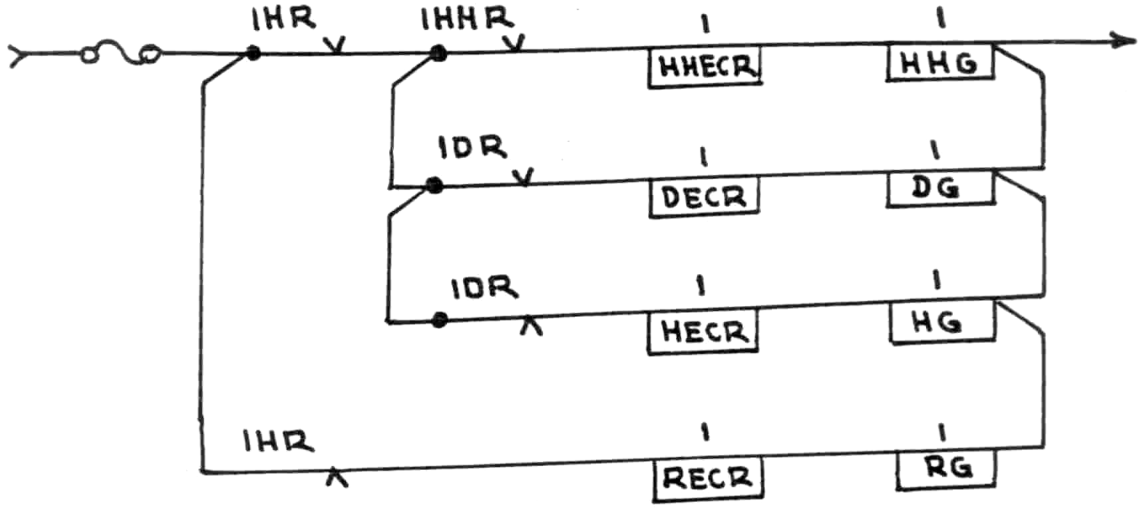


Fig 6.10.2 (b)

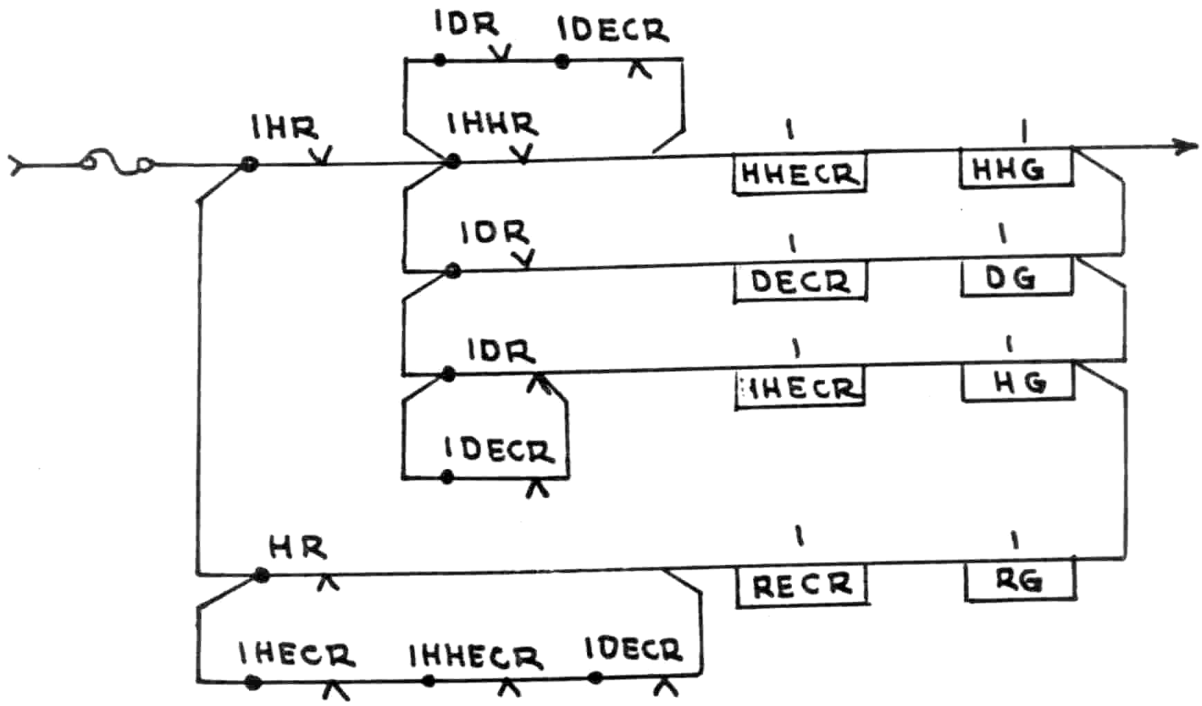


Fig 6.10.2 (c)

CHAPTER 7: LED SIGNAL UNITS

7.1 Introduction

Signals are provided to guide the rail engine driver for safe onward journey. Therefore, it is necessary that signals display correct aspect. In colour light signal territory, signal may go "blank". A blank signal is a grave safety risk as it can cause confusion to the drivers and can result in accidents if driver does not take action to control his train in time. Various CRS inquiry reports have recommended that adequate protection against blank signal must be taken. Railway Board have accepted the recommendations. Signal may go blank either due to failure of signal lamp or due to interruption in power supply. At present, filament lamps light signals. Rate life of lamp is only 1000 hours. It necessitates replacement of signal lamps every 45 days for Normal aspect and 90 days for other than normal aspect. Replacement of a signal lamp is not a simple work, as focusing is to be checked and adjusted after replacement of each lamp. With increase in signalling gears at most of the stations, signal technicians in general are not able to cope up with the huge work of adjustment of focusing. Due to this visibility of number of signals does remain up to mark. To overcome these problems RDSO developed LED Signal units, which has the life of not less than one lakh hours. LED Signal Units are basically available in two models depending upon the source (AC / DC) of operation:

LED SIGNAL

7.2 LED SIGNAL (Light Emitting Diode)

LED light sources are solid state p-n semiconductor devices. By doping substrate material with different materials, a p-n junction is formed within the semiconductor crystal. The dopant in the n region provides mobile negative charge carriers (electrons), while the dopant in the p-region provides mobile positive charge carriers (holes). Within a semiconductor crystal, when a forward voltage is applied to the p-n junction from the p-region to the n-region, the charge carriers inject across the junction into a zone where they recombine and convert their excess energy into light. The materials used at the junction determine the wavelength of the emitted light. A clear or diffuse epoxy lens covers the semiconductor chip and seals the LED. It also provides some optical control to the emitted light.

LEDs have been developed that have a luminous efficacy (lumens per watt) exceeding that of incandescent lamps. However, the relatively small lumen package that is produced by a single LED still means that dozens, if not hundreds, of LEDs must be used together to produce even a modest amount of light. For LED signals, over 80 of LEDs are packaged to create the high luminance signal face that is required by specifications.

7.3 Salient features of LED Signal Unit

There is no Phantom effect

(a) LED lamp is Pre-focussed and do not need external lenses or periodic focussing

(b) LED lamps are compatible with existing signal housings, hence can be retrofitted

(c) Traffic hazards while bulbs are being changed by maintenance staff is eliminated

(d) LED signals use less energy

(e) DC power feeding to signals possible, thereby eliminating transformers.

(f) Wide voltage variation in power feed is tolerated

(g) AC immunity up to 300 volts dispenses with cut-in relays

(h) One design of ECR for all LED signal lamp application including shunt signal and route indicator

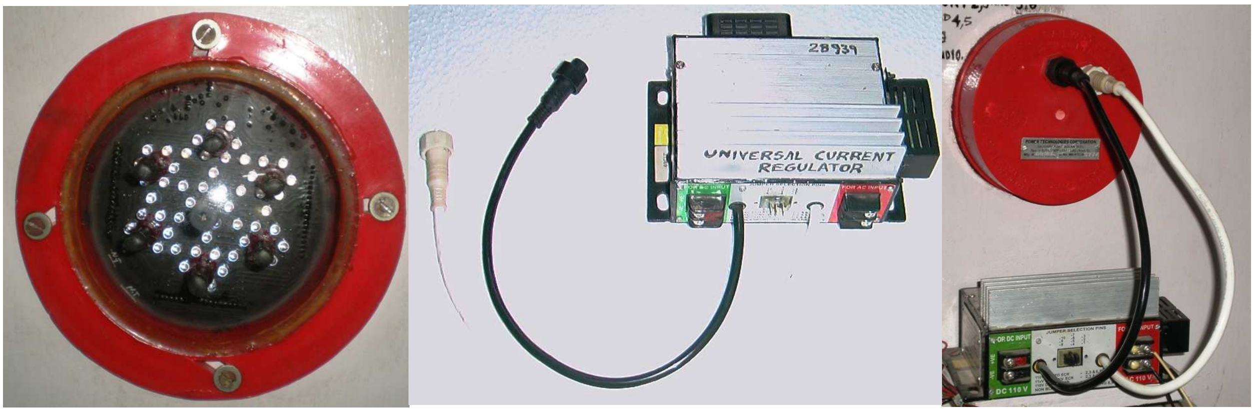
(i) Maintenance costs reduced, as they don't need frequent replacement. Only occasional cleaning of transparent cover needed in dusty areas.

7.4 CONSTRUCTION OF LED LAMP

LED signal unit comprises of the following units

7.4.1 LED Signal aspect unit

It comprises of a cluster of LEDs in series and parallel combinations. LEDs in a signal aspect are arranged in more than one array so that in the event of failure of even a single LED, whole unit does not become blank. LEDs in the arrays are interleaved so that effect of failure of any array is spread out equally to maintain uniform visibility. All aspects (except route and shunt) use two arrays for higher noise immunity and also provide the redundancy. LED in each array are in electrically independent path so that failure of any LED does not affect operation of other. The optical sensors are provided for each aspect and output from optical sensors is given to the current regulator unit for corrective / alarm action. A few LEDs in the signal unit are so arranged as to ensure near visibility of 5 meters so that the signal is clearly visible to a driver stopping at the foot of the signal.



LED LAMP UNIT AND UNIVERSAL CURRENT REGULATOR

7.4.2 Current regulator unit

LED is a current driven device therefore, LEDs clusters in a LED signal lamp are fed constant current irrespective of input supply voltage fluctuations by current regulator. It consists of solid-state variable resistance controlled by feedback from sensors (current and voltage for each array & optical sensor) and current regulator for each LED array. Solid-state variable resistance detects failure of

If optical sensor detects signal blank / dim, it reduces the current less than ECR pick up current to generate alarm and cut-off the aspect.

(a) Limits the current to cause low current alarm or

(b) Boosts the current to cause high current alarm.

LED signal unit housing is made either of mild steel sheet or of industrial grade plastic like ABS or fibreglass. The front cover is made of CV stabilised polycarbonate dome. LED signal unit is hermetically sealed in order to ensure that it is able to withstand the environmental severity. The dimension of LED signal unit is such that it can fit securely in the existing CLS units without any modification to them.

7.4.3 Failure indication unit

LED signal unit works in association with Failure indication unit located at the cabin/relay room end. The failure indication unit monitors the performance of the LED Signal aspect. The following failure conditions detected by current regulator unit are displayed to warn impaired visibility of the aspect due to LED failure & Low / High aspect current (below 105 mA / above 145 mA). No light/low visibility & aspect current less than 30 ma.

FUNCTIONAL REQUIREMENTS: The LED lamps should satisfy the following functional requirements:

1	The colour coordinates of LED signal unit	Red, Green and Lunar white aspect.	Class 'C' of BS:1376-1974
		Yellow aspect.	Class 'B' of BS:1376-1974
2	The visibility of each aspect of LED signal unit		600 metres in clear day light
3	Visibility of Route indicator		200 metres.
4	The minimum illumination of LED signal units measured at a distance of 1.5 metres in axial direction.	Red aspect.	50 Lux
		Yellow and Green aspect	100 Lux
5	LED signal lighting units display area.	Main and Calling-On signals	125 mm diameter.
		Route and Shunt signals	85 mm diameter.
6	ECR (DC) normal operate current.	All LED signal units.	125 mA of current.

7.6 Safety considerations in design of led signal aspect as follows

7.6.1 Hardware failure

A filament lamp either draws current when lit or does not draw current when not lit. Filament lamp fails only in open circuit mode while LED can fail in open or short or leaky mode. Thus LED can draw current when it is lit as well as when it is not lit. Therefore following conditions have been taken into account to make sure that LED signals fail on safe side:

(a) LED failing in short-circuit mode

(b) LED failing in open circuit mode

(c) LED failing in leaky mode

Design of LED array is such that with failure of one LED due to open circuit failure, no other LED is affected in the LED array. Similarly, with failure of LED due to a short, other LED is not affected and partial loss to the extent of that LED in the array (LED in series) takes place.

With open circuit failure of LED, the total array current will decrease and with short circuit failure of LED, the total array current will increase. These two variations of array current are monitored and used to generate alarm when 20-25% LED fail.

For leaky mode of failure of LED, an optical detector is used to detect light output of the LED signal unit. When the light output is below allowed level, alarm is generated along with switching "off" of the aspect.

7.6.2 Colour of LED signals

Indian Railways follow the BS: 1376:1974 standard. In this specification colours are defined in X, Y, Z coordinates in terms of CIE Chromatically chart. X coordinate is analogous to red, Y to green and Z to blue. The other colours are defined in terms of X Y, and Z coordinates and represented by dominant wavelength on the periphery. The colours which do not lie on the periphery of the CIE chart have to be necessarily defined by co-ordinates and for the purpose of visual appearance to the eye are defined by dominant wavelength.

LED is a solid state device, and can fail in open or short or leaky mode. P-n junction of LED is responsible for exhibition of colour. As there can be numerous stages of p- n junction failure, it is essential to carry out the colour failure analysis of the LEDs to ensure that LED signal failure take place on safe side.

7.6.3 Effect of voltage variation on LED colour

The LED aspect is fed through current regulator. Current remains constant to the LEDs with input voltage variation in the specified range. Input voltage variation has no affect on light emitted within the specified range of specification i.e. 90 to 130 VAC, with current regulator working.

7.6.4 Effect of Current variation on LED colour

The variation of colour in LED aspect has been checked on all colours from cut-in current till burnout current. Excessive current leads to primarily heating in the LEDs causing ultimately reduction in light out put.

(a) Red aspect and green aspect have been found to be in their colour ranges, even in the transient period of burnout.

(b) White aspect has been found to be in its colour range except during transient period of burnout where it becomes momentarily blue at current above 180 mA (7.2 times overdrive).

(c) Yellow aspect has been found to be in its colour range except it shifts towards Red when current is in excess of 300 mA (about 2.4 times over drive). Its shift into Class 'A' red is momentary during transient period of burnout at current above 460 ma (3.7 times over drive).

Therefore, there is no chance of change of colour on unsafe side due to increase in current. At the transition stage when the colour of LED is trying to change, the LED gets burnt out within milli-seconds.

7.6.5 Effect of Temperature on LED colour

Red, Green, Yellow and white aspects are found to be within their ranges within the specified temperature range. Yellow aspect colour coordinate improves at higher temperature.

7.6.6 Effect of Aging on LED colour

The degradation in LED colour after 100000 hrs of continuous stress is approx. 5%. Sealing of units reduces effect of moisture and further improves the performance. Thus LED lamps are safe and shall not fail on unsafe side.

7.7 AC Model and DC LED Models

LED Signal Unit - AC Model**:** It is suitable for fitment in existing CLS units available in RE & Non-RE areas. and

LED Signal Unit - DC Model**:** It is suitable for all new works in RE and Non-RE Areas. The ECR used in this model is DC ECR, which is common ECR for all type of signals.

(a) Main Signal - Red aspect, Yellow aspect, Green aspect.

(b) Calling on Signal.

(c) Route Indicator.

(d) Position Light Shunt Signal.

In case of DC models:

AC immunity of more than 300 VAC, no cutting in relays required in RE area and even for second distant signal.

Common ECR for all types of signals helps in reducing number of spares and hence spare parts cost.

7.8 OPERATING PARAMETERS

Parameter	**Main Signal**		**Calling-on Signal**		**Route Indicator**		**Position Light Shunt Signal**	
	AC Model	**DC Model**	**AC Model**	**DC Model**	**AC Model**	**DC Model**	**AC Model**	**DC Model**
Rated Voltage	110 VAC ±15%	110 VDC ±15%	110 VAC ±15%	110 VDC ±15%	110 VAC ±15%	110 VDC ±15%	110 VAC ±15%	110 VDC ±15%
Wattage	15 W	12 W	15 W	12 W	-	-	-	-
Current at rated voltage per unit.	125 mA to 130 mA	100 mA to 105 mA	125 mA to 130 mA	100 mA to 105 mA	25 mA to 28 mA	22 mA to 25 mA	55 mA to 58 mA	45 mA to 48 mA
Colour	R/Y/G	R/Y/G	Yellow	Yellow	Lunar White	Lunar White	Lunar White	Lunar White

7.9.1 ECR for LED Signal Unit of AC Model

(a) Universal Plug-in-type, tractive armature AC lamp proving relay is used.

(b) Maximum pickup current = 90 mA / AC, 50Hz.

(c) Minimum release current = 60 mA / AC, 50Hz.

(d) This ECR withstands for a continuous current of 250 mA / AC 50Hz.

(e) Contact configuration: 4F-4B identically in A to D rows.

(f) Voltage drop across R1 and R2 is less than 10V @ 125 mA /AC (normal working current).

7.9.2 DC ECR for LED Signal Unit of DC Model

(a) Universal Plug-in-type, tractive armature DC lamp proving relay is used.

(b) Maximum pickup current = 80 mA / DC.

(c) Minimum release current = 55 mA / DC.

(d) This ECR withstands & continuous current of 200 mA / DC.

(e) Contact configuration: 4F-4B identically in A to D rows.

(f) Voltage drop across R1 and R2 is less than 10 V @ 100 mA (normal working current).

7.9.3 Procedure to install Signal Aspect & Current Regulator

(a) Sticker provided may be put on the Current Regulator to indicate the selection.

(b) Remove both the lenses of the aspect.

(c) Remove the bulb holder, bulb & transformer.

(d) Install from the rear side the LED aspect on the four mounting screws of the roundel.

(e) Your Current regulator is Universal AC/DC field selectable mode as follows:

(i) Lighting supply – AC or DC

(ii) ECR type – Convl. AC ECR, LED AC ECR or LED DC ECR.

(iii) Cascading mode – ON aspect: Non-Blanking, OFF aspect: Blanking

(f) Install Current Regulator on the mounting screws of Signal Transformer.

(g) Connect the 4 pin & 2 pin couplers of the current Regulator to the aspect.

7.9.4 Table for Current Regulator mode selection

1. Route & Shunt signals :

AC LED ECR	:	Short Pins 1-2, 4-5, 7-8
AC Convl. ECR	:	Short Pins 1-2, 5-6, 7-8
DC ECR	:	Short Pins 2-3, 5-6, 8-9

2. Calling-ON :

AC LED ECR	:	Short Pins 2-3, 5-6
AC Convl. ECR	:	Short Pins 2-3, 4-5
DC ECR	:	Short Pins 1-2, 5-6

(Pins are counted from bottom to top from input terminal side).

3. Main Signal:

AC LED ECR	:	Short Pin 2-3, 6-7,	Blanking off aspect	: Short Pin 8-9
AC Convl. ECR	:	Short Pin 2-3, 5-6,	Non blanking ON aspect	: Short Pin 9-10
DC ECR	:	Short Pin 1-2, 4-5		

7.9.5 Operating Precautions for LED Colour Light Signals

(a) Loose connector between aspect & Current Regulator can cause dropping of ECR, false operation of blanking/non-blanking.

(b) Blanking mode should be selected for OFF Aspect Current Regulators. The units are shipped with default setting of non-blanking mode.

(c) Units supplied prior to version-1, voltage lower than 80 volts may lead to double aspect.

(d) Wrong selection at HMU side or signal lighting unit side can lead to an alarm.

(e) Please ensure the correct polarity while connecting Power supply in case of DC Lit Signals.

(f) Mounting Bolts/Screws should be secured tightly for the Aspect, Current Regulator as well as Health Monitoring Unit.

(g) Signal housing door should be kept shut and locked.

(h) After every tightening/opening of terminals of Aspect/Current Regulator, CRC should be sprayed on the terminals.

(i) Cleaning of the Aspect may be done periodically with soft cloth, anti-static.

7.9.6 ECR WORKING

(a) Main signal:

ECR should be pick up if aspect is fully glow and if aspect half glow and intensity are 50% ECR should be picked-up at input rated voltage 88 to 132 VAC/DC.

(b) Shunt Signals:

ECR should pick up with two shunt LED signal lighting units in parallel & both lit from 88 V to 132 V. ECR should drop when one shunt LED signal lighting unit is taken out from circuit.

(c) Route Signals:

(i) Route ECR shall pick up (minimum of 3-Aspects lit) on 5-Aspects lit.

(ii) Route ECR shall drop on 2-Aspects lit.

7.9.7 PROCEDURE TO INSTALL HEALTH MONITORING UNIT

(a) General:

Health Monitoring Unit is a safety monitoring device and essential to install. HMU is provided in series for each aspect through cable pair between the selection circuit and ECR. It connects in & then out on the Mother board for the respective aspect card locations. HMU conducts preventive monitoring as well as failure monitoring

(i) ECR remains picked-up at 50% illumination alarm given to user.

(ii) Cable current leakage sensing when signal is selected.

(iii) Cable potential leakage sensing when signal is not selected.

(iv) Fault monitoring of HMU, Current Regulator and aspect.

(v) Common alarm is given to the ASM and individual aspect status is given to ESM through aspect OK indicator.

(vi) At any instant of time, if any of the indications goes OFF for an energized signal, the same informs the deviation in the performance of that aspect or any of the circuit components of the signal lighting circuit.

(vii) In the event signal is not energized/selected the HMU conducts self-test and gives alarm on failure of its component. It also gives alarm when there is potential leakage of more then 30 Volts in the aspect cable.

(viii) HMU provides for individual aspect monitoring with O/P for datalogger.

(ix) HMU is vital monitoring devise checking the integrity of the lighting unit, which has electronic components and devices other than LED. The life span of LED signal is 10 years unlike the bulb runs for a few months. In LED signal light O/P is not directly related to current.

(x) Diagnostic flow charts are available for placement in Relay rooms.

(xi) Mark the HMU card in a shelf for the nominated aspect

(xii) Connect phase and Neutral (± in case of DC lit), (Aspect supply cable pair coming out of selection circuit) to the input of HMU card for the selected aspect.

(xiii) Connect the aspect cable pair to CT rack from o/p of the HMU aspect and through its ECR. Each shelf contains

- 8-aspect Monitoring aspect Cards One Power Supply Card.
- One Mother Board Card.

(xiv) The 19” Eight aspect shelves are cascaded to provide common alarm Audio/Visual Unit is connected through QNA1 Relay with last cascaded shelf of HMU

(xv) Connect the Power Supply input 110 VAC for AC Lit (24 VDC for DC Lit) signals and 24 VDC for operation of Audio/Visual Unit (see wiring diagram at fig. 3) and observe that the indicators on Health Monitoring Unit for all aspects are ON. This will confirm that all aspect cards are active and that the aspects which are ON are working well.

***Note**: (a) The Aspect monitoring cards in Health Monitoring Unit for AC & DC version are different. The Mother board & the shelves are Universal.*

(b) The AC Lit Health Monitoring Unit is suitable for use with LED ECR or conventional ECR. Please ensure the right selection to avoid alarms.

(b) Connectivity Test:

(i) Connect all aspect cable pairs through Health Monitoring Unit shelves and observe normal operation of all aspects. Power supply of the HMU shelves is not connected.

(ii) Activate the Power supply Card of the first shelf in the cascading arrangement by connecting main source 110 VAC (110 VDC in case of DC) & 24 VDC for operation of Audio Visual Alarm Unit as in fig. (2) and see that:

(iii) Its Power Supply indicator turns ON.

(iv) All aspect indications turn ON.

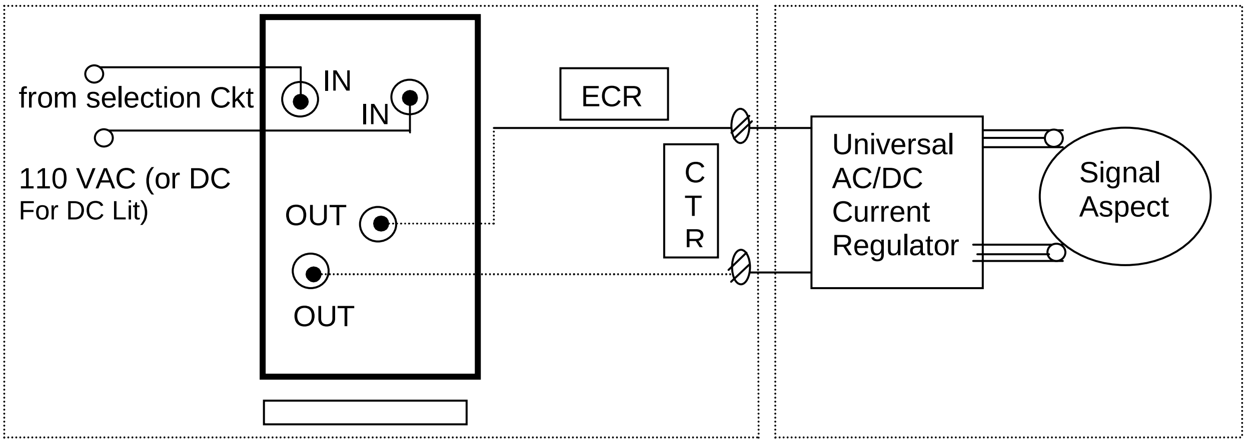
(v) Aspect O.K Indicator for the Power supply module is working (LED on).

***Note**: The AC should be pure sine wave i.e. 50 Hz$\pm$2 Hz.*

The station can operate with Health Monitoring Unit disabled by disconnecting the Power supply card from each 19" shelf.

Fuses have been provided for each aspect in Health Monitoring Unit. An overload shall disconnect the fuse.

(c) Wiring of ECR with LED Signal Lighting Unit –AC or DC Lit :



Universal AC or DC HMU
Sig. Ckt in RELAY ROOM

Signal Ckt. on Signal Pole

(a) Ø Indicates CT Rack terminals in relay room.

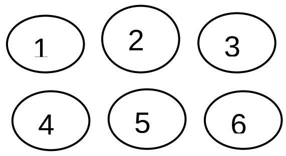
(b) The above repeats for each Aspect (Max. 8-Nos. HMU aspect monitoring cards in one 19" shelves).

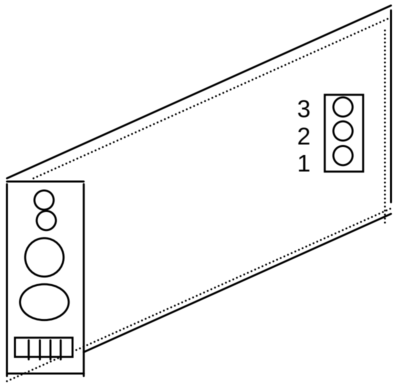
(c) Selection jumpers for selection of HMU card, to be in or out of circuit are indicated as:

Note:

(a) For Normal operation, Short 2,3 and 5, 6

(b) For maintenance bypass Short 1, 2 and 4, 5





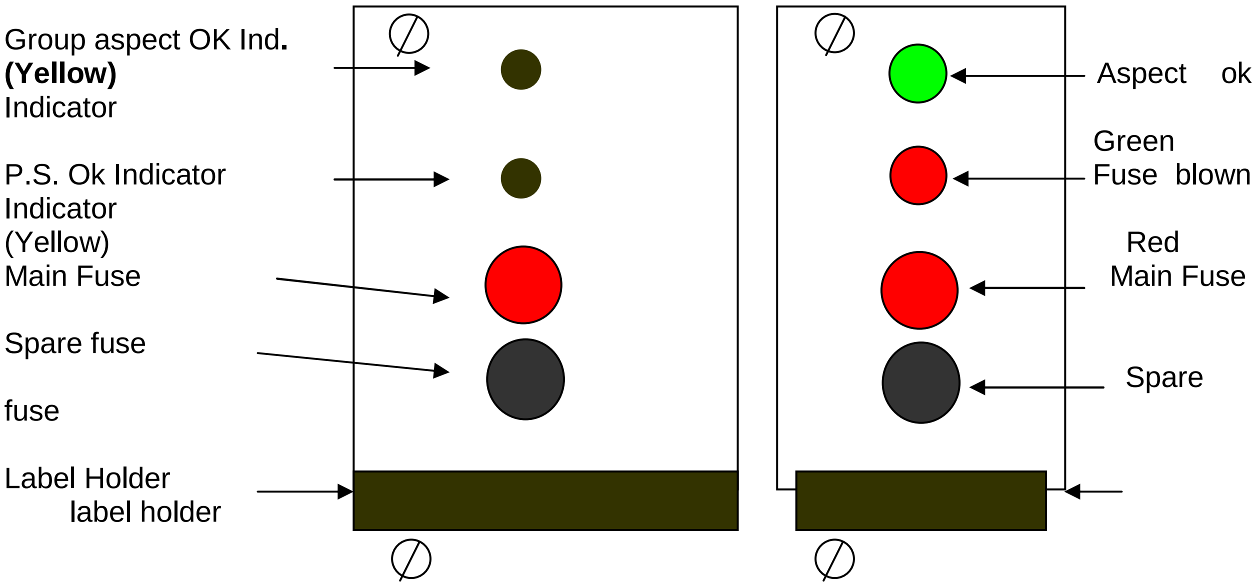
Aspect monitoring card of HMU

(d) Selection on HMU Card (Internally):

ECR type	Current setting	Jumper selection
(I) For LED ECR	125 ma rms	Short 1 and 2
(II) For Conventional ECR	220 + 20 ma rms	Short 2 and 3

* (Pin 1 counted from bottom edge of the card)

Front view DC or Universal AC Health Monitoring Unit Cards



Subjective questions

1. Write advantages of CLS over semaphore signals.
2. Prepare signal Indication circuit with L&H type current transformers.
3. Prepare Signal aspect control circuit for 2 aspect/3 aspect signal and discuss in detail.
4. Write short noted on triple pole lamps.
5. Prepare MECR Buzzer circuit and Explain.
6. Write short notes on Double Distant Signal.
7. What is cascading/cutting-in arrangement? Prepare lamp controlling circuit of 2/3 aspect signals with cascading arrangement?.
8. What is Red Lamp protection? Explain Red lamp protection circuit.
9. Write short notes on the followings7

(a) LED Signal unit (b) Universal current Regulator (c) Advantages of LED Signals over Conventional CLS.

Objective questions

1. When cascading is used in aspect control circuit them signal lamp to be used is/are--------(d)
   a) SL18 b) SL21 c) SL35 d) a&c both
2. The signal lamp terminal voltage shall not be more than ------------- of rated voltage.(a)
   a) 90% b) 98 % c) 80 % d) 12 %
3. The proceed aspect is displayed in four aspect automatic section when ________ automatic sections ahead and overlap are clear.(b)
   a) 4 b) 3 c) 5 d) 2
4. The signal lamps are triple pin lamp to avoid---------------- (b)
   a) Lamp theft b) out of focus after replacement of lamp c) use for domestic purpose d) loose grip
5. The no load current of signal transformer shall not be more than ----------------- (d)
   a) 5 mAmp b) 15 Amp c) 40 mAmp d) 15 mAmp
6. The power ratting of signal transformer is ------------------ (b)
   a) 400VA b) 40VA c) 4KVA d) 40KVA
7. The tapping on secondary side of signal transformer is/are ------------------ (d)
   a) 13 volt b) 14.5 volt c) 16 volt d) a,b &c
8. When MECR & Signal transformer are placed in side two aspect unit then number of cable conductors required in tail cable (with double cutting) are--------------------- (b)
   a) 10 b) 8 c) 12 d) 6
9. Lamp to be used in ON aspect of signal is/are (a)
   a) SL21 b) SL35A c) SL35B d) a&c

10. When Distant in double distant territory displays proceed aspect then indicates ------ (d)
    a) Run through on main line b) run through on loop line
    c) Train going to be received on main line b. d) a&c

11. When inner Distant in double distant territory displays proceed aspect then indicates ----(a)
    a) Run through on main line b) run through on loop line
    c) Train going to be received on main line band. d) a&b

12. Red lamp protection provided to---------------------- (a)
    a) Protect blank signal b) prevent blanking of signal
    c) Replacement of signal to ON d) a & b both

13. -----------------------------ECR can be used for LED AC signal (d)
    a) Conventional ECR b) LED AC ECR c) LED DC ECR
    d) a , b &

14. Normal working voltage of LED signal unit is / are ---------------- (d)
    a) 110 volt AC b) 110 volt DC c) 230 AC d) a&b

15. __________ relay back contact shall be provided across DR back contact to ensure cascading arrangement in 3- aspect signal circuit.(b)
    a) HECR b) DECR c) RECR d) HR

Match the Following :

1.	SL-5	(e)	a) 12 V / 33 W
2.	SL –17	(d)	b) 12 V / 24 W
3.	SL – 21	(c)	c) 12 V / 24 W & 16 V / 12 W
4.	SL – 35 A	(b)	d) 12 V / 4 W
5.	SL – 35 B	(a)	e) None