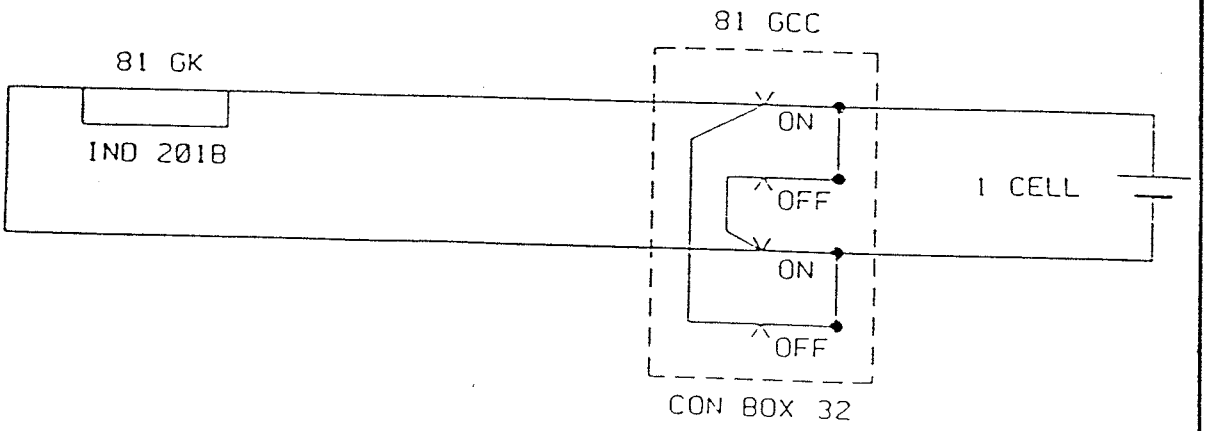
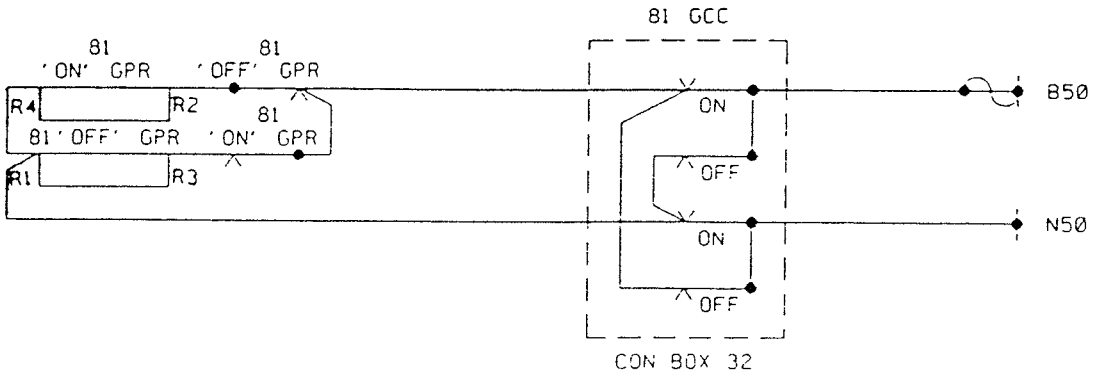
DIRECTOR OF S & T ENGINEERING.
WEST MIDLANDS PROJECTS GROUP.

INTRODUCTION TO SOME BASIC SIGNALLING CIRCUITS





INTRODUCTION

This module is intended as a brief introduction to signalling circuits at a basic level and is primarily to cover the general principles of signal control circuits, it also includes details of signal indication circuits, the two subjects being closely associated.

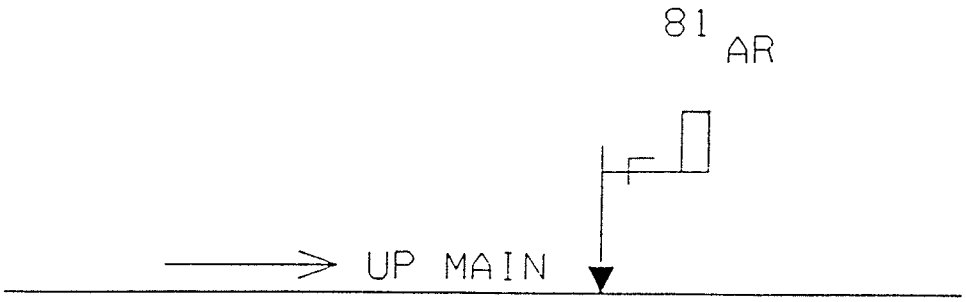
Railway Signalling circuits are more comprehensively dealt with in detail in Training Module 15 "Understanding Basic Signalling Circuitry".

This module assumes a certain amount of knowledge of the graphical symbols used in connection with wiring diagrams as in accordance with the current British Standard Institution's Specification.

continued

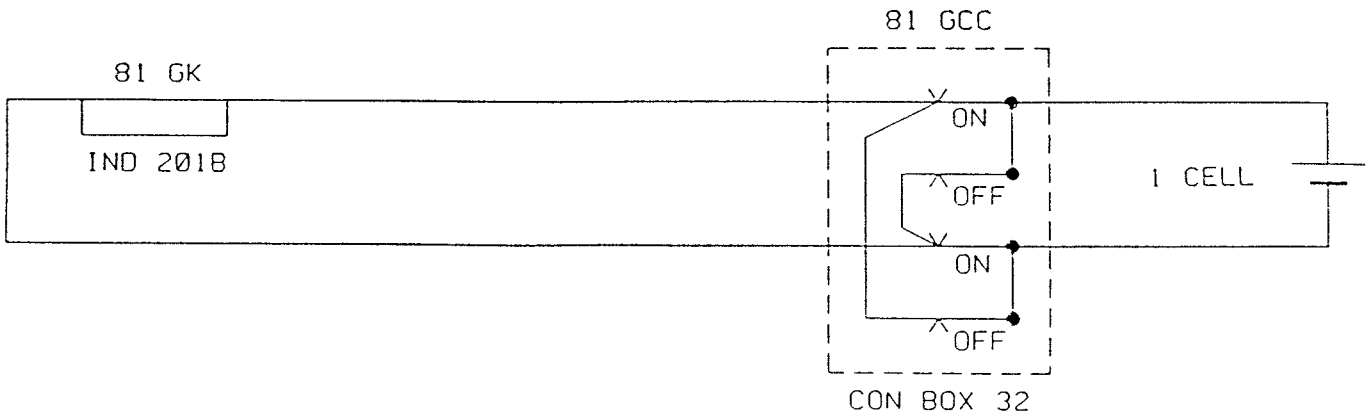
ARM REPEATING OF A SEMAPHORE SIGNAL

In the module **"Introduction To Plan Symbols"** we identified the symbol shown below as a **"Semaphore Stop Signal"** with an **"Electric Lock"** and **"Arm Repeating"** provided.



The circuit below is what we would provide. The circuit is a "pole changing circuit". What this means is, the current flows in one direction for the **"ON"** indication and in the reverse direction for the **"OFF"** indication.

ARM REPEATING OF A SEMAPHORE SIGNAL (WITHOUT POWER)



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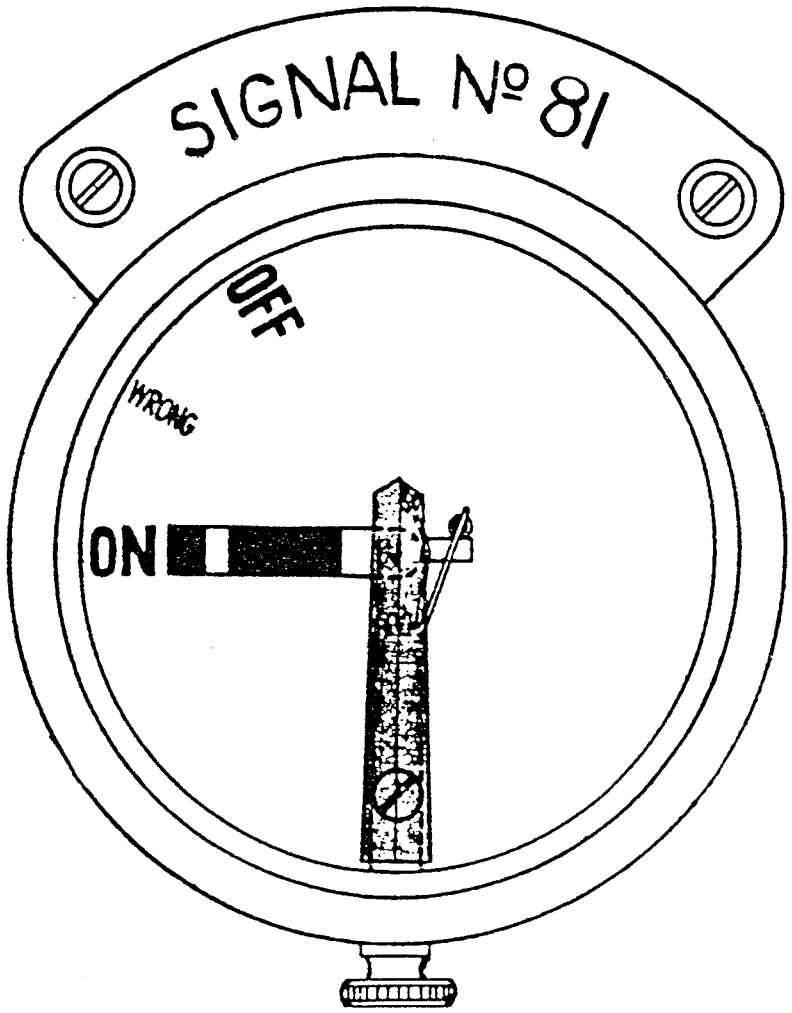
The indicator used is shown in Figure 3 and it gives a physical indication of the position of the signal arm.

Figure 3.



INDICATOR 201

FOR INDICATING THE ARM OF SEMAPHORE STOP SIGNALS

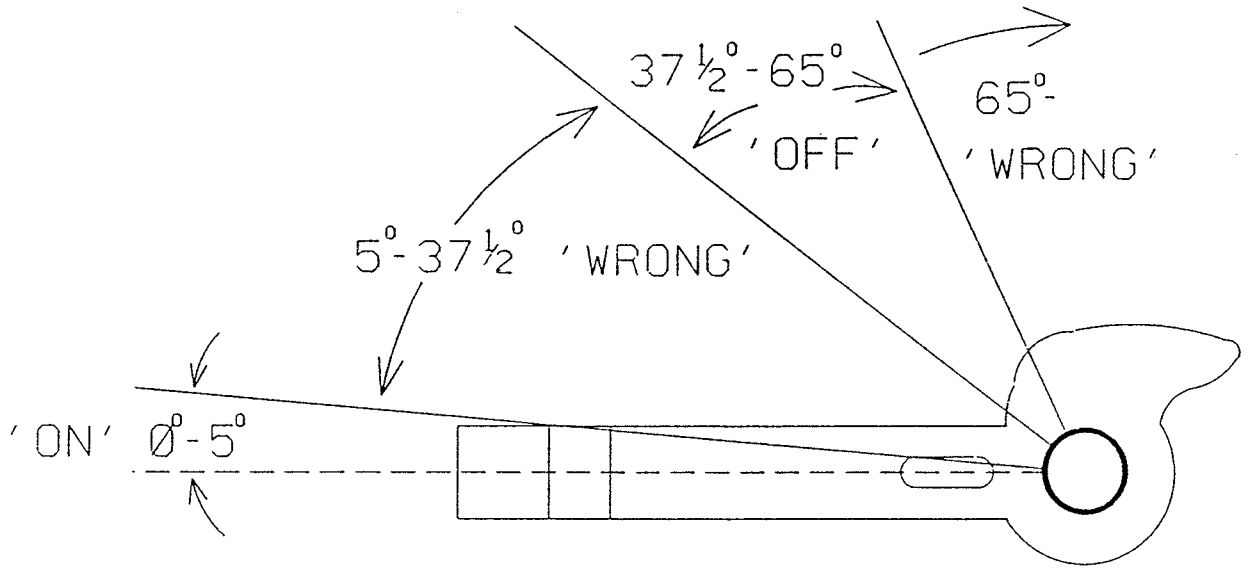
continued

When there is a break in the indication circuit the signal indicator shows **"WRONG"**.

Inside the contact box segments are cut in a cam to give the

"ON", "OFF" & "WRONG"

position of the signal arm.



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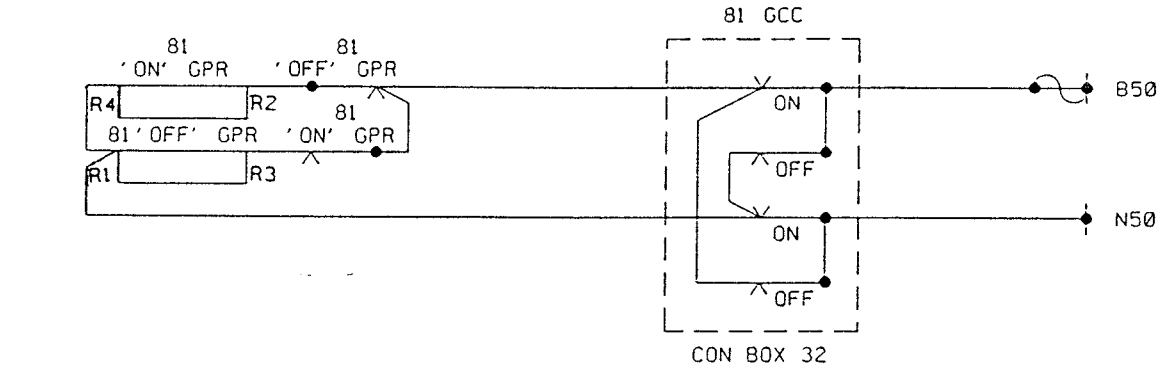
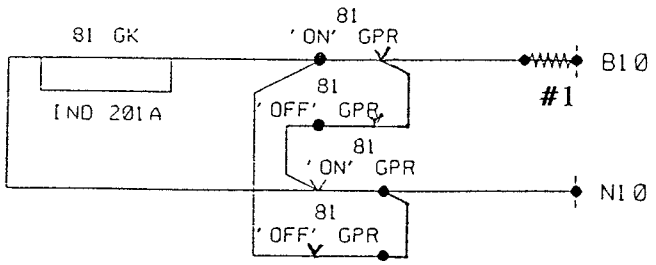
In certain circumstances power is available on site and the indication circuit can be operated by a 50 volt supply as shown in the diagram below.

ARM REPEATING OF A SEMAPHORE SIGNAL WITH POWER





continued

At the signal box the indicator is now separate from the line circuit and a simple **"Ohms Law"** calculation has to be used to find the value of the resistors to be installed in the 10 volt supply to give the correct operating current through the indicator. The current values of the various indicator values are shown in Table No. 1.

TABLE NO.1

RESISTANCE CODE	VALUE (ohms)	WORKING CURRENT (ma)
A	50	8
B	250	3.5
C	1000	2

$$R\#^1 = \frac{\text{VOLTAGE SUPPLY - VOLT-DROP OF INDICATOR}}{\text{OPERATING CURRENT}}$$

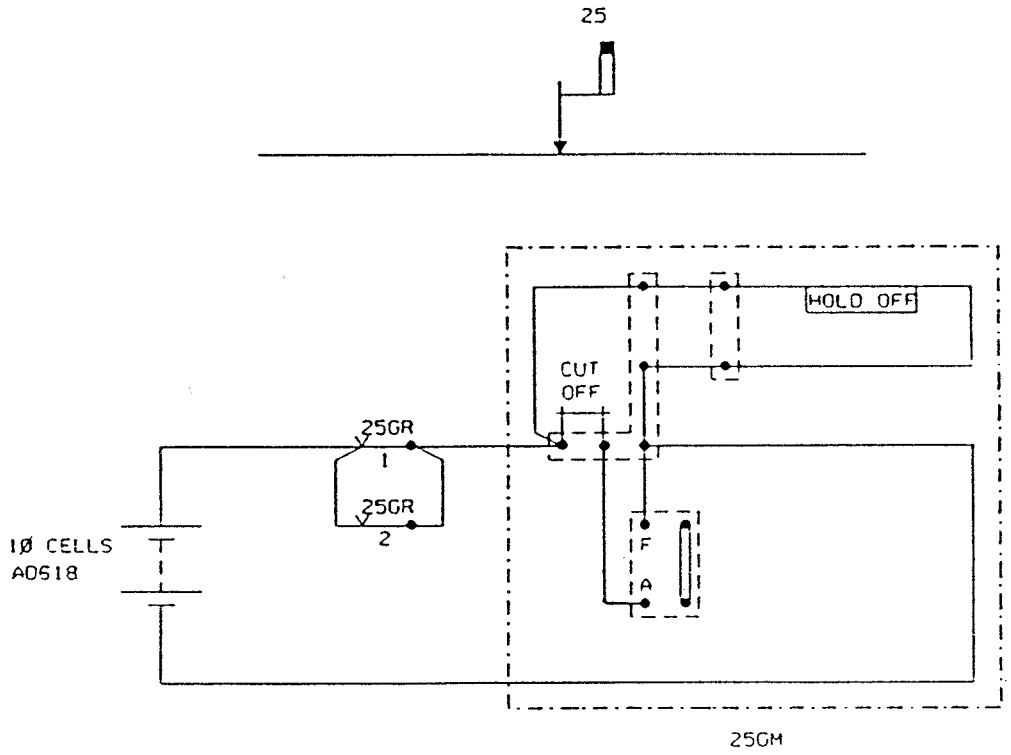
$$R\#^1 = \frac{10V - (50 \text{ ohms} \times 8mA)}{8mA}$$

$$R\#^1 = 1.2 \text{ Kohms}$$

continued

COLOUR LIGHT SIGNALS

At first, electric operation of the signals meant actuation of the semaphore arms by motor or a solenoid. An example of which is shown below:-



Soon the colour-light signal showed its superiority by giving the same aspect presentation by day and by night, and by its range, even in fog.

Colour-light signals of the multi-unit type have no moving parts, a separate light unit being provided for each aspect to be displayed. The light units comprise a concentrated filament lamp working in conjunction with a combination lens arrangement, the outer lens being clear glass and the inner lens of the desired colour.

The lamp filament is located at the focal centre of the lens system in order to obtain maximum beam intensity.

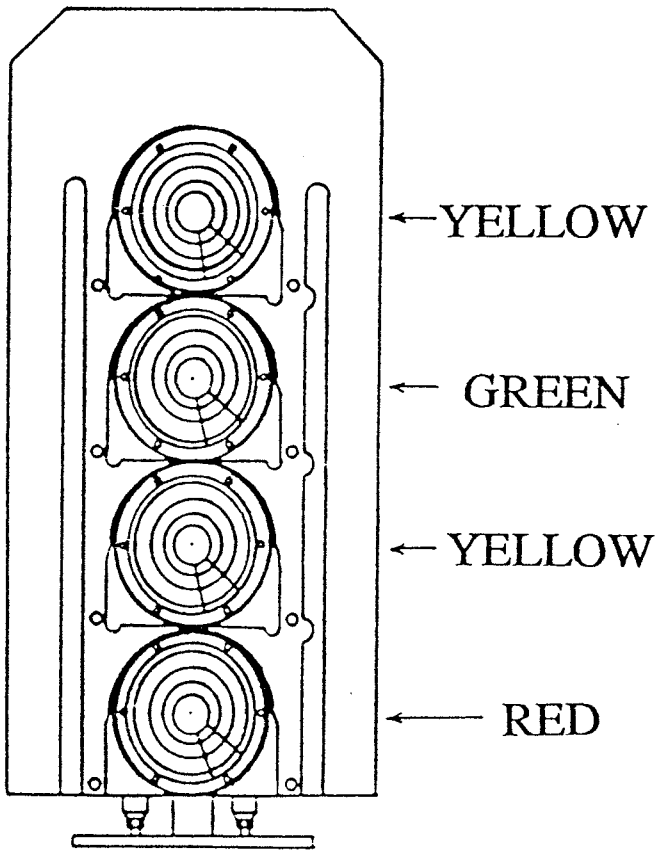
continued

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. The grouping of the light units is usually vertical with the Red aspect the lowest so as to be 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 the two yellow aspects must be as widely separated as possible to give a clear "double yellow" indication at a distance.

The order of units is therefore generally as shown below:-

MULTI-UNIT SIGNAL



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The control circuits for colour-light signals of the multi-unit type are generally not too difficult to understand, as will be evident from the typical wiring diagram for a two-aspect signal shown in the diagram below.

It can be seen that a control relay is required, the condition of this determining which aspect is to be illuminated.

The control relay in the example below is the "**DR**" relay. In railway coding terms this means it is the "**Green relay**".

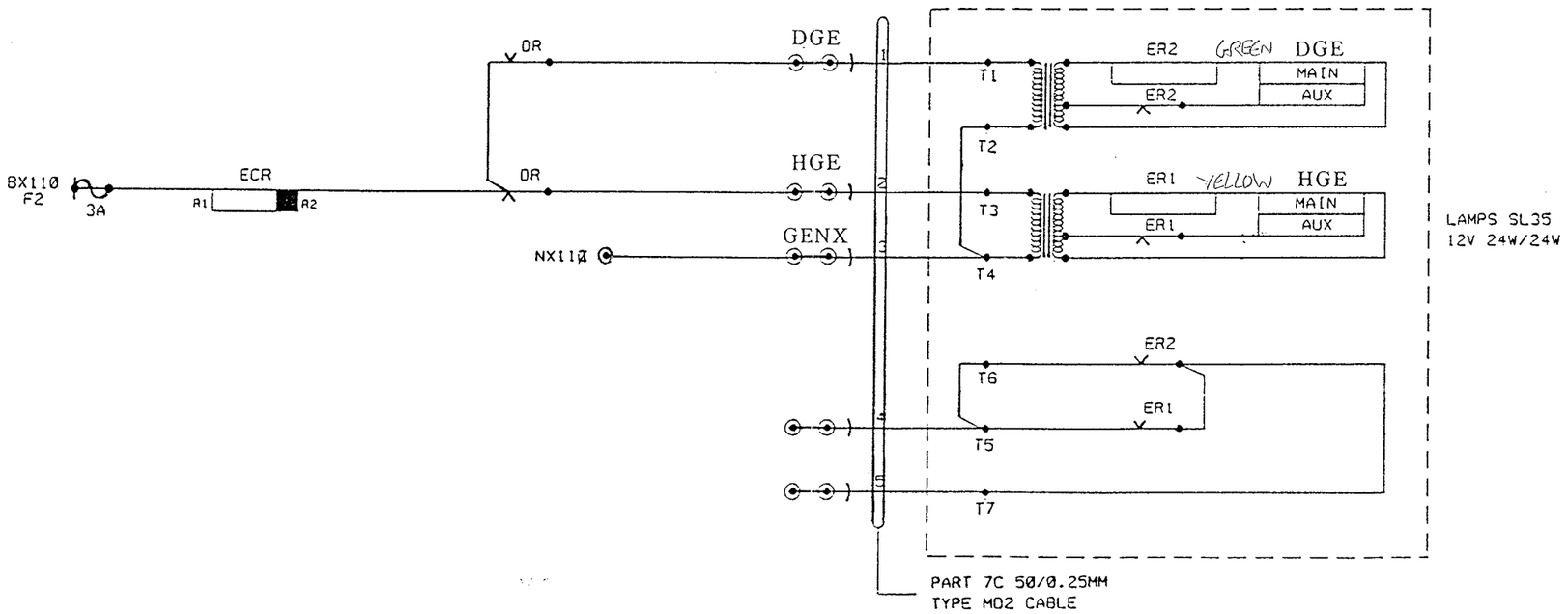
TYPICAL CONTROL CIRCUIT FOR A 2 ASPECT COLOUR-LIGHT SIGNAL

When the "**DR**" relay is de-energised the circuit will be completed by starting at the BX110 supply, through the "**ECR**" relay, over the back contact of the "**DR**" relay and to the signal-head transformer.

From the secondary side of the transformer the circuit is completed through the coil of "**ER1**", the main filament and returns to the negative busbar, via transformer secondary and primary.

The signal will display a "**Yellow aspect**".

When the "**DR**" relay is energised the feed will be transferred over the front contact of the "**DR**" so as to illuminate the "**Green aspect**"



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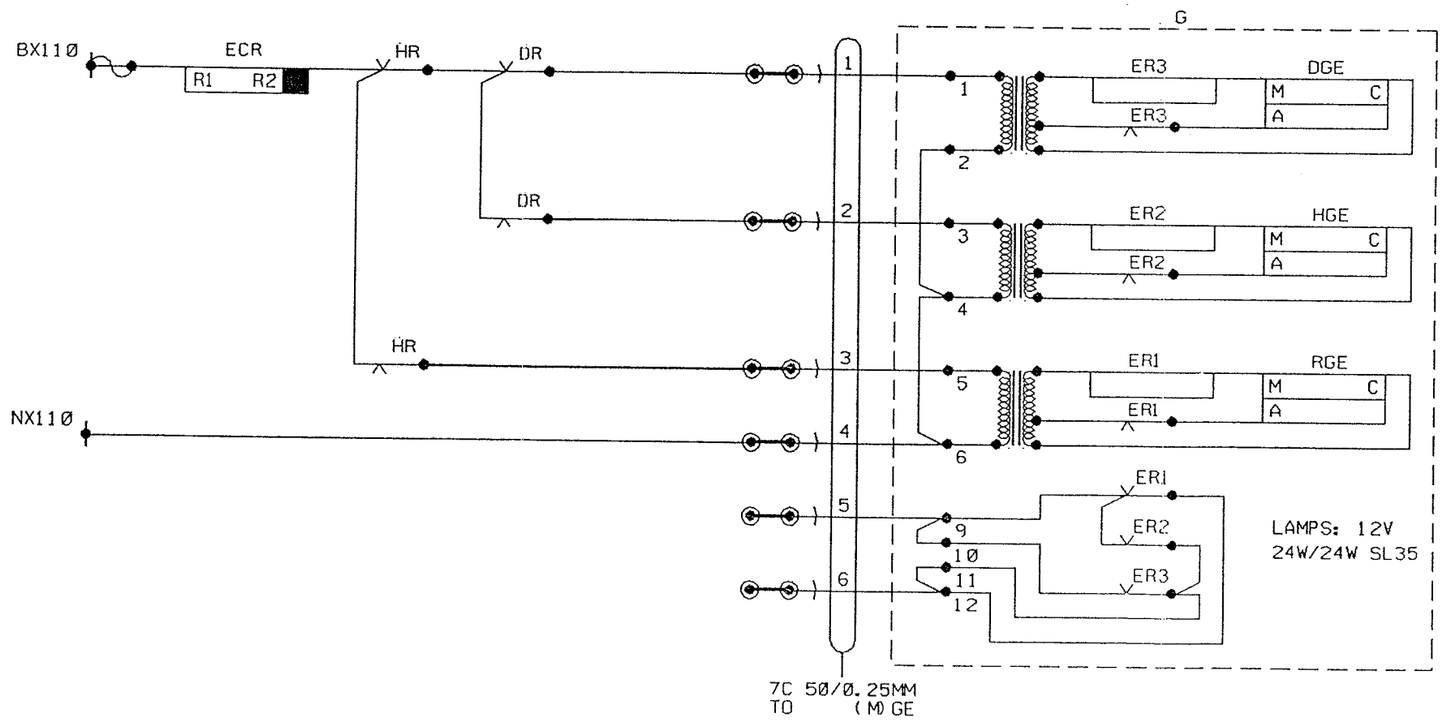
Where a three aspect signal is concerned, an additional control relay is necessary. This is called the "**HR**" relay. In railway coding terms this means it is the "Yellow relay".

In the diagram below if the "**HR**" is de-energised the red aspect will be illuminated irrespective of the condition of the "**DR**". If, however, the "**HR**" is energised, then the signal will display either a yellow or a green aspect depending on whether the "**DR**" is making its back or front contact respectively.

TYPICAL CONTROL CIRCUIT FOR A 3 ASPECT COLOUR-LIGHT SIGNAL



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For a 4 aspect signal, a third control relay is introduced. This is called the "**HHR**" relay. In railway coding terms this means it is the "double yellow relay".

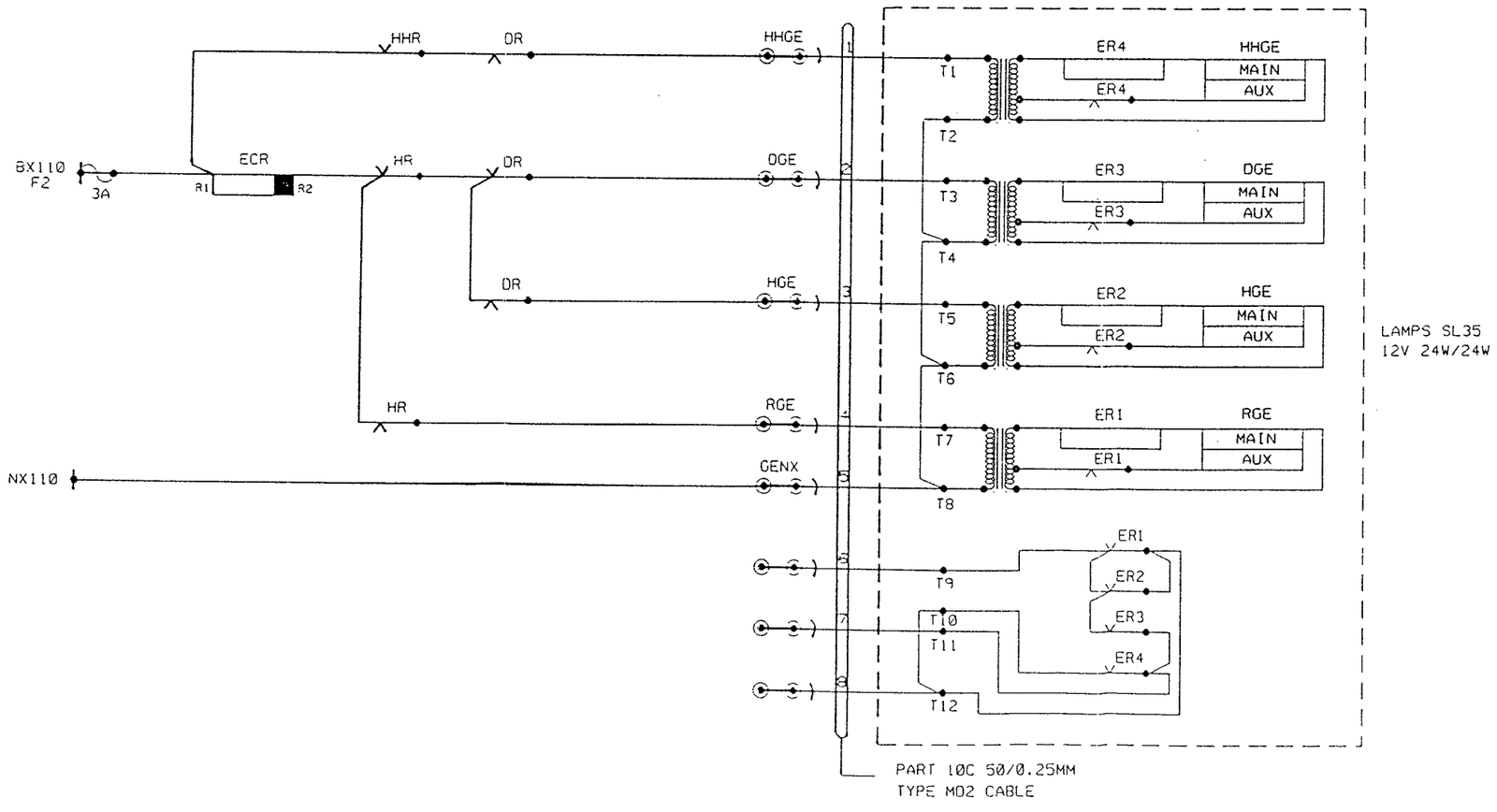
Here again, it will be noted that as long as the "**HR**" is de-energised, the signal will display a red aspect. With the "**HR**" energised, however, a single yellow indication will be given if the "**HHR**" and "**DR**" are both de-energised.

A double yellow indication will be given if the "**HHR**" is energised and "**DR**" de-energised.

When all three relays are energised the green aspect of the signal will be illuminated. At a first glance this statement does not appear to be correct as the path to the green aspect only passes through a front contact of the "**HR**" and "**DR**".

You will see later that a front contact of the "**HHR**" is in the energisation path of the "**DR**" and so this is where we need the "**HHR**" energised to display a green aspect.

TYPICAL CONTROL CIRCUIT FOR A 4 ASPECT COLOUR-LIGHT SIGNAL



continued

With each of the three circuits so far mentioned you will have seen a relay called, an "ECR". In railway coding terms this means it is the "Lamp Proving Relay".

The "ECR" is connected in the circuit so that it will be energised as long as current is flowing in the circuit.

No matter what aspect the signal is displaying if the lamp extinguishes completely, then the "ECR" will de-energise as no current is flowing in the circuit.

The "ECR" has to have a slow to release feature to ensure that, when normal working is in operation, it will remain energised during the period that the aspect changes.

We then use front contacts of this relay to satisfy Signalling Principle No. 5 which states:-

> **"If a lamp fails which should be illuminated (except the second yellow of a double yellow aspect) all main running signals authorising movements up to the failed aspect shall be maintained at RED."**

How this is achieved is explained later in the module.

continued

FILAMENT FAILURE ALARM CIRCUIT

INTRODUCTION

Standard Signalling Principle No. 5 states that:-

> **"For all running signals, indication of the main filament failure of any lamp shall be provided, with the signals grouped and a common indication for each group."**

In order to relieve the maintenance personnel of the duty of keeping a continual visual check of all signal lamps an alarm system is utilised.

The warning of a failure is presented to the signalman or the technician so that he can take action and have the lamp replaced. It is not an economical proposition to indicate each signal separately, let alone each lamp, so that signals are grouped into common alarm circuits.

The last document to mention how this grouping should be arranged was an L.M. Region, Signalling Specification 600, circa 1975 which said:-

> **"A common indication may be used for a group of signals up to a maximum of three successive signals on the same running line or, alternatively, for a group of signals up to a maximum of four applying to different lines - providing all such signals on any one circuit are associated with one signal box."**

continued

REPEATING THE MAIN FILAMENT OF A COLOUR-LIGHT SIGNAL

Consider signal No. 5 shown in Figure 1, the "ER" relays are in series with the main filament in the signal head.

It is evident that one of the "ER's" is energised at any one time assuming that the main filament is intact, when the aspect changes the relay monitoring the "ER" contacts stays up for the changeover time by means of a "slug" that is provided in the relay (Spec 934, slow to drop away).

If the red aspect main filament fails the following sequence of events occur:-

1. ER 1 drops.

2. The auxiliary filament in the red aspect alights.

3. 5 ECPS drops.

4. 5 ECPS dropping rings the buzzer in the filament failed unit in the signal box.

5. Signalman presses KEN to establish which signal has failed.

6. No light will show in signal 5 KE. Signalman then puts signal 5 XN to "B" position to silence the bell.

7. When the lamp is replaced the technician notifies the signalman who presses his reset button on the filament failure unit, which picks up the KENR.

8. Assuming ER1 has now picked, the KENR will supply a feed to 5 ECPS and this relay will stick up over its own front contact.

9. When the ECPS is up the buzzer in the unit will sound again and the signalman will replace signal 5 XN to the "A" position to silence the buzzer.

You can appreciate that it sometimes needs a careful method of elimination to determine which filament has failed when there are a group of 4 signals on one indicator light.

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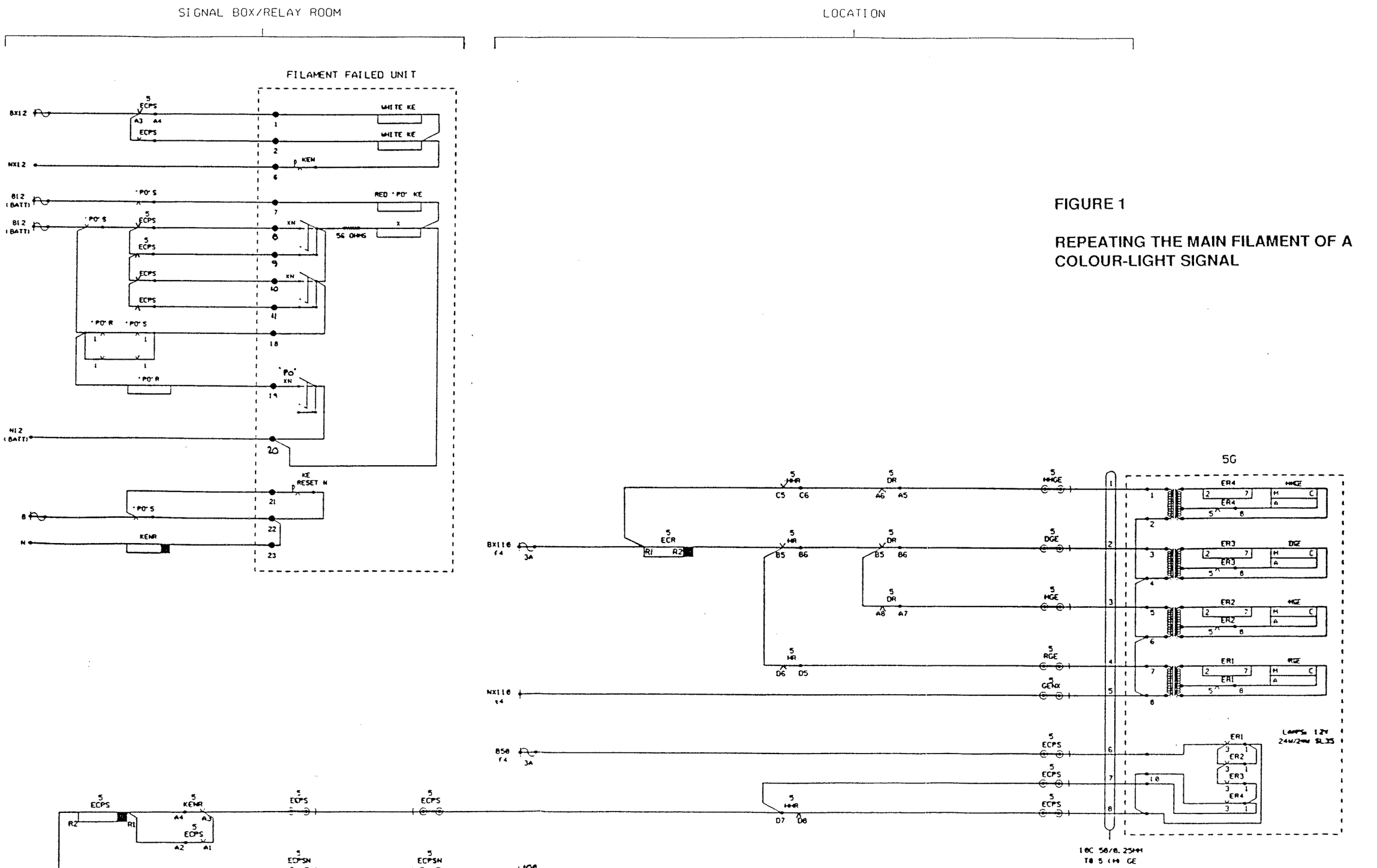


FIGURE 1

REPEATING THE MAIN FILAMENT OF A COLOUR-LIGHT SIGNAL

5G

continued

ASPECT CONTROL

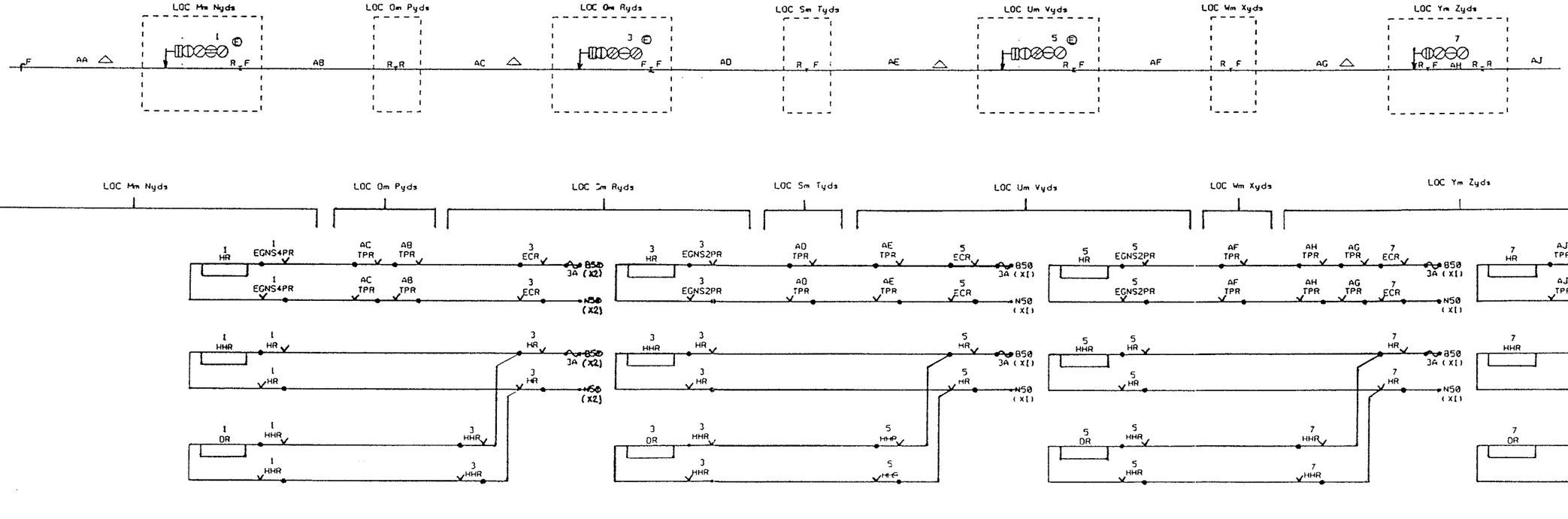
Figure 2 shows a typical layout you should be familiar with, a series of automatic signals preceded by two controlled signals. Having dealt with "Track Circuit Block" in a previous module you should be able to identify what conditions are required for signals 1, 3, 5, 7 and 9 to display a proceed aspect.

You should also be able to produce an "Aspect Sequence Chart". Now you have completed that we can look at the aspect control circuits required.

Having covered the control circuits for a colour-light signal and in particular a 4 aspect signal we have identified what control relays we require. "**HR**", "**HHR**" and "**DR**" relays are required.

Figure 2 shows typical aspect control through circuits.

A point to note is the "**ECR**" front contacts contained in the "**HR**" circuits, this is where we satisfy Signalling Principle No. 5.



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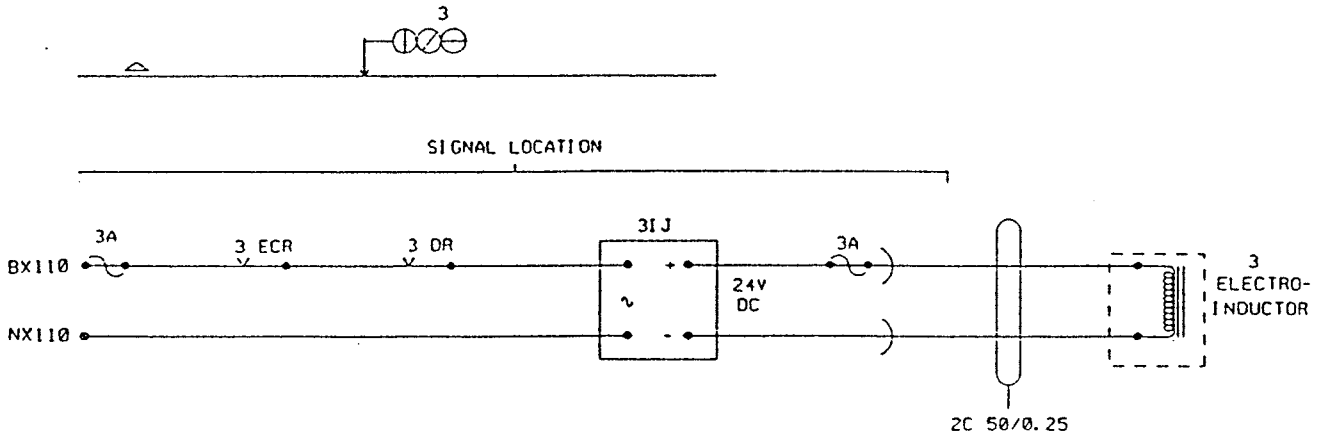
AWS CONTROL CIRCUIT

In the module on the Automatic Warning System we established that the driver only receives a clear indication, ie. a bell in the cab, when the signal is displaying a green aspect.

We also concluded that the bell only rings when the "electromagnet" is energised.

The diagram below shows the standard circuit for non-DC electrified lines which can be seen in the BR Standard Free-Wired Interlocking, BRS-SW67-26.

The electro-magnet is fed from a 110/24 volt transformer/rectifier which is controlled by a circuit through the contents of the "DR" relay and "ECR" of the associated signal.



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