SECTION 9

AUTOMATIC TRAIN CONTROL

Automatic train control is the name given to the various systems which give an audible and, in some cases, a visual indication in the engine cab of the position of a distant signal, followed by a brake application where necessary. There are three systems in operation in this country:—

(*a*) The former Great Western Railway system in use on the Western Region (Fig. 87).

(*b*) The system in use on the Eastern Region (London, Tilbury and Southend section) (Fig. 88).

(*c*) The British Railways system (Fig. 89).

The B.R. system which has been developed during the past five years will be adopted as the standard for use on all British Railways.

The methods of operation of the three systems are described in the following pages, but it may be helpful to outline the main features of each arrangement.

Former Great Western Railway System

In this system a fixed ramp about 44 ft. long is situated in the 4-ft. way. This makes contact with a shoe on the locomotive, and when the distant signal is at Caution the ramp lifts the shoe operating a switch on the engine, causing a siren to sound in the cab and applying the brake after a short delay. The indication can be cancelled by the operation of a handle. When the distant signal is in the Clear position the ramp is electrified. The lifting of the shoe operates the switch as before, but the current picked up from the electrified ramp causes a bell in the cab of the engine to ring for a short period instead of the siren and without any subsequent brake application.

Eastern Region—London, Tilbury and Southend System

This is operated by magnetic induction. When the distant signal is at Caution a permanent magnet in the 4-ft. way operates the apparatus, sounding a horn and applying the brakes after a short delay. Cancelling or acknowledging by means of a handle provided changes the visual indicator from black to yellow. If the distant signal is at Clear, an electro-magnet is energised which cancels the effect of the permanent magnet, allowing the horn to sound for a short time only and with no subsequent brake application.

British Railways System

The British Railways system also works on the principle of magnetic induction. When a distant signal is at Caution, the permanent magnet operates the receiver on the locomotive, sounding the horn and applying the brake after a short delay. Cancelling or acknowledging the indication by means of a handle provided changes the visual indicator from all black to black and yellow. If the distant signal is at Clear an electro-magnet is energised which cancels the effect of the permanent magnet and causes a bell to ring in the engine cab for a short period.

FORMER GREAT WESTERN RAILWAY SYSTEM

General Description

The primary object of this system is to give audible warning on the engine when the train is approaching a distant signal, or passing a lower distant signal fixed below a "Stop" signal, and the distant signal being in the "On" (proceed with caution) position, also, in the event of this warning being disregarded, to apply the brakes automatically, so as to ensure the train being pulled up before it reaches the home signal.

Another and distinctive audible indication is also given on the engine when the distant signal is "Off" (proceed).

The audible signals given are the sounding of a siren, indicating "be prepared to stop at the appropriate 'Stop' signal", and the ringing of a bell, indicating "proceed normally".

The point at which the audible signals are given is usually about 440 yd. (200 yd. in multiple aspect signalling areas) before the distant signal is reached. Where, however, the distant signal is a lower arm on a "Stop" signal, the audible signals are given just as the "Stop" signal is passed.

The apparatus fixed on the permanent way for operating the audible signals on the engine is a ramp about 40 ft. long, which is fixed between the running rails and is made up of a steel ⊥ bar mounted on a baulk of timber. The ramp at its highest point is $3\frac{1}{2}$ in. above rail level.

A telegraph wire connects the ramp with a switch in the Signal Box through a contact attached to the distant signal arm.

This switch is attached to the lever controlling the distant signal, so that when the lever is operated to place the distant signal to the "Off" (proceed) position, an electric battery is connected to the ramp, provided the signal has correctly responded to the movement of the lever.

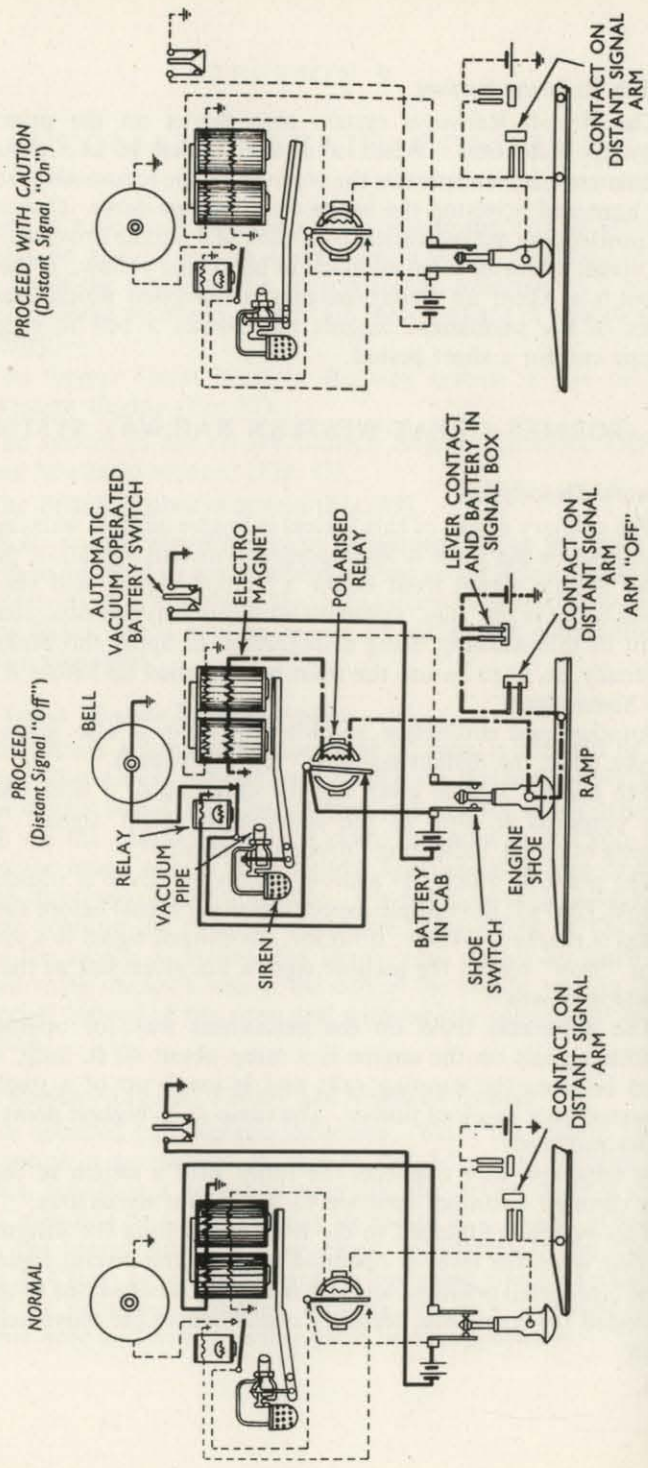

Fig. 87 AUTOMATIC TRAIN CONTROL
Former Great Western Railway System

Fig. 87

When the lever is replaced to restore the signal to the "On" (proceed with caution) position, the battery is disconnected from the ramp.

The ramp is, therefore, electrified when the distant signal is "Off".

When the distant signal is "On", the ramp is electrically "dead", as is also the case in the event of the battery failing, or the arm not responding correctly to the lever, or the telegraph wire breaking.

The apparatus on the engine comprises a contact shoe with switch, an electrically-controlled combined brake valve and siren, and an electric bell, in the engine cab.

The contact shoe is fixed in the centre line of the engine and projects to within 2½ in. above rail level, in which position it is held by gravity assisted by a powerful spring. It is capable of being raised vertically, and being in line with the ramp it is lifted 1 in. whenever a ramp is passed over. This lift of 1 in. is utilised for effectively opening a switch attached to the contact shoe. The switch is connected with the electrically-controlled brake valve and siren in such a way that whenever it is opened it results, except as hereafter described, in air being admitted through the siren and the brake valve to the train pipe, sounding the siren and applying the automatic brake on the train. This happens when an engine passes over an unelectrified ramp. The Driver, by acknowledging the warning given by the siren, can stop the siren sounding and stop the application of the brakes. This he does by raising a handle provided for the purpose.

When the ramp is electrified by the distant signal being placed in the "Off" (proceed) position, the brake valve is not released by the engine passing over the ramp, but the bell on the engine rings instead. The contact shoe is lifted as before, but the current is picked up from the electrified ramp, the effect of which is to cut out, or render inoperative, the switch attached to the contact shoe; so that although the switch is opened it does not release the valve admitting air through the siren to the train pipe.

When an engine is at a stand and remains thus for more than half an hour, the automatic battery switch operates and cuts the battery off from the cab apparatus, thus economising battery power. This battery switch is operated by the vacuum maintained in the engine reservoir or train pipe. When the vacuum is restored by the Engineman the automatic switch pulls up and closes the battery circuit and energises the cab apparatus.

In the event of a failure to pick up the electric current when a ramp is passed over, the effect on the engine apparatus is the same as though the ramp was not electrified, that is, the valve admitting air through the siren to the train pipe is opened, and the automatic

brake is applied on the train, thus ensuring that any failure of the electrical apparatus shall produce the warning indications irrespective of the position of the signals.

EASTERN REGION, LONDON, TILBURY AND SOUTHEND SYSTEM

Track Equipment

Two magnets are fixed in the centre between the rails, 10-15 yd. apart and approximately 200 yd. on the approach side of a distant signal (or outer signal only when more than one is provided). The first contains a horizontal permanent magnet with its north pole at the trailing end and the second contains an electro-magnet. The electro-magnet is "dead" when the distant signal(s) is at Caution and "alive" with its south pole at the trailing end when the signal(s) has been pulled to Clear. The tops of the magnets are 1 in. above rail level.

In addition to these, permanent magnets are provided in the outlet roads from sheds to test the equipment before going into service.

Engine Equipment

The equipment consists of a magnetic receiver, horn valve, vacuum horn, brake valve, re-setting magneto and indicator.

The receiver is operated magnetically from the track magnets, its internal permanent magnet changing its position and operating an air valve as it passes over the north pole of the permanent magnet or the south pole of the electro-magnet. The re-setting magneto is provided to change it from the position taken up after passing a permanent magnet if the electro-magnet is "dead", as at a Caution signal.

The admission of air through the valve in the receiver operates the horn valve which connects the horn to the vacuum reservoir and causes it to sound and admits air through a restriction to the timing reservoir and lower side of the brake valve.

The upper side of the brake valve is connected to the train pipe so that the valve is normally balanced and kept closed by a spring. The admission of air to the under side upsets this balance and, after 3 seconds, the valve opens to admit air to the train pipe, lowering its vacuum, and the valve assumes a new position of balance such that the fall in vacuum in the train pipe corresponds to the fall in vacuum in the timing reservoir. The fall of vacuum in this reservoir is calculated to reach 5 in. in about 15 seconds.

This action occurs whenever the distant signal is at Caution and

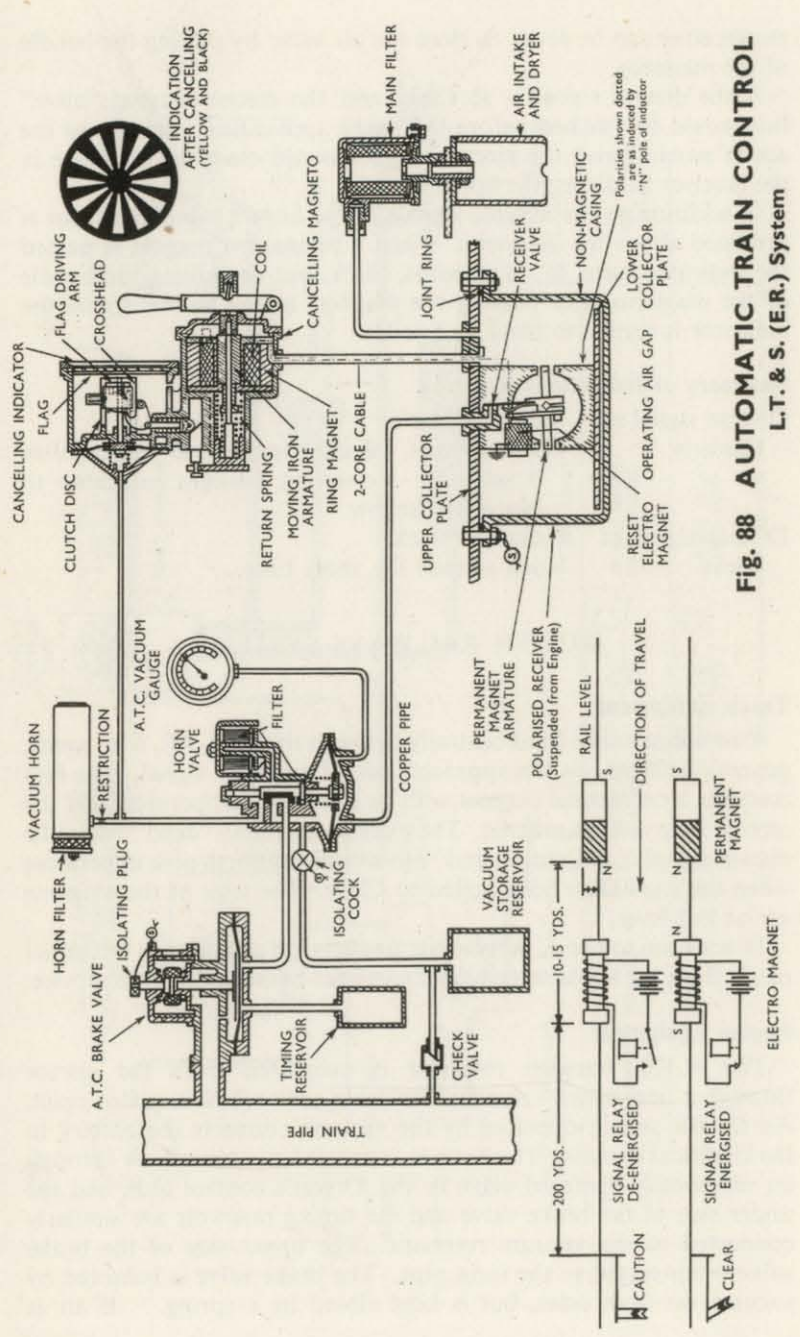

Fig. 88 AUTOMATIC TRAIN CONTROL
L.T. & S. (E.R.) System

the receiver can be re-set to close the air valve by pulling the handle of the magneto.

If the distant signal is at Clear and the electro-magnet "alive" this would be reached before the brake application started and the act of passing over the electro-magnet would close the air valve in the receiver to silence the horn.

In addition to the audible signals of the horn a visual indicator is provided above the magneto. When a permanent magnet is passed the indicator turns to, or remains, black, but on pulling the handle of the magneto after passing the magnets at a Caution signal the indicator is turned to black and yellow.

Summary of Indications Received

Distant signal at	Indicator black.
Caution	Horn sounds. Brake application starts after 3 seconds. Re-setting changes indicator to black and yellow.
Distant signal at	Indicator black.
Clear	Horn sounds for short time.

BRITISH RAILWAYS SYSTEM

Track Equipment

Two magnets are fixed centrally between the rails, 2 ft. 6 in. apart, generally 200 yd. on the approach side of a distant signal. The first contains a permanent magnet with its south pole uppermost and the second is an electro-magnet. The electro-magnet is "dead" when the distant signal is at Caution and "alive" with its north pole uppermost when the signal has been pulled to Clear. The tops of the magnets are at rail level.

In addition to these, permanent magnets are provided in the outlet roads from the sheds to test the equipment before going into service.

Engine Equipment

The A.T.C. vacuum reservoir is exhausted from the ejector through a non-return valve and isolation cock which is sealed open. An electric switch operated by the vacuum connects the battery to the electrical circuits. The horn is connected to atmosphere through an electrically-operated valve in the Driver's control unit, and the under side of the brake valve and the timing reservoir are similarly connected to the vacuum reservoir. The upper side of the brake valve is connected to the train pipe. The brake valve is balanced by vacuum on both sides, but is kept closed by a spring. If air is

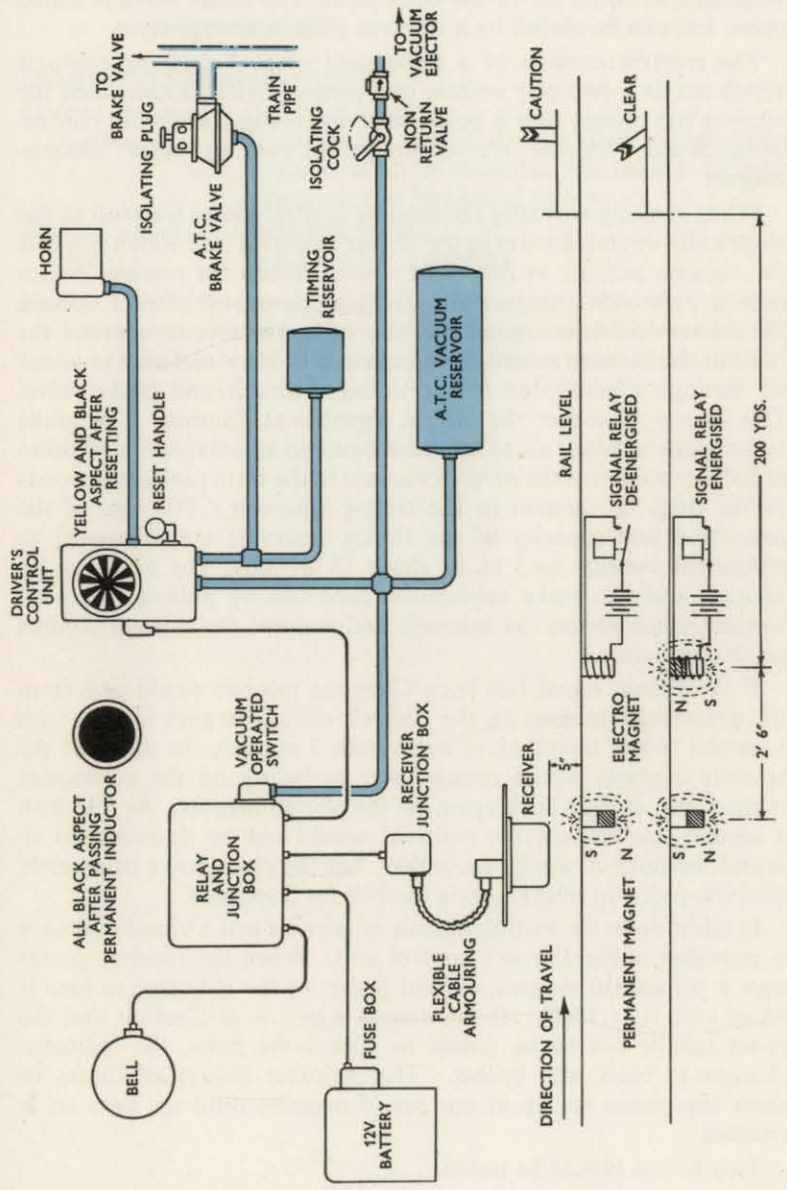

Fig. 89 AUTOMATIC TRAIN CONTROL
British Railways System

admitted to the under side of the valve, the balance is upset and the valve lifts to admit air to the train pipe. The brake valve is sealed open, but can be closed by a screwed plug in emergency.

The receiver consists of a permanent magnet carrying contacts which act as a two-way switch, one contact being closed when the receiver has passed over a permanent magnet and the other contact being closed when the receiver has passed over an "alive" electro-magnet.

When running normally the receiver contact closes a circuit to the electrically-operated valve in the Driver's control unit which controls the vacuum and air as described above. When the receiver passes over a permanent magnet the contact opens and after 1 second the solenoid is de-energised and the valve operates to connect the horn to the vacuum reservoir and cause it to blow and also to admit air through a restriction to the timing reservoir and brake valve. This occurs whenever the distant signal is at Caution. The brake valve opens to admit air to the train pipe and assumes a new position of balance such that the drop in vacuum in the train pipe corresponds to the drop in vacuum in the timing reservoir. The size of the restriction and capacity of the timing reservoir are calculated to reduce the vacuum to 5 in. in about 15 seconds. The horn can be silenced and the brake application cancelled by pulling the re-set handle, which re-sets the solenoid and restores the normal contact on the receiver.

If the distant signal had been Clear the receiver would pass from the permanent magnet to the "alive" electro-magnet in less than 1 second (when travelling at more than 2 m.p.h.). In this case the receiver contacts would change over as before on the permanent magnet and change back again on the electro-magnet. As less than 1 second has elapsed the solenoid would not be de-energised to sound the horn or apply the brakes, but the changeover of receiver contacts picks up relays to ring the bell for 2 seconds.

In addition to the audible signals of horn or bell a visual indicator is provided in the Driver's control unit. When the receiver passes over a permanent magnet, current passes to the indicator to turn it to, or keep it at, black. If the distant signal is at Caution and the re-set handle has to be pulled to silence the horn, the indicator changes to black and yellow. The indicator always continues to show the colour set up at one set of magnets until the next set is reached.

Two points should be noted:

(1) Pulling the re-set handle when not required to silence the horn will apply the brakes.

(2) Pulling the re-set handle will only change the indicator from black to black and yellow after passing the magneto at a Caution signal.

Summary of Indications Received

Distant signal at Caution	Indicator black. Horn sounds after 1 second. Brake application starts after 3 seconds. Re-setting changes indicator to black and yellow.
Distant signal at Clear	Indicator black. Bell rings for 2 seconds.

NOTE.—On both the L.T. & S. Section and British Railways systems the complete magnet and housing which actuate the receiver on the locomotive is referred to as an "inductor".

SECTION 10

THE RULE BOOK

Rules are drawn up for the purpose of ensuring method and order in all movements and operations.

METHOD and ORDER provide SAFETY.

We all know the story of the man who observed two trains approaching one another on the same line, his comment being that it seemed to him a funny way to run a railway!

Railways are the safest means of transport.

The Rule Book has been compiled on the basis of long experience and of common sense. Most of the rules have come into existence on the "case" method, that is, as the result of mishaps and of near-mishaps.

If you find the Rule Book hard to digest you must apply the case method to your study. Visualise a station with which you are familiar, for instance, and imagine a derailed wagon blocking one line. What should be done to ensure protection of the line and how do the rules apply?

It is an axiom that it takes two people's mistakes to create a dangerous situation. Rules aim at preventing misunderstandings. Each man concerned has a definite duty laid down for him to perform.

Any subject may be considered dull when studied in textbooks. Interest is aroused when your reading can be applied to real life and to real situations. Firstly, then, be prepared to visualise.

Secondly, it is helpful to have a proper arrangement in one's mind of the various groups of rules. Sub-divided in this way the Rule Book will appear less formidable and the rules applying to one's particular calling, such as that of Enginemen, can be given special attention.

We can proceed to divide the groups of rules as follows:—

Rules 1 to 16 cover matters of discipline and procedure. Discipline implies a standard of behaviour which is essential to good order in any organisation.

Rules 17 to 33 cover the working of stations.

Rules 34 to 49 describe the various patterns of fixed or permanent signals. Their working and application are, of course, an important part of an Engineman's knowledge.

Rules 50 to 54 lay down the authorised hand signals. Hand signals must be properly given and properly interpreted to avoid misunderstandings.

Rules 55 and 56 are very important safety rules, to ensure that a train standing on a running line is not forgotten.

Rules 57 to 60 cover the use of detonators, which are a form of audible warning signal used where other methods of attracting a Driver's attention are not practicable or need supplementing. A supply of detonators must be on every engine, with two red flags (see Rule 127).

Rules 61 to 76, covering the working of points and signals, must be understood by Enginemen, as they have a joint responsibility in their correct operation. Note Nos. 69 and 70 (*b*), (*c*).

Rules 77 to 80 refer to precautions imposed when signals are under repair, etc., and Rules 81 to 83 cover similar precautions when points and signals are defective. Certain paragraphs are directly applicable to Enginemen.

Rules 84 to 95 ensure the running of trains in safety under the adverse weather conditions of fog and falling snow (see also the special instructions issued in a separate booklet to the staff).

Rules 96 to 98 apply to the movements at stations.

Rules 99 to 107 apply to the working of level crossings.

Rules 108 to 118 cover shunting, where a thorough knowledge of hand signals is essential. Enginemen must observe certain precautions when not accompanied by a Shunter.

Rules 119 to 125 cover the use of lamps. Enginemen are responsible for headlamps and disc-boards and for tail-lamps when light engine.

Rules 126 to 176 cover the normal working of trains. Nos. 126, 127 and 128 are especially directed to Enginemen. Being train-operating rules, the whole of this group concerns Enginemen in their everyday duties.

Rule 177. Reporting of Accidents. This rule introduces the section of the rule book dealing with abnormal occurrences and requires careful study.

Rules 178 to 188. When the abnormal occurs, it is vital to preserve order in the face of emergency. Hence:—

Rules 178 to 181 set out the system of protection.

Rule 182 deals with "Trains divided."

Rules 183 to 185 deal with the systematic removal of an obstruction.

Rules 187 to 188 cover defects on a train.

Rules 189 to 208 deal with the setting up of single-line working. Great care is necessary in this operation and Enginemen should note particularly Nos. 192, 196, 197, 202, 203, 204 and 206.

Rules 209 to 239 cover the precautions to be taken when work is done on the line by the Civil Engineering staff. Enginemen must be familiar with Rule 216, Ballast Train Working, and Rules 217 and 218 in regard to speed restrictions.

Rule 240 should be studied, having in mind the fact that Enginemen, as well as others, are concerned with the conveyance of dangerous traffic.

Certain of the rules are amplified by instructions in the General Appendix, which should be carefully studied.

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