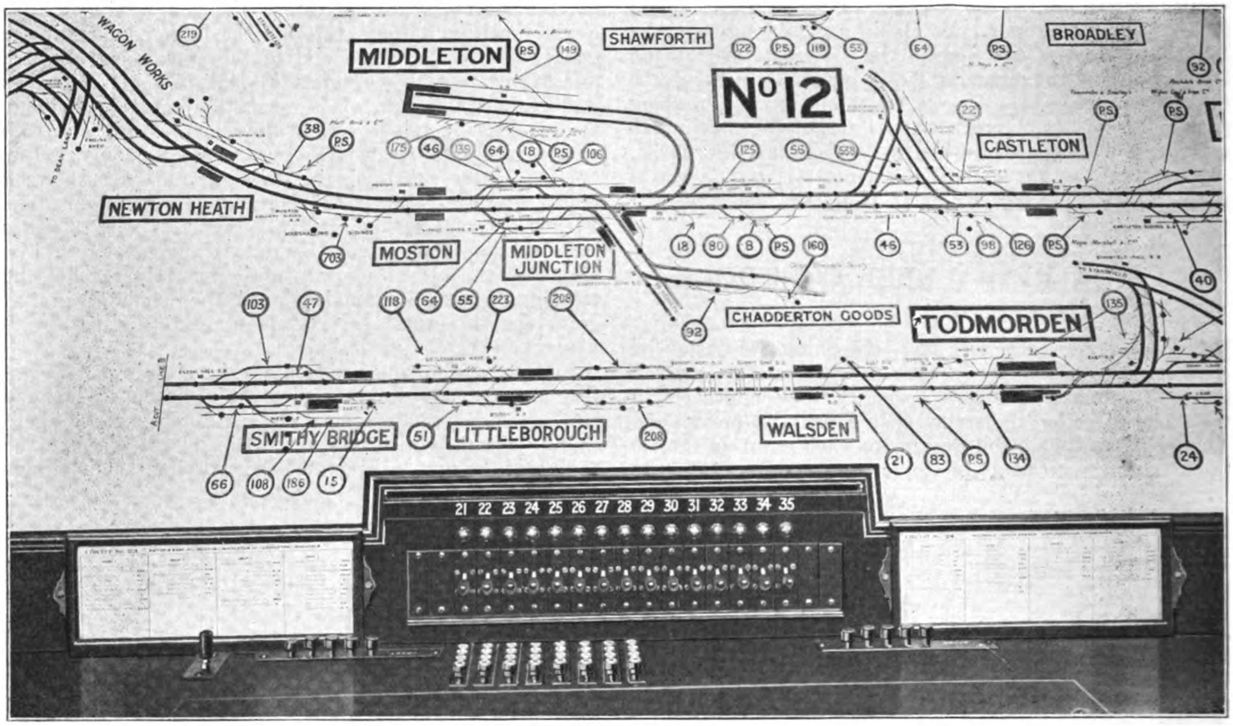



*Section Controller's Desk, Showing Racks, Telephone Apparatus, Time Peg Boards and the Miniature Diagram for Section*

# A Complete Train Despatching System*

*All Train Movements on the Lancashire and Yorkshire Railway Controlled From One Central Office*

IT may be justifiably stated that the most complete and comprehensive train control system in England is that in use on the Lancashire and Yorkshire Railway Company. Although the inauguration of this scheme took place as far back as August, 1915, the subject appears to have escaped general notice, presumably owing to its birth having taken place during the war. This unique installation was designed in all its details by officers of the Lancashire and Yorkshire Railway.

### Territory Covered by the Lancashire and Yorkshire Railway

The line extends from the west coast through the manufacturing centers of Lancashire and Yorkshire to Goole and Normanton on the east, and serving the manufacturing towns of Manchester, Wigan, Bolton, Blackburn, Accrington, Burnley, Oldham, Rochdale, Halifax, Bradford, Leeds and Huddersfield. Owing to the fact that the railway passes through such an important industrial area, the traffic density is exceptionally high. Because of the large number of junctions, yards and siding connections on the Lancashire and Yorkshire Railway, the average number of signalmen employed per route mile is 4.13, as compared with 1.80 and 1.46 on the London and North Western and Great Western Railways, respectively.

A railway system combining such factors as these entails the most minute and exacting supervision, while, at the same time, what might be termed its compactness appears to lend itself to the centralized system of a control office situated at their headquarters at the Victoria station, Manchester.

### Functions and Arrangements of the Control Office

The entire running and loading of goods, mineral and coal trains, the running of freight engines and brake vans, and the working of switching engines, helper engines and light engines are supervised from the central control office at Manchester.

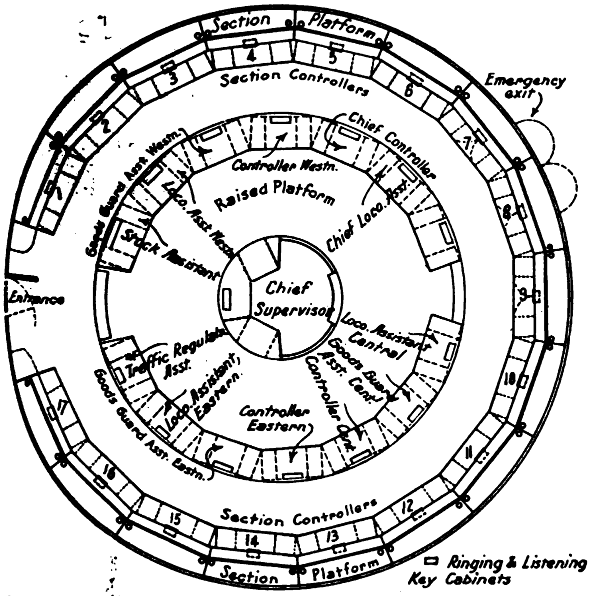
In the design of the control office, which is illustrated in the accompanying drawings and photographs, careful consideration was given to the comfort of the staff, the form of diagrammatic representation and the methods of recording train and engine movements. The office is a circular room surmounted by a large dome, which affords the greatest possible amount of daylight. The main diagram, covering the whole of the railway, including running lines, junctions and also sidings, loop lines and refuge sidings, together with the car capacity of each, is contained on a board suspended to the wall and stretching around the room. This serves as the general indication diagram, and one can see it any hour of the day or night, and the exact position of the traffic working over the entire system. For the purposes of immediate control and supervision, the line is divided into 17 sections, for each of which one controller is responsible. These sections are indicated on numbered diagram boards, placed below and a distance from the main diagram and suspended to the desks of the section controllers. Each

*From Modern Transport, London.

desk is so arranged that there is no need for the operator to leave his seat for the purpose of carrying out any movement to indicate the position of the trains. The desks are fitted with telephones, which enable the controllers to communicate with all points in their respective areas. When the attention of the controller is required on any of the circuits a light appears in the cabinet over the key of that circuit. A noticeable feature of the apparatus is the entire absence of bells.

### Combination of Sectional Work

There are three supervising areas covered by the control office—Western, Central and Eastern—each of which embodies a certain number of sections, and the cabinets, which are provided in common with the telephonic communication covering the sections in each area, are so arranged as to enable all the section circuits within the area to be operated by one or more controllers. It is thus possible, during slack periods of traffic working, such as on Sundays and holidays, for one controller to cover sec-




**Plan of the Central Control Office, Showing the Location of the Supervisor and Controllers**

tions additional to his own. On reference to the plan it will be seen that the center of the control office is covered by a raised platform on which there are a number of desks occupied by the district controllers and the assistants who deal with the relief of freight trainmen, the manning of engines and the regulation of traffic and rolling-stock. In the center of all is the desk of the chief supervisor, with an independent telephone cabinet. The supervisor's desk is in the foreground, while the district controllers and assistants sit facing the large diagram, their desks being also connected with the control circuits by means of which communication can be maintained with stations, yards and sidings, and also with the section controllers. An ingenious telephone arrangement has been provided between the desks of the section controllers, who answer the inward calls, and those of the freight trainmen, locomotive, stock and traffic regulator assistants. For example, if a light on No. 21 circuit indicates a call, this is attended to by the section controller; if he finds that the calling station requires to communicate either with the freight trainmen, locomotive, stock or traffic regulator assistants, he obtains their attention on that particular circuit by pressing a button on his desk, labelled "B," "L," "S," or "W," respectively, which is fixed on to the ring and listening key on No. 21 circuit.

### Work of the Section Controller

The control system provides that all stations, goods yards, marshalling and exchange sidings shall report to the control office details of the arrival and departure times of trains, together with particulars of loading. Signalmen are also required to advise the control office of any delay which takes place in connection with the running of such trains, and also the time of arrival at, and departure from, any interlocking tower station or siding where a train performs work.

On receipt of such information, the section controller, by means of tokens and time-pegs, indicates the positions of the trains within the area shown on his miniature board. The placing of a token and time-peg on the miniature board at any point effects the lighting of a corresponding point on the main diagram, and, in order that the various positions can be easily identified, the following colors are utilized on the tokens:

Red—Train on down line.
White—Train on up line.
Purple—Train on the up loop.
Amber—Train on down loop.
Green—Train in sidings.

### Recording of Train Movements

Having inserted on his diagram the necessary tokens and time-pegs, the controller enters train movements and all other essential details on a series of cards, which are ranged in a rack on his desk. The train running card is used for the recording of train movements. Of these cards there are four series corresponding to the various types of merchandise trains, namely, "R," signifying fast or "right away," and classes "A," "B," and "M,", indicating semi-fast, slow and pick-up goods trains. In this manner the movement of every train on the system is recorded from start to finish of its run, the actual times of departure being shown, together with the number of cars attached and detached, and the load on leaving every station. This close scrutiny of the running and loading of the trains enables the controller to cancel engine power when necessary, and to combine the working of trains to secure maximum loads. It also enables him to give instructions for the prompt despatch of any particular trains, when necessary, and for the holding over of traffic in the yards for a more suitable working.

### Loading of Freight Trains

The section controller also records, on printed cards, particulars as to the loading of all freight trains passing certain defined points on the system. From this statement it is possible to ascertain what percentage of the power provided is not actually employed, that is to say, a run over two sections may justify a light train rather than dropping cars out of the train. By a review of these figures the economic allocation of power can be arranged.

### The Relief of Train Crews

The central control enables steps to be taken promptly for affording relief for enginemen and trainmen, as necessary, to suit the requirements of the daily traffic, and for this purpose a special freight trainmen assistant has dealings over each area, and is enabled to keep the necessary records by the use of specially designed cards. These assistants are kept informed of the manning of all trains, details being entered on the cards which are sorted and placed in racks. When the time arrives at which relief will have to be arranged, attention is called to the matter and the necessary arrangements made.

Should the traffic position in any of the yards necessitate an extra engine, the section controller passes a note to the locomotive assistant, asking him to arrange for an engine at a stipulated time. In this manner yard masters and station masters are relieved of responsibility over engine working, and all arrangements can be made from the central authority, which works out to the advantage of all concerned.

### Concentration and Distribution of Rolling-Stock

The concentration and distribution of empty rolling-stock is ordered from the control office. All stations telephone the control office at 5 p. m. daily, and at other times as required, the number and types of the spare empty cars on hand and the number and types of the empty cars required.

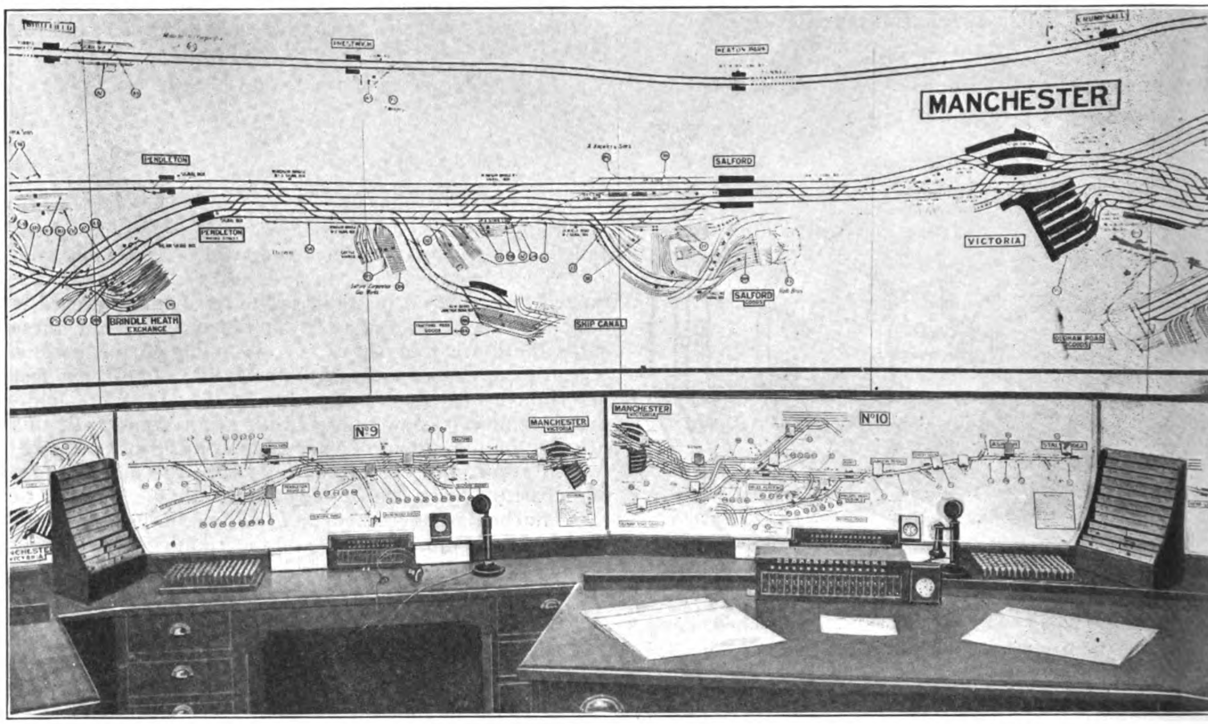
Daily records are compiled showing, for every station on the line, the numbers of each type of car reported spare and the name of the station to which such cars are ordered to be despatched. Similarly, particulars are entered up relating to empty goods cars required at each station, and the manner in which the requirements are to be met. Through the medium of these sets of forms, it is possible for the whole of the rolling-stock requirements of the system to be gaged daily, and arrangements made for the best possible allocation.

### The Advantages of the Control System

Summaries of the working of all the principal yards and of the daily records of the control office in the matter of engine miles and time in traffic, and helper and switch engine miles and time in traffic, are compiled for the 24 hours ending at midnight, and are available for scrutiny by the superintendent of the line and his assistants the following morning.

Experience has shown that the following advantages have been gained by the institution of the train control system on the Lancashire and Yorkshire Railway: In the first instance, the controller, from the information he receives, knows exactly the position of the trains throughout the area, the traffic which requires to be dealt with and the traffic which each train is hauling, so that under varying circumstances he can at once give instructions to break up certain trains at a given point if they cannot possibly be dealt with further ahead, or in the event of two trains lightly loaded approaching a given point from different directions but for the same destination, he can couple up the trains and save the mileage of one of them.

By constant supervision of the running of the trains within the area the controller can reduce the time of the train en route by arranging suitable paths. Knowing also what traffic requires to be moved at different points, he can utilize within the area engines and train crews which have not completed their day's work, and thus avoid bringing out other engines and crews, as invariably happens, when stations have to arrange their individual requirements. Evidence of accumulations of traffic is revealed as such accumulations arise, and the controller is at once enabled to arrange for the traffic to be promptly dealt with and to dispose of the trains to the best advantage, having regard to existing requirements.




**View of Sections No. 9 and 10, Showing the Miniature Diagrams Below, with a Portion of the Main Diagram Above**

It is possible for all relevant facts governing the requirements of the traffic to be considered and assimilated with due regard to the volume of traffic, the times and places at which the cars are available for dispatch to various destinations, the room at the destinations for the reception of various commodities, the relative urgency of consignments, the need for frequent clearances at productive centers where siding accommodation is limited, the limitations of loads on account of grades, and so forth. A close watch can be kept upon traffic offered, so that, in the event of a decrease, prompt steps may be taken to reduce the power which is booked to come out, or, in the event of an increase, additional power can be requisitioned so as to give prompt and effective clearance, and thereby avoid congestion in terminal yards.

The control system in operation on the Lancashire and Yorkshire Railway is particularly suited to cope with the high density of, and variations in, the traffic passing over the line, and for keeping a check on terminal work—a very important feature in the traffic operation of this company. Moreover, the control office is an invaluable instrument for the collection of data, not only for the close supervision of actual working, but also as a basis for the preparation of a practical and well-conceived programme of statistics.

# Principles of Alternating Current Signaling

## *Article III—Mechanical Illustrations of Inductance in a Circuit Causing the Lag of the Current*

By J. S. HOLLIDAY,

**Formerly with the Union Switch & Signal Company**

THE idea of inductive reactance is somewhat hard to grasp and since it is of such great importance in the theory of alternating currents we will devote some additional space to it. When we say that a current lags behind the e.m.f. producing it we mean that when the e.m.f reverses in direction the current does not reverse immediately, but continues to flow in the same direction for a short time. Likewise when the e.m.f. reaches a maximum the current has not yet become maximum and does not do so until after the e.m.f has begun to decrease.

In order to illustrate this with a pipe circuit we require a circuit in which the water will not immediately reverse its direction of flow when the driving pump reverses its direction. Such a circuit is shown in Fig. 17 (drawn partly in perspective). The piston pump of our previous illustrations has been replaced by a pump of the rotary type. The reciprocating motion of the crosshead is converted into rotary motion by the thread on the shaft *S*, which fits the threaded hole in the crosshead. By this device the rotation of the crank *OP* about *O* will drive the blades first in one direction and then in the other and produce an alternating motion of the water in the pipes.

In order to get the lagging effect we make use of the device shown at *W*, which consists of a set of blades similar to the pump blades at *B*, but provided with a heavy rim like a flywheel.

Now imagine what takes place when the crank *OP* begins to rotate. As the threaded crosshead *C* slides along the shaft *S* it causes the blades *B* to rotate and this causes the water in the pipe to move in one direction. As the water flows through the blades of *W* it will set them in motion. The motion of *W* will be slow at first because of the inertia of the heavy rim and this will impede the flow of water until *W* comes up to speed.

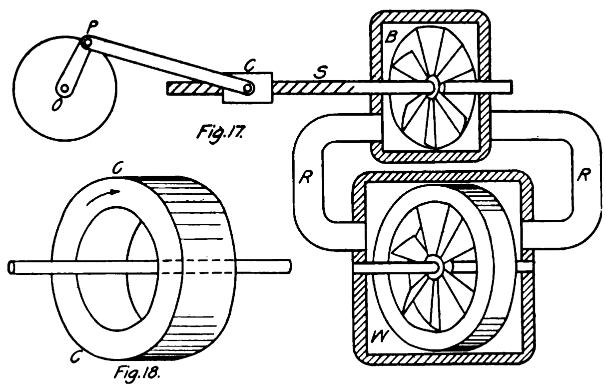
Next consider what happens when *C* comes to the end of its stroke and starts back, reversing the motion of the blades *B*. By this time the blades *W* and their heavy rim are going at a considerable speed and will tend to pump the water along in the direction in which it is already going. We thus have two pumps *B* and *W* acting on the water in opposite directions. The motion of *B* will be slow at first, while the crank *OP* is near dead center, but *W* will be near its maximum speed. Consequently the action of *W* will prevail at first and the water will not reverse its direction for a little while after *B* has reversed.

When *C* gets to the other end of its stroke a similar action takes place. By this time *W* has been brought to rest and set in motion in the opposite direction and when *B* again reverses the water will not immediately reverse on account of the action of *W*.

This apparatus gives an illustration of a ***lagging current.*** The water current lags behind the motion of the crosshead. Both motions are of the same frequency, but the moments of maximum velocity and of zero velocity for the water occur later than those of the crosshead.

Now compare this with the electric circuit. In Figs. 14 and 15 (see *Railway Signal Engineer* for April, page 153) we found that in an inductive circuit there is a counter e.m.f. which causes the current to lag behind the applied e.m.f. To connect this up with our illustration take the case of an inductance in which the wire passes through the core only once, as in Fig. 18. In this case a circular core *CC* is shown. The mechanical similarity between this and the device *W* of Fig. 17 is apparent and will help one to appreciate that just as the alternating motion of the rim *W* of Fig. 17 causes the water current to lag behind the applied force, so the alternating magnetic flux in the core *CC* will cause the electric current to lag behind the applied e.m.f.

Figure 18 has a very practical application. Suppose the iron ring *CC* is extended along the wire until it becomes an iron pipe enclosing a considerable portion of the wire of an a.c. circuit. An alternating magnetic flux will be produced in the pipe along its whole length and this flux will all produce counter e.m.f. and may cause a serious




**Mechanical Illustration of Reactance**

drop in voltage in this part of the circuit. If the return wire of the circuit can be brought through the same pipe in the *opposite direction* this bad effect will be neutralized.

If an iron pipe carries only two wires and these wires are parts of different circuits the counter e.m.f. due to the current in one wire will act on the other wire as well and there will be a transformer action between the two circuits.

Now suppose that the wire of Fig. 18 is brought around and passed through the core in the same direction as in Fig. 19 and still carries the same current. Two things will happen. First, there will be approximately twice as