# DIVISION II.

## *BLOCK SIGNALLING.*

## CHAPTER V.

### HISTORICAL SKETCH.

83. ELECTRICITY was first applied to the signalling of railway trains on the opening of the Blackwall Railway in 1840. At this date the traffic of this railway was worked by ropes—one for the up and one for the down line. The line was four miles in length, and comprised, in all, eight stations, including the terminals, viz., Minories, Cannon Street Road, Shadwell, Stepney, Limehouse, West India Docks, Poplar, and Blackwall. The rope required for each line measured something over eight miles, four miles being laid out over free rollers placed between the metals, the rest being coiled around a drum at the terminal station, at the opposite end to that in the direction in which the train was to proceed. These drums were worked by stationary engines at the Termini—Minories and Blackwall.

84. Taking now the working of a down-train, we should have some four carriages standing at Minories,



one at Cannon Street Road, one at Shadwell, one at Stepney, and one at Limehouse. For stations below there was no communication to Blackwall, the distance being so short. In a similar manner the up-trains were only made up at stations below Cannon Street Road. The train, as made up at the terminal station however, contained a carriage for certain of the stations at which carriages were not attached for the terminal station. Thus in the down-train under consideration, one of the four carriages would be for Limehouse, another for West India Docks, and the rest for Poplar or Blackwall.

We have now the carriages, as stated, standing ready

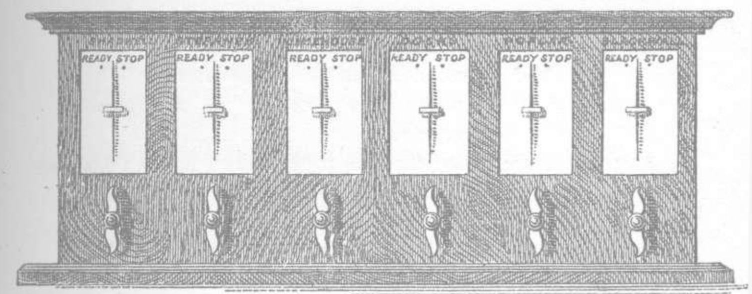


FIG. 13.

for transit to their several destinations. Each carriage is fitted with a means for gripping the rope, and all carriages are provided with conductors and brakes. But before the rope is set in motion it is necessary that the engine-driver, under whose control it is, should know that each carriage *has* its hold of the rope. It was for this purpose that the electrical communication was established.

85. Fig. 13 represents the instrument employed at Minories and Blackwall, Fig. 14, that used at the inter-

mediate stations. Each instrument or indicator was capable of giving, or receiving, two signals—"Ready" and "Stop."

86. The system pursued was this. The carriages were brought up to the stations, the passengers loaded into them, the carriages hooked on to the rope, and the signal "Ready" (made by pointing the needle to the left-hand side) sent. When this signal had been received from each station the engine was set to work and every coach attached to the rope thus put in motion. As each carriage approached its station the guard loosened his hold of the rope and brought it to a stand under the control of the brakes. The up-line was worked in a similar manner.

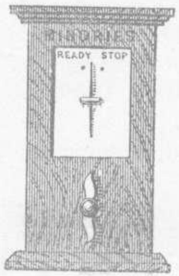


FIG. 14.

At times it happened that the rope broke; it was then necessary to stop the engine. This fracture of the rope was easily observed by its want of tension at any station, and immediately such was the case, a signal to "Stop"—the opposite of that indicating "Ready"—was sent either to Minories or Blackwall, according to the direction in which the broken rope was being wound.

Thus, each instrument was limited to two signals—*Ready* and *Stop*. Speaking instruments were also employed, but the duties of the two were distinct.

These were the early days of telegraphy; the speaking instrument had five needles. To work the line there were no less than thirty wires (several being kept spare for repairs). They were of copper, covered with cotton and served with resin for insulation. Fourteen were laid on one side and sixteen on the other side of the line, in iron pipes, screwed together in the usual manner.



87. In 1842 Mr., now Sir William Fothergill Cook issued a pamphlet called "Telegraphic Railways," which may be said to have established the principles of block signalling. Railways were now making their way, and the necessity of regulating the movements of trains upon some definite principle was becoming apparent. In his pamphlet, which was addressed principally to single-line working, Sir William advocated the division of the line into sections, each of which was to be governed by its own telegraph, and into which no second train should be allowed to enter until the first had been signalled clear of it. The principle here advocated has become the fundamental principle upon which block signalling is based. By it, trains are kept apart by a *certain* and *invariable* interval of *space*, instead of by an *uncertain* and *variable* interval of *time*,—the method originally, and still, to a large extent, pursued.

88. Let *A*, *B*, *C*, *D*, Fig. 15, be a section of line divided into three parts, *AB*, *BC*, *CD*, and provided with signals at *A*, *B*, and *C*. Now it is clear that if trains are kept apart by the space of any one of these intervals no collision between them can arise. A train enters the section *AB*. In order to protect it from a following train, the signal at *A* is required to be kept at *danger* till it arrives within the protection of the next signal, at *B*. It passes into the section *BC*; the section *AB* is now clear, and the signal *A* may be lowered to admit any following train. On the arrival of the train at *B*, the signal there has been set at danger, and it has now to be kept in that position till the train arrives at *C*. But the line signals, which are those governing the engine-driver, can only be worked a limited distance, seldom

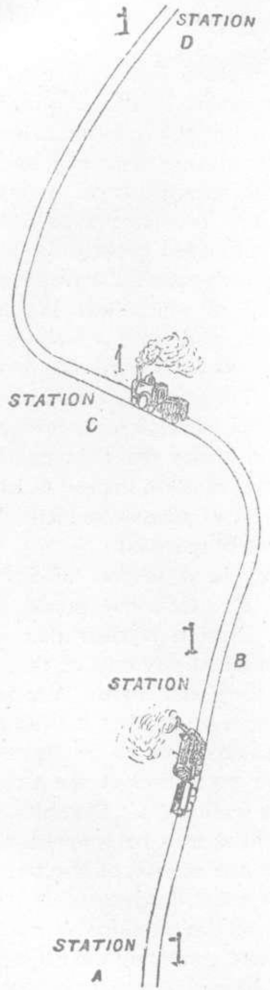


Fig. 15.

sufficient for a block section. It is for the regulation of these out-door (line) signals that electricity is employed. Each signal station is provided with its electrical instrument for up and down trains respectively. The indications of the instrument employed for this purpose must be such as will show whether a train is in the section or not—or in other words, whether the section is *blocked* or *clear*. The out door, or line signals are worked in accordance with these indications, and thus become the exponents of the electrical signals.

89. The principles enunciated by Sir William Fothergill Cook, and thus broadly explained, received their first practical application on the Norwich and Yarmouth section of the Great Eastern Railway, in 1844. Fig. 16. represents the instrument employed. The section of line was divided into five portions. It was a single line, and each station was provided with an instrument similar



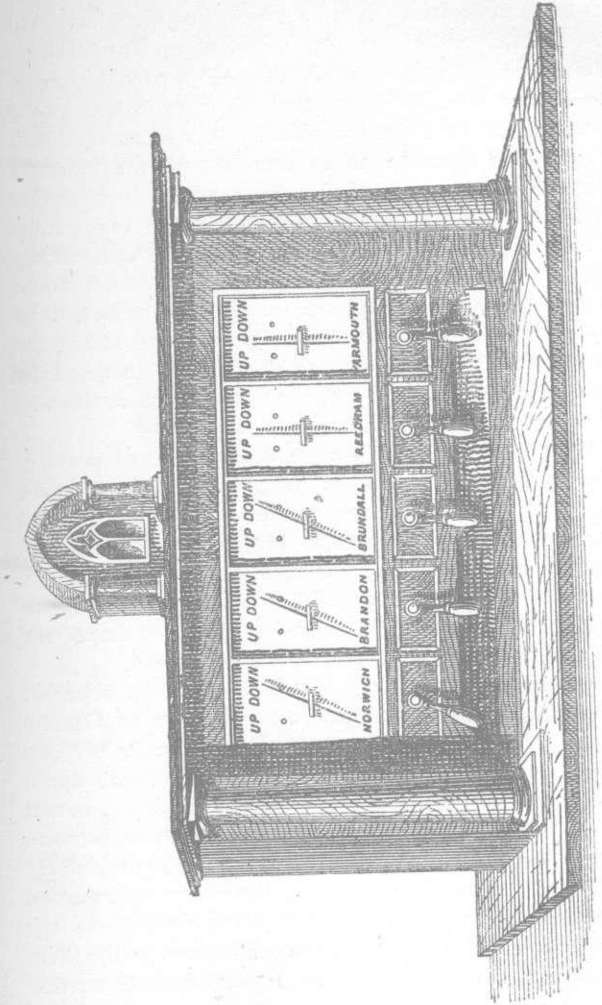


Fig. 16.

to that represented. A train proceeding from Yarmouth to Norwich would be first signalled by Yarmouth to Reedham. The latter would then block over the needle to the up-side, indicating that an up-train was in the section between these two points. Arrived at Reedham, it would be signalled on to Brundall, and the indicator for the Reedham-Brundall section would in a similar manner show its presence between those two points. Clear of the Yarmouth-Reedham section, Reedham would release the indicator for that section, and it would assume the vertical position, showing the section to be free. Thus each station had the power of signalling the progress of the train through the section governed by it, whilst the signal was apparent to all, and in this way every station was cognizant of its progress.

This system, though simple in its mode of working, was cumbersome and costly. Judged by existing systems, it meant multiplying the number of instruments and wires at each signal station by the number of signal stations composing the division; so that a division of five sections, or five signal-stations, would, worked upon this system, cost something like twenty-five times that of any of the single wire system at present employed.

90. In 1853 or 1854, Mr. Edwin Clark's attention having been directed towards the subject by Captain Huish of the London and North Western Railway, an instrument less costly, more complete, and equally applicable to the subject, was produced, and employed on that line. The instrument employed was the well-known "double needle," Fig. 17. A third wire was provided for a bell or alarum. Thus each signal-station was connected by means of three wires, two being devoted to the double-needle block instrument, and one to the bell. The handles by which the needles were worked were so



arranged that when brought fully over to the right, or to the left, they could be pegged over and so maintained in that position. Each line, up or down, had its own indicating dial, which was arranged to represent three signals, viz., the needle inclined towards the left, "Train on

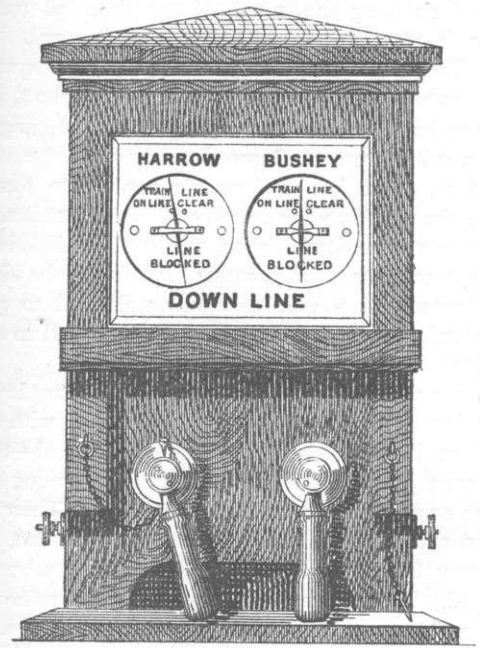


FIG. 17.

line;" towards the right, "Line clear," and vertical, "Line blocked," or "Instrument out of order." The two first-named indications were maintained by constant currents of electricity; the third indication was the normal position on line," and "Line clear." Each indicating needle had two movements, one to the right (line clear), the other to the left (train on line).

95. Immediately below the dial were two keys, or plungers, by which the signals were worked, one being appropriated to the block, or "train on line" signal, the other to the "line clear" signal. When pressed in, the line wire was placed in circuit with the battery, and a current thus passed out through the coils, actuating the red indicator, to the distant station, where, after operating the black needle, it passed into the earth. When in its normal position, the line-wire was in connection with the coils of the black indicator. Thus, supposing station A required to signal "Train on line" to station B, the signalman at A called B by pressing one of the plungers a specified number of times. The signalman at B then pressed in his "train on line" plunger, which caused his red indicator to pass over to "Train on line," and the black indicator at A to coincide with it. On the arrival of the train at B, the "line clear" signal was sent by pressing the plunger for that signal which reversed both the red needle at B and the black needle at A, causing them to indicate "Line clear." The black indicator thus became the *block* signal and the red indicator the *recording* signal.

The handling of the plungers or keys required some care on the part of the operator in order to avoid mistake, but improvements effected in the more recent forms of these instruments reduce this danger.

The bell or gong was constructed on the electro-magnetic principle, similar to that of Walker's, and was a great improvement upon the electro-mechanical bell hitherto in use, as by it, separate and distinct blows were sounded each time a current was transmitted to the distant station.



96. The introduction of Mr. Tyer's instrument served but to herald the advent of that invented by Mr. Bartholomew. Both made their appearance in or about the same year. The outward form of the instrument is shown in Fig. 18. The face of the instrument, like Tyer's, was divided into two portions, one for the up, the other for the down traffic. Each portion had its own indicator. Each indicator was capable of assuming two positions, one to the left, "Clear," the other to the right, "Closed," which signals were rendered by means of the two knobs,

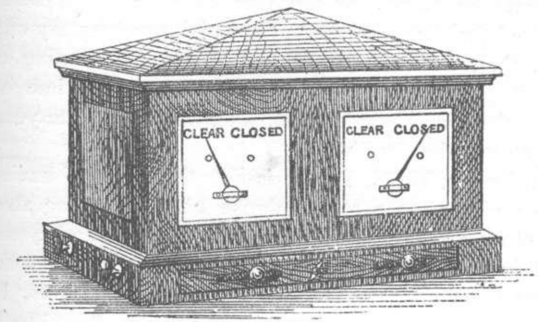


FIG. 18.

seen immediately below the needles. A pressure of either to the right gave the "closed" signal, and a pressure to the left the "clear" signal. The right-hand knob was for the down line, or down traffic, and the left-hand for the up. The outer needles, or pointers, were fixed upon spindles which also carried an inner needle or magnet, free to move between two poles of an electro-magnet. Placed in front of these poles was an armature carrying a small rod with a hammer-head fixed upon it, in such a position that it should, when drawn forward by the attraction of the armature at each passage of the current through the coils, strike a bell-dome placed within its range and within the instrument case. Thus on A signalling to B, the knob was carried over to the left, and the battery current sent through the instrument coils at A into the line. Arrived at B, it passed through the coils of the indicator there, carried the needle over to the "clear" side, and attracting the armature, caused the hammer to strike the bell. The instrument was compact in form but required two wires for each section for up and down trains. The indicators were maintained in the position last placed by the current, by gravity, being weighted for that purpose. Worked by momentary currents, their position was easily reversed by lightning or contact. The instrument was used for some time on the Brighton and South Coast line, but has of late years been superseded by Tyer's.

97. To Mr. W. H. Preece is due the credit of having done perhaps more to popularise block-signalling than any other engineer. In 1862, the London and South Western Railway completed its connection between the Exeter Queen Street and the St. David's stations, by means of a somewhat unusually severe incline. Block-signals were required for working it. To meet this demand Mr. Preece invented his system, the characteristic of which is, independent of its electrical advantages, its assimilation, in form and mode of working, to the outdoor form of signals in use for the guidance of the engine-driver. In the session 1862-3, he read before the Society of Civil Engineers a paper which drew considerable attention to the subject of block-signalling. Regarding it as a fact that one reason why the adoption of block-signals had been, up to that time, so slow and partial, was the difficulty of teaching those to whom they



had to be intrusted, the method of working them, he aimed at placing in the hands of the signalman a form of instrument, so similar to that used by him out-of-doors, as to destroy at once that timidity which something so different in character and management to those in use but too frequently inspired men of this class. Thus, he caused the block signal to assume the form of a semaphore or disc, the arm or disc of which was actuated by the electric current in a manner corresponding to the movement of the outdoor signal. In like manner, the instrument by which this signal was worked, was constructed after the fashion of the lever by which the distant signal itself was wrought—a miniature lever, as the block signal was a miniature semaphore. The electric signals thus became in form and in manipulation a repetition of the line signals, with the working of which every pointsman and every signalman was conversant. No greater proof of the aptitude of the idea thus conceived and carried out need be produced than the fact that it was speedily taken up by Messrs. Tyer and Walker, the former employing the semaphore arm in the place of his needle indicator, and the latter as an adjunct to his bell system.

Independent, however, of the advantage thus gained, another most important step was secured by Mr. Preece. The bell employed by him was constructed, not only to indicate by the number of beats signalled, the nature of the signal sent, but also to record *the condition of the block signal at the distant station.* In all other forms of instruments where this is shown, we see it done by the out-going current. Thus it is in Tyer's, in Walker's, in Spagnoletti's, and in the double or single needle systems. With Preece's this is effected, not only by the distant station, the station to which the block or clear signal has been sent, but it is so effected that the current used for the bell signal depends upon the actual position which the block signal has been caused to assume. Thus when *A* puts up the arm of the electrical semaphore at *B*, the semaphore places in circuit with the bell-key that battery current—copper or zinc—which shall cause a movable indicator on the face of the bell fixed at the station from which the semaphore is wrought to read "Signal ON at B," *so that the signalman not only knows he has, by his own action, sent the block signal to B, but that it has been received at B, and that the semaphore arm there actually stands at danger.*

The principles which characterised this form of instrument at its introduction still attach to those now in use, of which a more detailed description will be given hereafter.

98. At or about the same period which saw the introduction of Preece's system, came also into notice a modification or adaptation of the single needle, as a block instrument, by Mr. Spagnoletti, of the Great Western Railway. It was adopted by the Metropolitan Railway, and is still in use on that and the Great Western lines. Being one of the forms of instruments at present in use, it will be described more fully under that heading.

99. In 1866, Mr. Preece introduced his single wire system. Though considerably improved in 1872, it may also be considered one of the systems of the present day and will be fully described as we proceed. It retains all the outward characteristics of his earlier three wire system, but like all single wire systems its signals are produced by momentary currents of electricity; the evil of which is, that permanent or polarized magnets being employed, foreign currents, either atmospheric, or by the



signal wire coming into contact with other wires, may, unless specially provided against, be conveyed to the block signal instrument, and so produce a reversal of the signal without the knowledge of the station which governs that signal, and at a moment most inopportune for the safety of the traffic. To meet this Mr. Preece so arranges his instrument that the *all clear* signal *can only be produced by the concurrent action of the signalmen at both ends of the section.*

From this date to the present time there has been little change in the main characteristics of block signalling instruments. Improvements have from time to time been effected in every form, the double and single needle, perhaps least of all; still, without doubt, all alike are superior in character and manufacture to the earlier instrument of the same type. Many of the earlier forms are still retained by those companies which first adopted them. The Great Northern, the North Western, and others, having adopted the earlier kind of instrument, and extended it throughout a great portion of those systems, would find some inconvenience in introducing a system totally distinct in its mode of working. But whilst some allowance must be made for established systems, it yet remains a grave question if this inconvenience is of such weight as to preclude the use of other instruments possessing well-known advantages.