CHAPTER XIV.

AUTOMATIC BLOCK SIGNALLING.

166. THE idea of operating fixed signals which should govern railway traffic, by the trains themselves, either directly or indirectly, mechanically, or by the aid of electricity is by no means of recent date. In 1862 letters patent were granted to Mr. John Imray for "improvements in apparatus for telegraphing and signalling by means of electricity." He proposed to mount on the column of the distant signal a vane, disc, arm, or coloured light, which, when turned in one direction, should indicate line clear, and when turned partly round in another position should indicate line blocked. For this purpose he employed clockwork, actuated by a spring or weight which had to be kept constantly wound up and ready to turn the signal or light when released by a detent; the detent being acted on by electro-magnetic apparatus worked either by hand, as from a station or junction, or by a treadle laid in proximity to, and parallel with the railway metals.

The disc revolved in quarter sections, and when in that position in which its whole surface was presented to the approaching train represented *danger*, and when exhibiting its edge only, *all clear*. In combination with

this arrangement bells were fixed at the station or elsewhere which were set ringing by the current employed to put the signal on, and which continued to ring until the signal assumed the danger position, when the movement of the signal interrupted the circuit and so stopped the ringing of the bells. Miniature vanes were also to be provided at the station or place from which the signal was worked, which were, by the action which caused the ringing of the bells to cease, turned to a position corresponding with that of the distant signals which they represented.

The same specification further embraced a means for indicating at a railway station the progress of trains approaching, or departing from it. At various distances along the line instruments were fixed which, when acted upon by the passing train, made or broke contact, and so brought into action an electro-magnet, by which an index fixed at the station was caused to move forward one step for each current sent.

167. A system of automatic signals has recently been brought into use on the New York Central Railway which in principle is very similar to that referred to as emanating from Mr. Imray.

168. The signal employed is of the disc description, and is inclosed in a case encircled by a shield A as shown in Figs. 77, 78; the former of which gives a front, and the latter, a side view of the same. The shield A is coloured white both front and back. D is a circular aperture, protected with glass, through which is seen the disc which forms the signal. The back of the case or box is also protected with glass. Thus, when the internal disc stands parallel with the outer shield, the aperture is filled up, and when it stands crossways its edge only is to be seen and the aperture consequently

appears vacant. The former position gives the *danger* signal, the latter the *all clear* signal.

169. Fig. 79 is a representation of the internal arrangement inclosed in the box B. DD is a broad circle of metal painted red, inclosing a disc of similarly-coloured glass, the whole of which is rotated *in one direction only* by the clockwork below, and which in its turn is propelled by the weight E. Upon the shaft carrying the signal disc, are four arms F^1, F^2, F^3, F^4, having downward projections as shown in the figure. G is an electro-

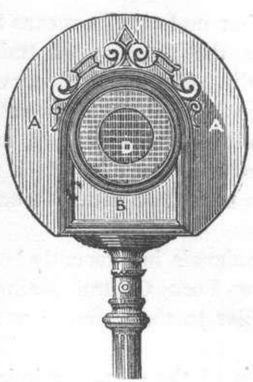


FIG. 77.

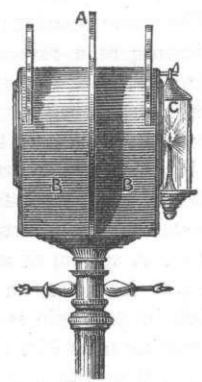


FIG. 78.

magnet fixed to the framework H, the armature of which is provided with a stop-block or catch-piece, so that when the electro-magnet is not in action and the armature is at rest, the stop-block may catch the projections F and prevent the rotation of the disc, which would otherwise take place under the influence of the weight E. Attached to the shaft just below the point at which the arms F are fixed, is a metal cam, having two metal studs, and having metallic circuit with the framework. I is a

circular stage, on which is fixed two insulated metal springs, so that when DD stands at *danger*, one of the springs shall be in contact with one of the studs whilst the other is free; and when the signal is in the *all clear* position the other spring shall be in circuit with the other stud, whilst the spring and stud formerly in contact shall be free. Let one of these springs—the former—be

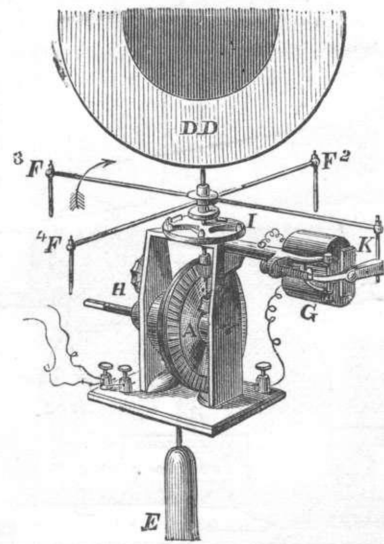


FIG. 79.

termed the "all clear" spring, and the latter the "danger" spring, because, as will be seen hereafter they are connected with wires required to produce those indications.

The post upon which the signal is fixed is usually of metal, and is hollow, so as to admit of the passing up and down of the weight, within it. In order to insure due action on the part of the machinery, it is incumbent on the signalman to wind up the weight, by which it is operated, before he can open the door at the back of the case B to insert his lamp for the night signals.

170. Fig. 80 represents a vertical central section of

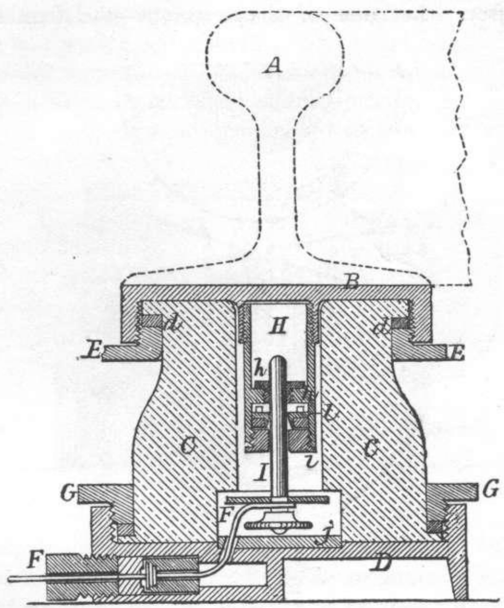


Fig. 80.

the commutator, or circuit closer, in its normal state. Fig. 81 is a similar representation of the same when in action, that is, when pressed down by the weight of a passing train. A is the railroad metal, B a metal plate in contact with it upon which the metal rests. C is a hollow cushion of india-rubber, flanged at its upper and

lower ends, and held in its place by the bed-plate D, and check screws E and G, between which and the flange of the cushion is a washer *d*. H is a metal tube in connection with the plate B, carrying within it a hollow plate *h*, which is in metallic connection with the body of the tube; *i* is a screw ring of india-rubber, and *j* a disc of the same material, upon which rests the rod I, to which is attached the line wire F. Within the hollow plate *h* is fitted an india-rubber washer, and resting upon the rubber ring, *i*, are two semi-circular pieces of metal, held firmly against the pin I by the rubber ring with which they are

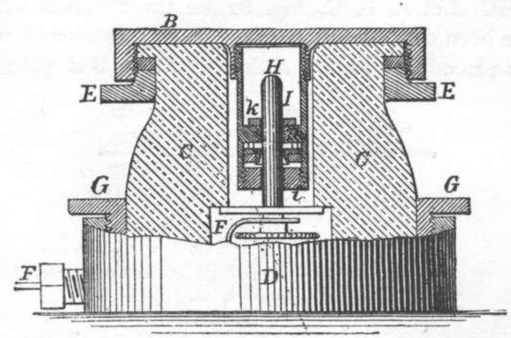


Fig. 81.

packed. To these semicircular pieces are fitted contact studs, the arrangement being such that the pin I shall be free to pass through K, but that the friction of the metal plates *l*, caused by the action of the india-rubber ring, which presses them closely upon I, shall be such as to enable the latter to carry them along with it, or to keep them stationary whilst the plate *h* is pressed down upon them. When this is so the connection between the line wire F and the earth, by way of the metal tube H, the metal top B, and the rail is established.

171. These commutators are fixed at the beginning and end of every section. Two are required, one for the *block* or *danger* signal, the other for the *all clear* signal. The former is placed some two hundred yards in front of the signal, so that the driver may see the signal is operated

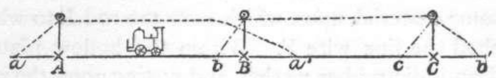


Fig. 82.

as he passes it; the latter, a similar distance beyond the signal. Let A, B, C, Fig. 82, be three signals such as have been described, *a* will be the commutator by which A is placed at danger; *b* that by which B is placed at

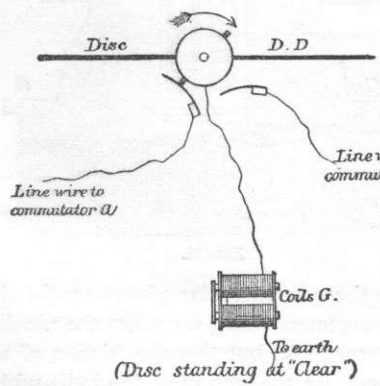


Fig. 83.

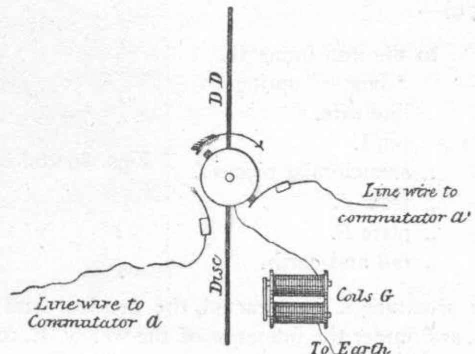
danger; then comes the signal B, and after that another commutator *a'*. It is by *a'* the signal A is set at clear, *c* is that which puts C at danger, and *b'* that by which B is again set to clear. Each commutator is connected with its signal, as shown by the dotted lines.

172. Let us now trace the course of a train through the two sections A B, B C. The wire connections of the commutators are as follows:—from *a* to the "danger" spring, Fig. 83, of the signal A; from *b* and *c*, to the same springs of signals B, C, respectively; and from *a'* and *b'*, to the "clear" springs of signals A and B. We now start our train, and it passes commutator *a*, and by its weight the electrical action between *h* and *i*, Figs. 80 and 81, is completed. A current now flows from the battery along the battery wire, through the coils G (Fig. 79)—

to the iron frame H. " "danger" spring. " line wire. " pin I. " semicircular pieces *l*. " plate *h*. " plate B. " rail and earth.	Figs. 80 and 81.

The armature K is attracted, the pendant arm F[1] released, and under the influence of the weight E, the disc is set in motion in the direction indicated by the arrow, Fig. 83. No sooner, however, does this motion take place, and the arm F' pass the catch-piece of the armature, than the "danger" spring is carried away from the stud on the cam below the junction of the four arms F; and the line wire in connection with the commutator *a* is now no longer in circuit with the coils G. The disc makes its quarter revolution. The signal stands at danger, and in that position is brought to a stand by the arm F[2] coming against the catch-piece of the armature, which on the circuit being broken as just explained, falls back with that object: and now we have the "clear" spring in contact with its stud ready for the receipt of the clear signal as shown by Fig. 84.

Our train now arrives at commutator *b*, which it operates in a similar manner, puting signal B at danger. It then passes over a'; the circuit is again completed, and the armature K is again attracted and now allows F^2 to pass. This done, the "clear" spring is freed from its metal stud, the "clear" circuit is again interrupted, the armature engages with F^3, and the signal stands at clear with its



(*Disc standing at "Danger"*)

Fig. 84.

contact arrangements in circuit with commutator *a* ready for the next danger signal. When the train reaches *c*, the signal C is placed at danger, and when it passes over b', that at B is restored to clear. Thus each train is protected by one, and at times by two, stop signals in its rear.

Of course, for single lines the system is applicable to blocking in front as well as in rear.

173. Moreover, it is capable of duplication, in which

case two signals take the place of one of those described. Let A B (Fig. 85) be a section. Duplicate signals are erected as shown at the commencement of each. The signal *aa* is dependable upon that at a'; and that at *bb* upon that b'. When *a* is at *danger*, *aa* stands at *clear*; when *a* is at *clear*, *aa* is at danger. Thus a train arrives at *a*, where it actuates the commutator and puts a' at danger. a' in taking its quarter revolution, from the clear position to that of danger, brings into play two springs fixed upon the signal shaft, which close the electric circuit with *aa*, and thus cause it to rotate from the *danger* position to that of *clear*. Should the commutator *a*, or the signal a' fail to act, *aa* remains at danger

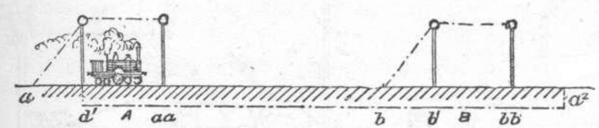


Fig. 85.

and warns the driver that such is the case. *a* is, when *on*, a *positive stop signal*; *aa*, when *on*, merely a *cautionary signal*.

On the arrival of the train at *b*, the signal b^1, if all in order, goes to danger, *bb* being set at clear; and on its passing a^2, a^1 is set to clear and *aa* to danger.

It will be evident that the signals may be actuated by a hand key from a signal-box, from the superintendent's office, or any other point; and that their repetition may be obtained automatically in any direction. The battery power can be kept at the stations and the current conveyed along the line by a wire provided for that purpose.

174. The system is necessarily worked by *momentary currents*. It is the invention of Mr. David Rousseau, of New York.

175. Dr. Whyte, of North View, Elgin, proposes, under a recent specification, to set the outdoor signals at danger mechanically; to set them at clear or caution by means of electricity; and further, by the latter agency, to warn the driver when such signals are at danger.

176. To this end each signal is provided with a special apparatus shown in Figs. 86 and 87, inclosed in a water-tight case to protect it from the weather. Fig. 86 shows

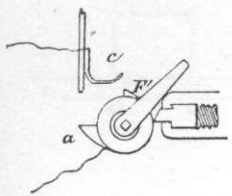


Fig. 86.

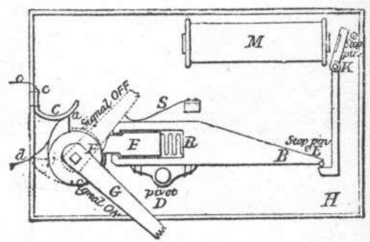


Fig. 87.

the arrangement when the arm is down, Fig. 87 that when it is raised. G is a crank lever in connection with a rod actuated by a lever laid alongside the metals, so that it may be actuated by the flange of the wheels of any passing train. As the semaphore arm is being raised the bolt F is pressed against the spring R by means of the graduated projection F^1. As soon as F^1 has passed the bolt it is again carried forward by the force of the spring R, when F^1 being unable to pass F, the signal is held at danger.

The bolt F is contained within a socket or frame B,

pivoted at D, and provided at one end with a spring S, and at the other with a check-bolt or stop-pin E; the tendency of S being, at such times as its influence is not overcome by the leverage of the arm when at danger, to keep the tail end of B pressing against E. M is an electro-magnet, K its armature, to which is attached a rod and catch-piece. When the arm is raised, B is tilted up at its tail end until F^1 has passed F, when it falls, under the influence of the arm, till it presses against the catch-piece, where it is held till a current is passed through M, when K being attracted, it escapes, and the leverage of the arm overcoming the influence of the spring, the fore end of B is raised sufficiently to allow F^1 to pass, and take up the position shown in Fig. 86. It will thus be seen that, contrary to the usual practice, the normal condition of the signal arm is *all clear*.

a is a graduated projection fixed upon the same arbor as is the signal arm, and moving with it. *c* is a spring so arranged that when the signal is at danger it shall be in contact with *a*.

177. On the engine or other portion of the train is placed a bell and a battery, together with three or more insulated metallic contacts, constructed and arranged that they shall form contact with corresponding metallic contact plates fixed on or above the roadway. Each of the ends of these contact pieces is formed either of a metallic brush or a piece of metal, hinged, so as to admit of a backward or forward movement. These are joined up electrically, as shown in Fig. 88—contact brushes 1 and 2 being connected together, 2 and 4 the same, with a battery in circuit, and 3 and 4 the same, with a bell as well as the battery in circuit. There is also placed on the engine a projection or stud 5, terminated by a small

friction wheel, the object of which is to depress the lever L, which is in connection with G (Fig. 87).

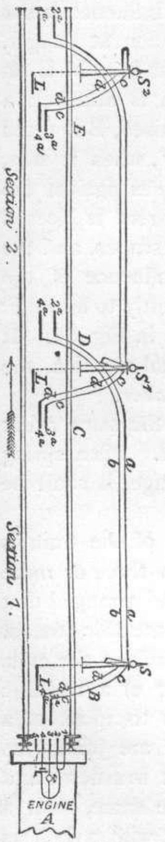


FIG. 88.

Along the line the block sections are marked by signals S, S′, S². To these are connected levers L, which actuate them as previously explained. Some two hundred yards in front of the signal are placed contact pieces or plates, 3^a 4^a, corresponding with the contact brushes 3 and 4 on the engine. To these are connected wires *c*, *d*, which are continued to the semaphore signal S, and there connected to the spring *c* and projection *a*. A short distance past the signals, plates 4^a and 2^a, corresponding as regards position with contact brushes 4 and 2 on the engine, are placed. At signal S′ there is a like arrangement, and so on for each block section.

178. Supposing the engine, as shown in Fig. 88, to advance in the direction indicated by the arrow, we shall have, on its arrival at signal S, contacts 3 and 4 in circuit with wires *c* and *d*, but these being disconnected at the signal post, the arm being at all clear, no current will flow from the battery, and the bell will not therefore be sounded. Arrived at L, 5 presses upon it and sets the signal at danger. The train now passes on till it comes to the plates in connection with signal S′. Here let it be assumed that the signal is at danger, and the wires *c*, *d*, are

therefore in circuit; a current will now flow through the bell to contact brush 3 of engine, to wire *d* to projection *a* (Fig. 87), spring *c*, wire *c*, plate 4^a, and contact brush 4 to negative pole of battery. The bell is thus set ringing, and the engine-driver is, by it, warned that the signal which he is approaching is at danger. His duty is then to pull up before he arrives at S′.

On S′ being lowered the train passes on, actuates the lever L, and again sets the signal at danger. Arrived at contact plates 4^a, 2^a, the contact brushes 4 and 2 on the engine, corresponding therewith, complete the battery circuit. A current passes from the engine to plate 2^a, wire *b*, electro-magnet M (Fig. 87), wire *a*, and plate 4^a to the zinc pole of the battery. On the passing of the current through M, K is attracted, and B being deprived of its support, no longer holds the projection F^1, which accordingly passes F, and the signal falls to the all clear position. The wires *a*, *b*, may be led into station-yards, termini, &c., and the current for the purpose of lowering the signal when desired sent by hand if preferred.

In the figure two wires are shown in connection with each pair of contact plates, but it is obvious that the "earth" may replace one of them, and the cost thus be confined to one wire instead of two. The approach of a train may be signalled to any given point by connecting such point by wires with contact plates, corresponding with brushes 2 and 4 of the engine.

179. The Royal Administration of Traffic on the State Railways of Sweden has recently decided on making experiments with an automatic electro-magnetic apparatus, the invention of Mr. H. Brunius, which has for its object the prevention of collisions, automatic registration

of movement of trains, communication with train when in motion, and automatic registration on the engine of the distance travelled.

To accomplish this two wires are required. These may be the ordinary telegraph wires, extended at the desired points to metal brushes supported by an overhead obstruction in such a manner that it shall make contact with a plate fixed for that purpose on the engine or other vehicle. Each wire and each brush is insulated, the one from the other, and the metal contact plates of the engine are so arranged that they shall make contact only with their respective wire, one wire with its extensions and brush being appropriated to one train, and the other to the following train.

The engine carries a bell and two indicators, one of which is required to record the distance travelled, and the other to indicate whether the train may "proceed" or whether it is to "stop." The former indicator thus has a step-by-step movement, each step being obtained by a current which is passed through the instrument on every occasion on which the train makes contact with the metal brush overhead. The "proceed" or "stop" indicator has but two movements—one to the right and one to the left—and thus gives at the same time the indication required, the one signal or movement being produced by a positive and the other by a negative current. The instruments are connected to "earth" by the engine and railway metals.

At either end of the section there is a duplicate clockwork arrangement insulated the one from the other, each propelling, under an electrical escapement, an indicating hand which traverses the same face-board, and which is provided with four flat circular metal rings. To each of these indicating hands is attached a tail piece which

traverses one of the metal rings. The positive pole of a battery is in circuit with two of these rings, and a negative pole with the other two. The centre of the dial is to earth. The two wires are connected to the hands which by their tail pieces are in contact with the rings, and thus a constant current flows along the line wire from the one station to the other. Each ring is divided into degrees or spaces, and each hand is moved one step forward each time its train makes contact with its extended wire at the overhead metal brush, or in other words, puts the line wire to "earth." So long as the current continues as originally arranged, the indicator on the engine obtains at each contact point the signal "proceed," the bell at the same time being sounded, and the "distance" indicator being moved forward a step, and this is the case so long as the trains remain apart the required distance. But now suppose the second or following train is travelling too quick for the safety of that in front of it, its contacts are more quickly made, and its clockwork hand is consequently advanced, in a corresponding manner, after that which is actuated by, and which indicates, the progress of the first train, until it comes in contact with, and rises upon the tail-piece attached to it. This produces a change in the battery current, so that if formerly the wire in connection with the second train was charged with a positive, it now acquires a negative current, and on the engine of this train making its next contact, a negative, instead of a positive current passes through its bell and two indicators. The "distance" inindicator records another degree, but the remaining indicator is now brought over to "stop" instead of "proceed." The driver, seeing this, slackens speed, and brings his train to a stand *in contact with the next metal brush*, where, if the indicator again falls to "stop," he has to remain until it is reversed, which reversal is of course obtained only on the preceding train having travelled a sufficient distance to move its clockwork hand away from that applying to the second train.

At each terminal station there is also a cylinder propelled by clockwork, and which has imparted to it a lateral as well as a revolving movement. This cylinder carries a sheet of paper or "train journal" divided into sections representing hours and minutes. In its neighbourhood are placed two electro-magnets, the armatures of which are provided with marking pens, so that when the armature of either is attracted a mark may be made upon the train journal. These armatures are attracted on their respective trains making contact with the metal brushes. Thus the form becomes a record of the progress of each train and at the moment is a confirmation, or otherwise, of the movement of the clockwork hands, whilst at other times it is available for reference.

If necessary the "stop" signal can be sent by hand to either train by reversing the battery current. The dial traversed by the clockwork hands is also provided with means by which, when the hands arrive at that point which indicates the neighbourhood of a station, the "stop" signal is sent, *in this instance*, as a warning that the train is approaching a station, and that it must slacken speed.

The three methods thus explained will serve to give an idea of the means by which it is proposed automatic signalling shall be carried on. In no case has sufficient experience of its capabilities been obtained to warrant any expression of its value. The employment of such means for working railway traffic involves deep and serious consideration. The expense attending the establishment and maintenance of the block-signalling system is unquestionably very great. It is not the cost of the apparatus so much as the cost of the weekly wages. These considerations alone are sufficient to obtain, for any means which will enable a saving under this head to be effected, a favourable consideration. Automatic signalling would no doubt powerfully operate in this direction, and the only question to be solved is its reliability. With the present system of signalling there remains, on occasions of failure in any portion of the apparatus, a responsible officer, who, acting under prescribed rules and regulations, is able to take the necessary precautions for the protection of the traffic. With an automatic system devoid of line signals, failure means failure in full: there is no reserve. That failure will arise, whatever the agency employed—whether human, mechanical, or electrical—may reasonably be anticipated. Hence it is desirable that in the adoption of any automatic system there should be some form of reserve against the day of failure. On these grounds it is highly improbable any railway company will be found willing to adopt a system which does not embrace line signals.

Given a line wire with projections which may, by metallic brushes or springs, be brought into circuit with electrical apparatus arranged on an engine or other vehicle, there can be no difficulty in communicating with trains in motion so long as the conditions remain undisturbed; but in this much difficulty will be found, for even the traffic itself must occasion deviations in the course and the level of the metals; whilst it must be borne in mind that any system which may depend upon communication between train and train will admit of no omission in any one part, each train or engine must be complete in all its parts, and all must be in full, complete, and reliable working order. Considered as an adjunct—

as a further protection to the existing system of signalling—such an arrangement would probably be of some service.

180. To the efficiency of the present system of out-door signals is the degree of safety acquired by English railways mainly due. Any automatic system should be based upon the principles which govern that system.

1. **The normal condition of the signal should be danger,** *i.e.* any failure of the apparatus, or interruption of the wires, should result in producing this signal.

2. **The agency by which the signal is placed at "clear" should be, and remain active during the existence of such signal.**

3. **The apparatus employed should be perfectly free from atmospheric influences.**

4. The apparatus should be **simple, strong,** and **not easily deranged.**

5. It should be capable of **hand,** as well as **electrical manipulation.**

6. It should **conform to the existing system of electrical signals,** so as to work in co-operation with them at points where signal-boxes, and signal-men must, owing to local requirements, be retained.

There are no doubt many sections of railway where a system based on these principles would be a boon to the railway service, and whilst introducing a large economy, in no way jeopardise the traffic.