RAILWAY SWITCH AND SIGNAL APPARATUS.

BY ELMER P. HOWE.

GROUP ——

The frequent recurrence of railroad accidents caused by misplaced switches, or by deceptive signals, has made the problem of their construction and management of great importance, and on its exact and certain solution depends the safety of the travelling public, and the avoidance of great pecuniary loss to the railroad companies.

The electric-bell systems and telegraphic communications adopted almost universally in Europe, and to some extent in this country, regulate the departure of trains, and serve to inform the conductor as to the condition of the track he is to traverse. They thus diminish the chances of collision. Their value, however, is between stations, as they do not afford security while entering or passing through places where there are many branches and crossings. To guard these, semaphore arms and suspended balls are used, which, in their various positions, denote the state of the track. On roads where the traffic is limited, they can be watched by one man, and a tolerable degree of security is afforded. As tracks are multiplied, and as at terminal stations the number of trains and shifting locomotives is larger, the general oversight is more difficult, and there is greater probability of mistakes arising from the forgetfulness or incapacity of signal-men. Moreover, with the increase of traffic more employés are necessary; an objection of great weight in this country. The desideratum is, then, to have all the signals and switches under the immediate supervision of one man, with as few assistants as possible, and to have machinery so arranged that there shall be no incongruity between the position of the signal and that of the switch.

In England the following regulation of the Board of Trade is in force, in respect to all new lines and new junctions upon old lines : —

"The signal handles and levers of the switches at junctions shall be brought together under cover upon a properly constructed stage with glass sides, ... enclosing the apparatus. They should be so arranged that, while the signals are at danger, the points shall be free to move; that the signal-man shall be unable to lower his signal for the approach of a train until after he has set the points in the proper direction for it to pass; that it shall not be possible for him to exhibit at the same moment any two signals that can lead to a collision between two trains; and that after having lowered his signals to allow a train to pass, he shall not be able to move his points so as to cause an accident, or admit of a collision between two trains. Every signal-man should be able to see the arms and lamps of his home as well as his distance signals, and the working of his points."

The system devised by Messrs. Saxby and Farmer, of London, and exhibited in the English department at the Exposition, seems to satisfy the requirements of this regulation and is a great improvement upon all systems yet used. It was exhibited at Paris in 1867, and since then has been thoroughly tested and adopted on the best English lines.

In order to understand the application of this apparatus, it may be well to examine a simple case, where, as in Figure 3, Plate I., a branch line starts from a double track main line. The relations of the tracks are easily comprehended from the figure. There are switches at 5 and 6, with their corresponding home signals $\frac{3}{8}$ and $\frac{4}{7}$, and distance signals at 1, 2, and 9. The machinery for operating these (Figures 1, 2, Plate I.) is contained in a glass house, which is raised from the ground, so that the operator can easily command a view of the tracks in every direction.

For the case under consideration there are nine levers used, which are connected with signals or switches as the case may be. Their uses are shown by reference to the fol-

PLATE I.

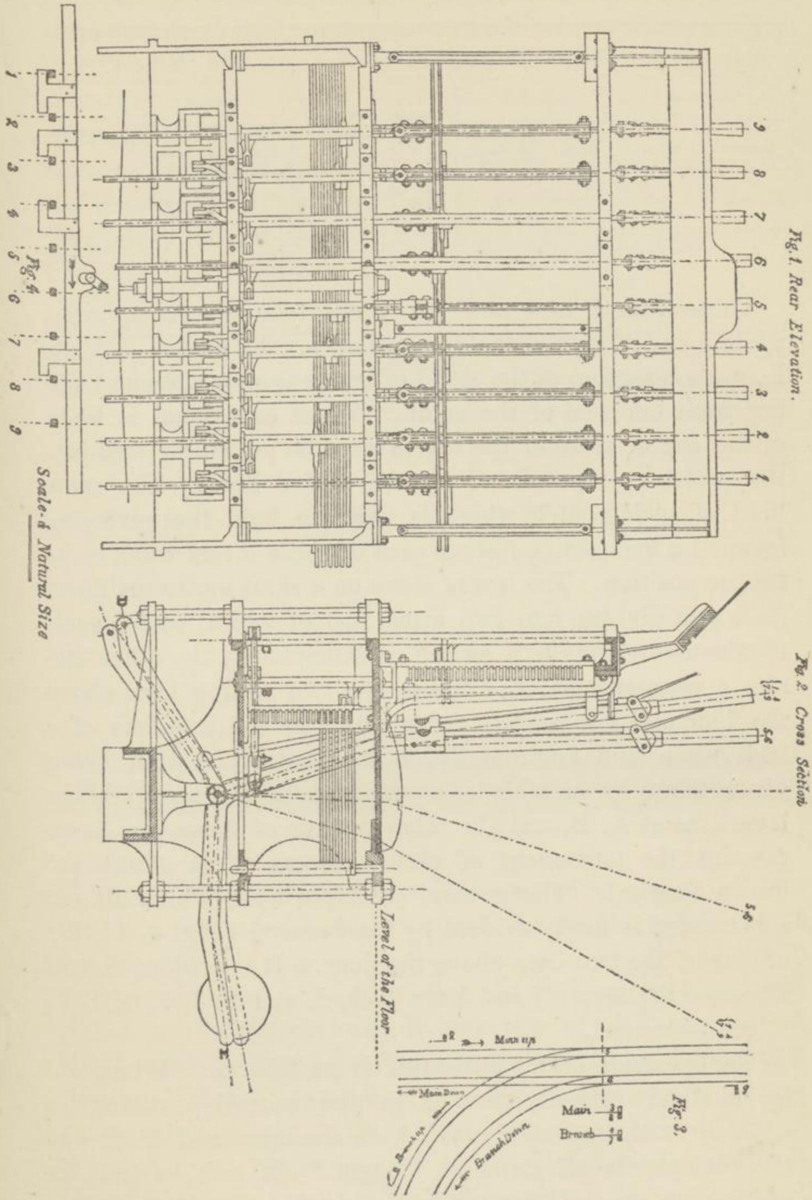


Fig. 1. Rear Elevation.
Fig. 2. Cross Section
Fig. 3.
Fig. 4.
Scale-¼ Natural Size
Level of the Floor
Main up
Main Down
Branch Down
Main
Branch

lowing index-plate. The numbers denote the manipulating levers: —

Up-Track Signals.				Main Up.	Main Down.	Down-Track Signals.		
Distance.		Switch.		Branch Up.	Branch Down.	Switch.		Distance.
Branch.	Main.	Main.	Branch.			Branch.	Main.	
1	2	3	4	5	6	7	8	9

Those from 1 to 4 and 7 to 9 are to move semaphores, while 5 and 6 are for the two switches. In Figure 2, Plate I., a cross-section of the stand of levers is shown to one looking from one end of the cabin. When any signal is to be given, one or more of the levers must be pulled forward into the positions represented by the dotted lines. The same kind of spring-catch which is used to hold the reversing lever of a locomotive fastens each of these levers when in its proper position. The levers move on a shaft under the floor. Each one divides into two arms, one of which, as D, communicates by rods to a switch or semaphore; the other carries a counterpoise, E. There are two sliding bars above the floor and six beneath, which act like the tumblers of a lock when laid horizontally, a longitudinal motion being given them by suitable connections with the manipulating levers, as at A, B, and C. The purpose of these bars is to prevent the movement of certain levers while others are drawn forward. The general principle upon which all are constructed is made evident by the drawing (Fig. 4, Pl. I.) of one of the two bars above the floor. It is evident that in Figure 4 the levers 1 and 4 are locked, and 2, 3, 5, 6, 7, 8, 9, can be moved.

The operation of the apparatus is as follows: When the levers stand vertically, that is, in their normal position, the *main up* track and the *branch down* are open and free; but the semaphores all stand at "danger." If, now, a train is coming up on the main track, the signal-man will pull forward levers 2 and 3, which raise the semaphores (at 2, 3,

Fig. 3, Pl. I.), and inform the engineer that the way is clear. By this movement, the levers 1 and 4, which work the signals for the branch up, are locked, by means of a sliding bar (Fig. 4, Pl. I.), and cannot be moved until lever 5 has been pulled, the main track closed, the distance and home signals at 2 and 3, Fig. 3, placed at "danger," and a junction effected with the branch. Yet levers 6, 7, 8, 9 can be used, because they affect the main and branch down lines, and do not interfere at all with the train in question. The following table gives the combinations which allow the passage of trains over the four tracks :—

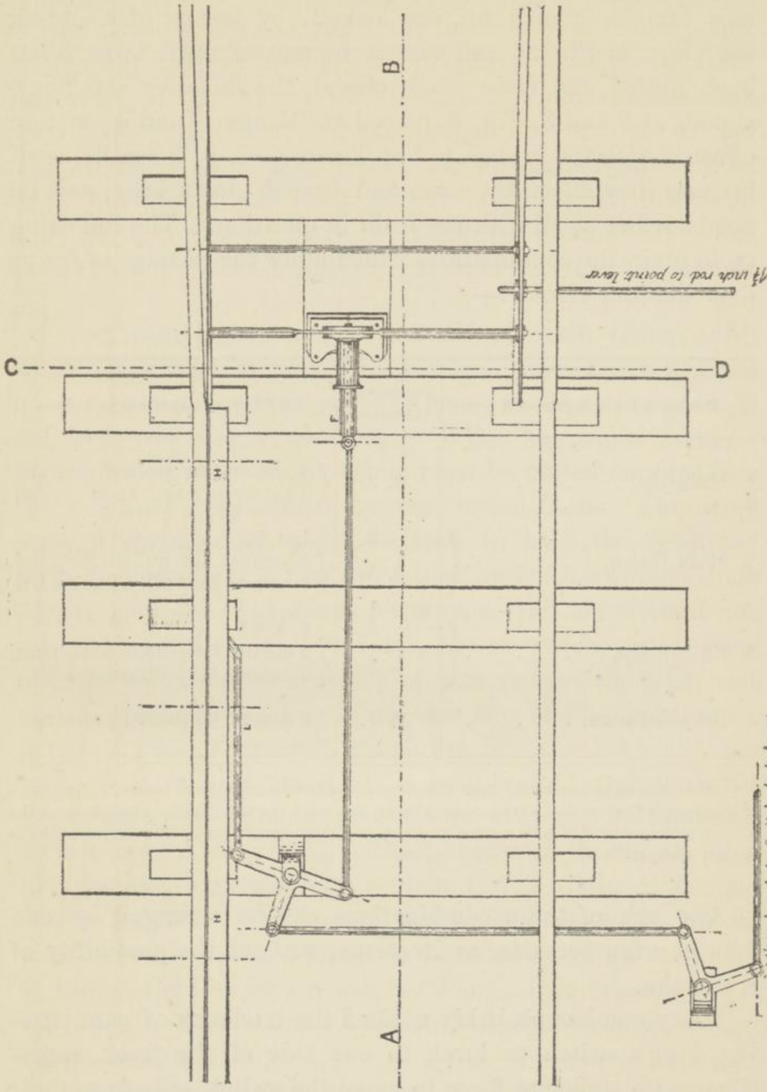
To allow a Train to pass on the—	Pull forward Levers—	The following levers will be locked:
1. Main Up, ...	2, 3.	5 cannot be pulled forward. Therefore 1 and 4 are locked.
2. Main Down, . . .	6.	1, 4, 7.
	9, 8.	5 cannot be pulled forward. 6 cannot be pulled backward.
3. Branch Up, . . .	5.	2, 3, 8.*
	1, 4.	5 cannot be pulled backward. 6 cannot be pulled forward.
4. Branch Down, . . .	9, 7.	6 cannot be pulled forward.

* At the first sight one would think that lever 9 in this case ought to be locked, but a glance at the track will show that a train coming down the main track would be carried off on the branch, since switch 6 is in its normal position, and there would be no interference with the branch up-track.

Any one of these combinations can be arranged by one man in a few seconds, as it seems, without the possibility of a mistake.

Every one has probably noticed the tendency of cars passing over a switch to lurch to one side of the track, sometimes with sufficient force to move the switch rails from their position. Some way of guarding against this contingency is therefore necessary. Many contrivances are in use, which are under the direct control of the signal-man, and which therefore afford only a conditional security. The one adopted by Messrs. Saxby and Farmer cannot be moved during the transit of the train. This "safety locking apparatus" is represented in Plate II. A lever is added to those already in

Plate III.



the signal-cabin, called the "switch-lock lever," from which motion is communicated to a fastening bolt, F, as is shown in the drawing. This bolt slides in a stationary guide, and, when the switch is properly placed, fits into holes in the flattened portion of one of the switch stay-rods. A comparison of the plan, and the section upon the line C D, will serve to make the details plain. There is also a long flat bar, H, of wrought iron, held alongside of the rail, supported by short links, which move around studs fastened to the lower part of the rail. These permit the motion of the bar through an arc indicated by the dotted lines. A rod, L, joins this bar to one of the bell-cranks of the locking apparatus, so that the motions of the fastening bolt must be isochronous with those of the bar. When the links stand vertically, the bar is parallel to the surface of the rail, and about $\frac{1}{4}$ of an inch below it. In the drawing, the fastening bolt is withdrawn. When the "switch-lock lever" is drawn, the fastening bolt will be inserted, and at the same time the bar will rotate into the position denoted by the dotted lines. If, now, a train pass over, the rims of the car-wheels will rest on this bar and hold it down, so that, as long as there is a wheel on the rail above the bar, the bolt cannot be withdrawn, and consequently the switch cannot be shifted.

This contrivance is rapidly coming into use on English roads, where some such arrangements are required by law on new lines. The bar need only be as long as the longest distance between two car-wheels. With their short cars, this does not make an inconvenient length. To extend between the trucks of our long cars, would require a cumbersome bar, and it would be only with great difficulty kept clear from dirt and snow, since there is no ready way of covering it. However, if this appendage be deemed impracticable, the locking apparatus proper could be used, since it adds an element of security, and is simple, practical, and not likely to get out of repair.

At the Cannon-street station, in London, perhaps, there is a greater complication, arising from the number of trains and the narrow space in which the tracks are located, than at any other similar place in the world. The following description is taken from the London *Engineer*. It needs only to be explained that the "points" or "facing points" correspond to our switches.

"The lines from London Bridge and from Charing Cross take circular sweeps which bring them to a junction near the Borough Market. The lines so joined, as well as others parallel to them, run along the handsome bridge which connects the Surrey side with Cannon Street. Along the bridge run four main lines and one engine line; in all, five pairs of rails.

"Between and among these straight lines curved lines meander, touching one pair of rails, cutting across another pair, but, upon the whole, effecting junctions of each with all, and so furnished with points that trains can be run from any one line to any other, as may be required. The five principal lines, as they approach the station, spread out into various branches, so that altogether, nine lines enter the station, one to each of its eight platforms, and the ninth for the accommodation of locomotives. Those branches have also their points, and it results that on the bridge and at the station there are in all thirty-two pairs of points, which serve to guide locomotives and trains to and from the several platforms, and along the various routes which communicate with them. The existence of all these branches necessitates signals, the chief of which number sixteen for up lines and eight for down lines, besides five distant signals and six subsidiary signals; making a total of thirty-five signals. The number of operations which those points and signals have to conduct may be understood from the fact that, at the most crowded time of the day, eighteen trains arrive and eighteen depart within the hour. The locomotive which brings a train in is at its head, and consequently at the inner end of the station. To bring the train out again, the first locomotive is detached from the inner end, and another locomotive is attached to its outer end, and when it has drawn out the train, the supplanted locomotive moves leisurely out from the platform, and waits quietly by to supplant, in its turn, a brother locomotive, on the arrival of a succeeding train. In this way, for every arrival and departure there are required two movements of locomotives; and thus, in the crowded hour, no less than 108 operations of shifting points and signals have to be performed, or, on the average, one in every thirty-three seconds.

"To sum up, we find that thirty-two pairs of points, and thirty-five signals, some of them two hundred yards distant, have to be worked, sometimes to the extent ef 108 operations per hour, and generally to 80 or 90."

To accomplish this, there is a glass house erected at a short distance from the entrance to the station, over the track, containing thirty-two switch and thirty-five signal levers. During the day, two men are required to tend them, and at night only one. In twenty seconds, the switches and signals can be arranged to transfer a train from one outside track to the platform on the other side. This is the most complicated movement that is required, and involves an alteration of about twenty-five switches and signals. Information in regard to the arrival and departure of trains is communicated to the signal-men by telegraph. The despatches are received by two instruments, one at each end of the glass house. One apparatus rings a bell; a boy in attendance consults the index, and immediately calls out the name of the train which is to come over the bridge into the station; the proper movements are made by the signal-man as soon as the train appears, and it enters the station without delay. The other telegraphic instrument is for the general business of the road. All messages received are noted, so that an accurate record of the movements of trains is kept. By means of this Saxby and Farmer system, in this compact arrangement, the immense business at this point is transacted with speed and safety, with astonishing ease and precision. In the old way, with isolated switches and signals, at least thirty men would be needed, and the greatest care and attention would have to be exercised to avoid accidents.

It remains to consider the durability of the mechanism, and what may occur if any part should break. Since the normal position of the semaphores is at "danger," the breaking of a signal-rod would either leave the arm unmoved, or it would return by its own weight to the point indicating "danger." Therefore, no break or derangement of the semaphore mechanism can occasion anything worse than delay. As there are a number of rods and bell-cranks used to convey the motion of the manipulating lever to the switch proper, quite an expenditure of force is required to overcome the friction. Now, if a part give way, the increased ease of operating the lever would make it evident to the signal-man that something was wrong, and he would therefore leave the signals unchanged. Here, again, no evil consequences would result. If any considerable obstruction should prevent the moving of the switch into its proper position, not only would it be evident to the signal-man, but he could not move the lever far enough to unlock the signal-levers, even if he desired to do so. When there is "lost motion" in the connecting tackle, or when dirt and snow stop the switch before it comes into place, the fault, though not revealed by the working of the switch-lever, will be detected when the locking apparatus is used, since that lever cannot be drawn, unless the switch is correctly placed.

In all these contingencies no harm can result, since a train will always be stopped by the "danger" signal before reaching the switch. The apparatus, in short, besides insuring safety when it is in order, is a guard against any derangement in itself.

Since its adoption in England, but one accident has occurred, out of the many which have been attributed to switches, at a point where this system is in use. This is important in view of the fact, that in the (English) Board of Trade report on accidents in the year 1871, Captain Tyler attributes the majority to defective signal and point arrangements, or want of locking apparatus. The Wigan disaster, last summer, on the London and North-western line, is the exceptional instance. An excursion train passing over facing points was divided, and the majority of the cars went off the track entirely, or else on to a side track. The mechanism for moving the points had been inspected shortly before, and was found uninjured after the accident. The points were also found to be placed rightly for the transit of the train. As near as I have been able to ascertain, the locking apparatus described above had not been applied at this point, though in use on other parts of the road. Whether the accident was caused by the faulty action of the switch mechanism, or whether the signal-man attempted to move the switch before the train had all passed over, it is impossible to decide, before the court of investigation shall have published its conclusions. It seems as if a properly constructed locking apparatus would have fastened the switch, and would have effectually prevented any change in its position. The value and necessity of some such system is unquestionable. It is for American engineers to decide to what extent the one described is applicable upon our railroads.

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