No. 16 "office" wires were run directly to the relay connections.

The electro-pneumatic machine consists of a 20-lever frame with 15 working levers and eight spare spaces. Six levers are devoted to signals and nine to switches. Emergency releases were recently added to this machine.

Fig. 1 is a general view of the interlocking showing the type of construction followed; Fig. 2 is a view of the cabin; Fig. 3 shows the interlocking machine surmounted by the track diagram and indicators; Fig. 4 shows the relay case and methods of connecting; and Fig 5 is a view of one of the signal bridges.

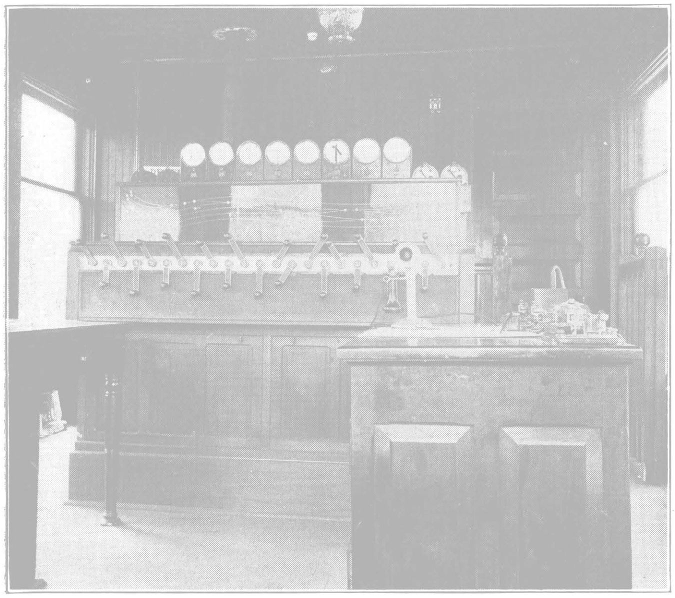


Fig. 5. View of the Interlocking Machine.

The plant at Brinton handles 150 scheduled passenger trains each day, and also a vast amount of freight over the main line, as well as to and from the Port Perry Branch.

CROSSING BELLS IN AUTOMATIC TERRITORY

BY A. B. SCHEVE.

A method of operating a crossing bell in automatic block signal territory is shown in Fig. 1. The circuit requires only one additional relay indicated by "T", and the track circuit governing signal 1 is broken through its front contact. A train in the section causes the bell to ring. Sections are generally 2,000 to 2,500 ft. in length. The circuits are very simple,—current flows through battery A, the rail, wire D, front contact C on relay T, and thence to wire D, the rail, and relay E; and it returns through the rail, wire F, front contact G on relay T, wire N, and the rail, to the negative side of the battery. The track battery S energizes the relay T, and when the section between them is occupied, the armature of relay T is down, breaking the contacts C and G, opening the track circuit, and preventing relay E from picking up. At the same time the back contact J is closed, which causes the bell to ring, and the back contact H is also closed.

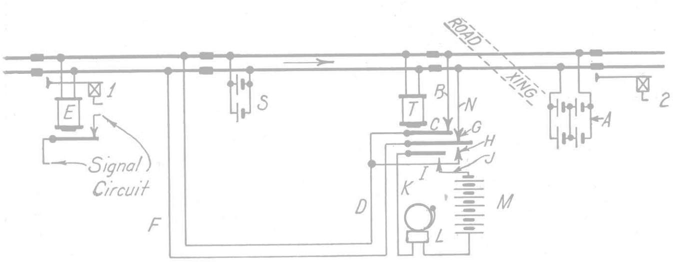


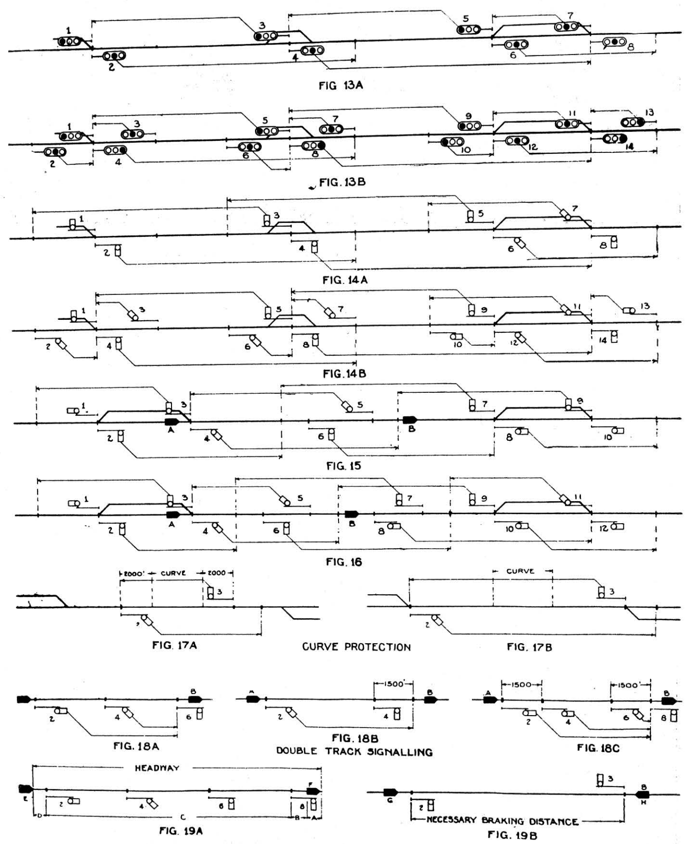
Fig. 1. Crossing Bell Circuit for Automatic Territory.

THE ABSOLUTE-PERMISSIVE BLOCK SYSTEM

BY W. K. HOWE.

At a meeting of electric railway officers at Syracuse, N. Y., on January 19, W. K. Howe, of the General Railway Signal Co., read a paper on "Automatic Signaling for Electric Railways," describing controlled manual and dispatcher's signal systems and d. c. and a. c. track circuits for automatic signaling. The body of the paper, however, was devoted to a description of the Absolute-Permissive Block system as follows:

Signals, for the purpose of this article, may be divided into two general classes, viz., absolute and permissive. Absolute signals "stop and stay" are those which normally permit but one train in a block at a time except by special permission, such as an order from the dispatchers, or another signal displayed with absolute signals. Permissive signals ("stop and proceed") are those which normally permit trains to follow each other into the same block under certain prescribed rules. Absolute signals are used to govern the entrances to a piece of single track which of course could not be used by trains in the opposite directions at the same time. Permissive signals are used for following movements.



Figs. 13a to 19b.

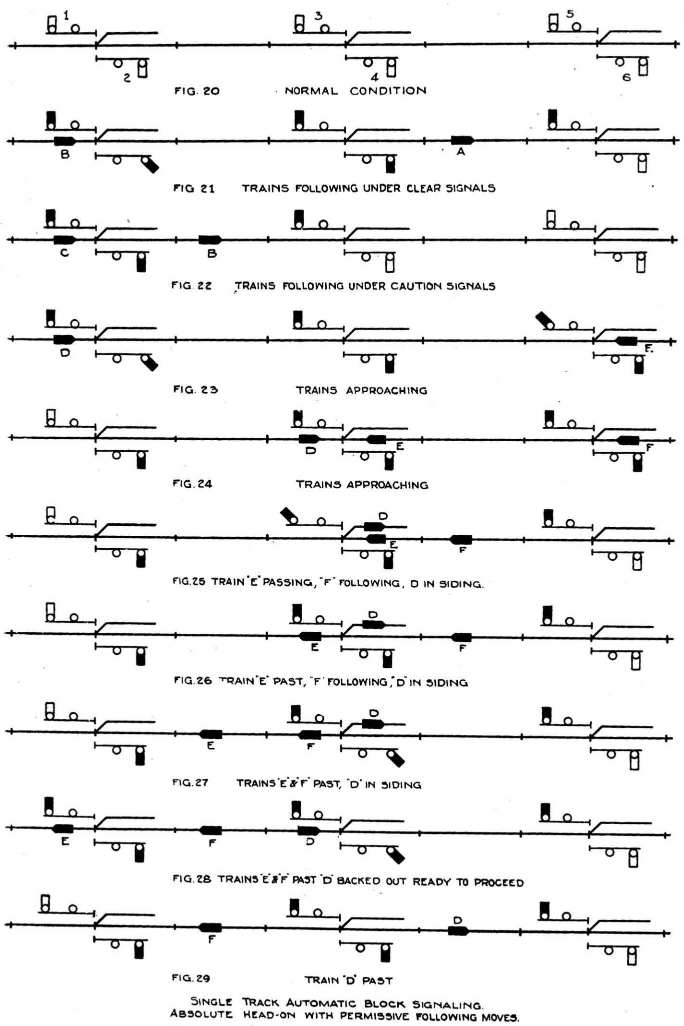
Figs. 30 to 36, inc., show a series of day and night indications in which an arm in the horizontal position or a red light always means "stop," the arm inclined upward at an angle of 45 deg., or a yellow light displayed above a white light always means "proceed at normal speed prepared to stop at the next signal," and a blade in the vertical position or a green light always means "proceed at normal speed prepared to pass the next signal at normal speed." Furthermore, a yellow light displayed below a white light gives authority to proceed into an occupied block, and is named a "call-on signal" as shown in Figs. 36 and 39.

The white light next below the semaphore is used as a marker and to show whether a signal is absolute or permissive. Lights in a vertical line indicate an absolute signal as shown by Fig. 30, and when staggered, as shown by Fig. 31, indicate a permissive signal.

These signals are always so designed that the breaking of a glass cannot give a wrong indication. This of course bars white for clear and requires the use of the distinctive colors red, yellow, and green as explained. This color scheme prevents mistaking a foreign light for a signal.

Furthermore these signals are so arranged that the going out of a light will not give a wrong indication with the exception of the signals shown in Figs. 36 and 39, where the absence of the lower yellow light will leave signals Figs. 35 and 38 respectively. But as these are stop signals no dangerous conditions can result.

Another very important matter in planning this series of indications is to have them as few and simple as possible,



Figs. 20 to 29.

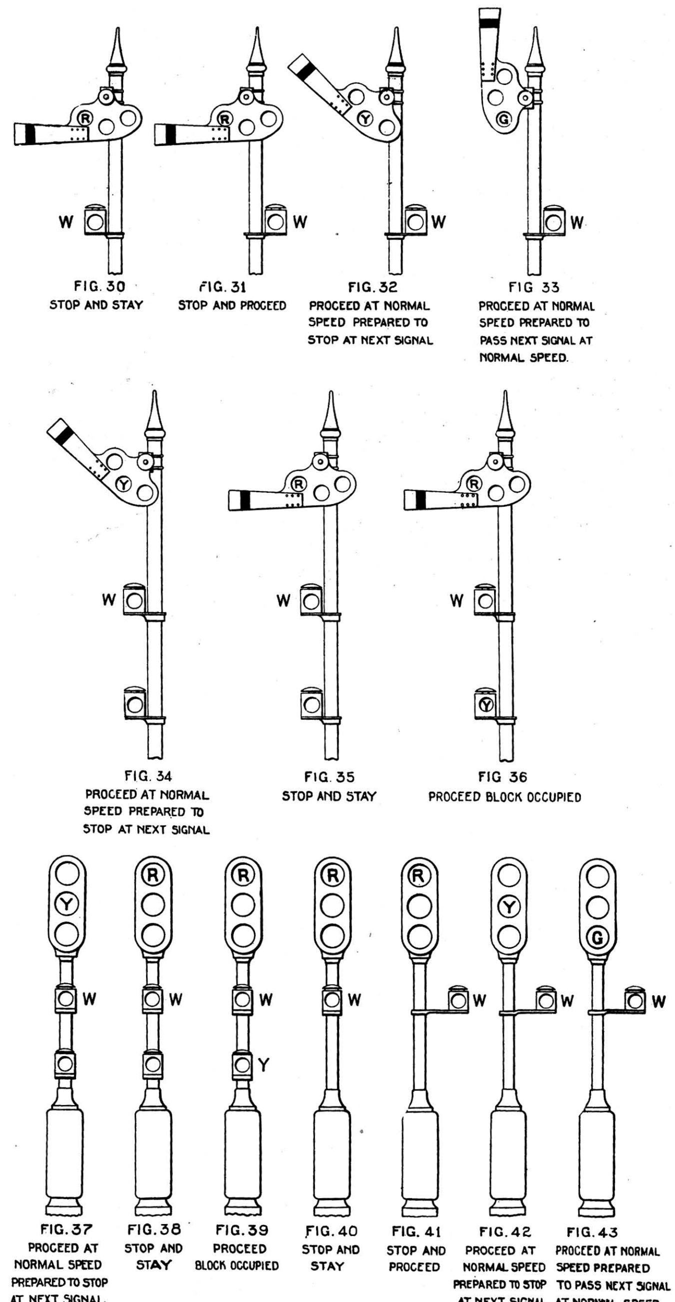
and always have them indicate only one and always the same thing so that the motormen can easily learn and remember what they mean, and so that they can comprehend their meaning in an instant when the signal is seen. This is in comparison with certain steam roads where in making a run an engineer would have to read over 100 different indications.

The system of signal indications shown is the result of a prolonged and careful study made by prominent members of the Railway Signal Association. It is safe, uniform, and consistent, and will meet practically all of the conditions to be encountered in automatic block signaling on electric lines.

As interurban lines grow, and their equipment becomes heavier and their traffic denser, and as they become involved with the steam lines at crossings and junctions, the need of uniform methods of signaling will become more apparent. The history of steam road signaling has been largely "every man for himself" in the matter of signal aspects and indications as well as in the apparatus required for their display, with the result that a great variety of devices have been made to accomplish the same thing, many of which are obsolete, as a look at the stock rooms of any large signal company will eloquently testify.

Were the steam roads to start over again there would be a very different story to tell, and it is hoped that the electric lines will profit by their experiences.

The signals shown in Figs. 37 to 43 inclusive are purely light signals corresponding, as regards their day and night



Figs. 30 to 43.

indications, to the light indications of Figs. 30 to 36. By the use of large and powerful lenses and reflectors and by suitably hooding each light they can be clearly seen several hundred feet in the bright sunlight and of course very much further at night. They are recommended where the speeds are moderate or where the trains can afford to slow up at all sidings. They are very simple and inexpensive as compared with semaphore signals, their only objection being that they cannot be seen so far in day time. Their use for electric railway signaling is more justifiable than in steam road signaling for the same reason that siding signs are, as described elsewhere in this article. Light signals have the advantage as compared with semaphores in that there are no exposed moving parts to be interferred with by sleet, ice, or broken wires.

Each section of single track should be protected by absolute starting signals placed one at each entrance thereto, and so controlled that two trains approaching from opposite directions can never both get clear signals into the same block at once. This is accomplished by "overlapping" one signal by the other, i. e., by having the control of one signal extend beyond that of the other as shown in Fig. 17b, for example. It will be noted that No. 2 will go to stop before a train approaching signal No. 3 reaches it, and that signal No. 3 will go to stop when a train coming from the other direction reaches signal No. 2. If now one train should pass signal No. 2 before an approaching train had reached the overlap for signal No. 2, the latter train would find 3 at stop and vice versa. The distance which the control for signal No. 2 extends beyond signal 3 is known as an "overlap."

Before a proceed signal can be given into a piece of single track the opposing signal should be required to be at stop. This can be guaranteed by electrically interlocking opposing signals, and by so designing the circuits and apparatus that no breaks or crosses between the line wires controlling such signals can by any possibility cause the opposing signals, which should be at stop, either to remain in, or be moved to, the proceed position. This can be accomplished in a very simple manner.

Now with regard to the arrangement of signals at passing points. It must be recognized at the outset that as conditions are at present there is a great difference between steam road and interurban electric railway practice as regards the weight, speed, and make-up of the trains moved, and hence as regards the braking distances which can be depended upon. For example it is one thing to handle a heavy freight train as against a light passenger train in steam road work, whereas on interurban lines where the equipment is uniform it is another and a simpler problem. On account of this and other reasons to be named later, there is little doubt that for equal safety electric lines operating practically uniform equipments can dispense with some of the provisions necessary on steam roads.

On single-track lines various arrangements at passing point are used, namely: the distant signal, staggered signals, siding signs, or a combination of such schemes.

To take care of certain situations signals on single-track work are frequently "staggered," i. e. opposing signals are set at a certain distance from each other, as signals 6 and 7, Fig. 14 A, and signals 5 and 6, Fig. 15. In this arrangement approaching trains stopping at their signals will have a predetermined space between them. The need for this separation becomes less as speeds becomes less and the equipment becomes more uniform and lighter, and therefore the braking distance shorter and more uniform. It also becomes less as the distance at which seeing a signal can be guaranteed is greater than the braking distance, or when distant signals or fixed siding signs are used to indicate the approach to and the condition of the signal at the point of danger. The siding sign indicates to a motorman that he is approaching a danger point, and is a definite distance away therefrom and must be on the lookout to see that the switches are properly set and no other trains are in the way. Siding signs are frequently set 2,000 ft. in advance of the point of danger, on a level with the headlight and close to the track, and are very large and conspicuous. Furthermore the motorman is located in the very front of his car and has very little to do or think about except to observe his signals and control his car accordingly. There is therefore very little chance that siding signs will be missed, in fact the writer has been advised by a number of motormen with whom he has talked that they never have any trouble in seeing them, and that they are of great value in indicating the approach to a siding, especially in foggy weather. On steam roads there is a different set of conditions. Owing to the physical conditions surrounding them siding signs can not be brought as close to the track, and then too the engineer has more things to think about in connection with his engine, and is not located in the front thereof, as in the case of the motormen. Furthermore the smoke from the engine may interfere with his vision. It is therefore believed that siding signs in electric traction work are a greater safeguard than they ever could be in steam road work.

The distant signal is both a siding sign and an informant of the conditions at the point of danger. If "clear" the motorman knows that the way is clear, and can proceed at speed. If at "caution" he knows that he must apply his brakes ready to stop. It is a time saver especially in bad or foggy weather. It is very useful where the view of the home signal is regularly obscured. The distant signal says what to do and when to do it. The siding only says when to get ready to find out what to do. Distant signals, if used, should be "fully automatic," i. e., they should go to stop behind a train and remain so until the train is under cover of the next signal in advance if there is ever any chance of a following train getting into the same block with another train. If the distant signal were not fully automatic and a train should be standing between it and the signal next in advance, a following train seeing a clear signal would have the right to run at full speed past such signal with the likelihood of an accident. To make a signal fully automatic a track circuit must be used as formerly described. A distant signal No. 13 is shown in Fig. 14 B. Figs. 31 to 33 and 41 to 43 show signals which can be used as distants. Fig. 31 shows its position if a train is standing between it and the next signal ahead. Fig. 32 shows the position with no train between it and the next signal ahead, but with said last-named signal at stop, and Fig. 33 shows its position when "clear." Signals 41 to 43 show an arrangement of light signals which can also be used as distants. The larger and more conspicuous the home signal becomes the less the need for a distant signal, especially where siding signs are used.

From what has just been said it will be evident that any degree of protection desired can be given and that the degree required depends on the braking distance, etc., as described. Furthermore as the requirements become more severe the expense will go up. For moderate speeds, or when traffic conditions permit slowing up on the approach to each passing point, the simple scheme using light signals opposite each other as shown in Fig. 13 A with siding signs, will be found satisfactory, and is the least expensive. The next thing in the scale of expense would be, for example, to stagger such signals as 1 and 2, Fig. 13 A and the next, to use distant signals as shown at 2 and 3, Fig. 13 B, or use semaphore signals as at 1 and 2, Fig. 14 A, and so on until the elaborate arrangement shown by signals 10 to 13 inclusive, Fig. 14 B is reached. In this connection it should be remembered that a starting signal into a given piece of single track, when clear, tells the motorman that said block is clear and that it is safe for him to proceed to the next signal only, and that he must approach said signal prepared to stop short of it. The motorman knows that an ample distance before he reaches the next signal, a sign conspicuous in all kinds of weather both day and night, will tell him of his approach thereto. If upon reaching this sign he is unable to distinguish the indication of the next signal he must come under full control and continue under control until the indication of said next signal is visible. If clear he can resume normal speed, and if at stop he will be able to come to rest before reaching it. With a full size semaphore in moderately clear weather either day or night, and when the view is unobstructed, a high-speed electric car will be able to sight the signal in plenty of time to stop if it is at danger, it being necessary to slow down, when the signal is clear, only in foggy or otherwise bad weather. With light signals high-speed cars would have to slow down in all kinds of weather, hence such signals are only recommended where the speeds are moderate, say around 30 m. p. h.

In view of the foregoing and other reasons which might be named, it is believed that on many electric lines it is neither necessary to stagger the home signals nor use distant signals where the view of the home signal is unobstructed, where siding signs are used, and where a full-sized semaphore is employed. If the locality is such that much bad weather occurs, or if the view of the home signal is obstructed by a curve, or if for any reason the view of the home signal is often obstructed it would be economical to use distant signals.

In addition to the foregoing, the arrangement of signals at passing points is largely influenced by the nature of the siding, as indicated in Figs. 13 A to 14 B inclusive. For stub-end or short passing sidings, two signals, with or without distant signals, will generally be found sufficient, but where long passing sidings are employed, as shown at the right-hand end of the figures above referred to, four signals, with or without distant signals, should be used. In speaking of sidings the practice employed by some roads of requiring cars to head in and back out is to be heartily commended from the standpoint of safety insuring as it does the setting of the switch in the main line position.

Wherever spurs or sidings exist other than at regular passing points, they should be protected by switch indicators so arranged that they will show whenever it is safe for a car to leave said siding; and furthermore that when the switch is thrown the proper signals will be set at stop, indicating to any other train which may be approaching that the block is occupied. Furthermore the proper signals at passing points should be controlled by switches in such manner that they will give the proper indications when said switches are opened and when closed.

Another important, though often overlooked, consideration in determining the number and arrangement of signals, and in fact what type of signal system shall be employed, is the cost of stopping or slowing down high-speed trains for the sake of finding out whether or not to enter the next block. It has previously been intimated in this paper that systems, initially less expensive than the track circuit advocated may be employed where trains are required to slow down or stop at all passing points. I refer to the staff system or an automatic system using miniature signals, etc. While it is true that such systems are comparatively inexpensive it is a question if they could be justified especially on high-speed lines in view of the higher operating costs, loss of time, etc. Through the courtesy of an officer on one of the large interurban railway systems of the country I have obtained the cost to stop and start an ordinary 40-ton car running at 40 miles per hour, this cost including power, wear and tear on the brake rigging and on the tracks, and also including brake shoes. The cost of power was taken at 1¼ cents per k. w. h. Based on this information the cost was found to be approximately 3 cents per stop. Assuming this to be correct, and with a train movement of 20 a day each way, the cost per day at one passing point would be $1.20 and per year $438 which would pay the interest on an investment of $8,750.00. For higher speeds and greater weights this would be more, and for slower speeds less; also if the train did not come to a full stop it would be less. Be this as it may, if my figures are correct it shows conclusively that any system in which trains have to do much stopping for the sake of getting indications is a poor investment. Not only is stopping expensive but it means a loss of time. In the case cited above about one minute was lost per stop. Where a road gives limited service, and where there are many sidings and only a few stops for the limited train, it would be a serious handicap even to slow down at the various passing points. The loss of time and money occasioned by the stopping or slowing down of trains is a subject which will bear further investigation and should have careful consideration by those who are contemplating the installation of signal systems.

With the foregoing in mind let us pass to a discussion of the various signaling schemes shown in Figs. 13A to 29 inclusive, bearing in mind that signals shown opposite each other may be staggered if necessary; that the various schemes shown are based on the system of indications in Figs. 30 to 43 inclusive; that marker lights on the signals, although not shown, would be used; that the continuous track circuit is used throughout as the means whereby the signals are automatically controlled by the trains; and finally that siding signs will be used governing the approach to each siding where there are no distant signals. The various schemes shown may be divided into the following groups:

1st. Single-track signaling in which following trains are spaced not less than the distance between passing points as shown by Figs. 13A to 14B inclusive.

2nd. Single-track signaling in which the spacing of following trains is less than the distance between passing points and is limited by intermediate signals as shown by Figs. 15 to 16.

3rd. Single-track signaling in which the number of trains following each other between passing points is unlimited as shown by the absolute-permissive automatic system Figs. 20 to 29 inclusive.

4th. Curve protection for single track, see Figs. 17A and 17B.

5th. Double-track signaling, see Figs. 18A, 18B and 18C.

Taking up the various groups in the order given: In single-track signaling where the traffic requirements will permit following trains to be held apart the distance between sidings or more, the scheme shown by Figs. 13A to 14B inclusive will be found satisfactory.

All of these schemes are absolute for both head-on and following moves, i. e., if two trains approach the same piece of single track, but one of them can get the right to it. Likewise if one train is following another the following train cannot enter the block until the preceding train has left it, as shown by the lines which indicate the extent of signal control in the various diagrams. Each pair of opposing starting signals such for example as 2 and 3, Fig. 13A, is electrically interlocked in such manner that one must be at stop before the other can clear. In each of the four schemes is shown at left a single stub-end siding, in the center a double stub-end or short passing siding, and at the right a long passing siding. Both light and semaphore signals are shown, with and without distant signals. In every case the lines indicating the extent of signal control mean that as long as any part of a train is occupying that section of track between the base of the signal in question and the point of the arrow that signal will remain at stop. Referring to these schemes individually, Fig. 13A shows an arrangement of light signals having an overlap in one direction only. The object of having the overlap is to prevent two trains approaching each other from entering the block simultaneously under clear signals as previously explained. All of the starting signals such as 1, 4, 5, etc., are two-position absolute signals as shown by Fig. 40, it being understood in the case of signals 1, 3, and 5 that the red changes to yellow on the approach of a train provided the opposing signal is red, meaning stop. Signals 6 and 7 are permissive as shown in Fig. 42, and change to red as a train passes. The scheme shown by Fig. 13A is the least expensive, extremely simple, and well adapted to roads operating at low speeds.

Fig. 13B illustrates an arrangement similar to 13A except that automatic distant signals are added, allowing higher speeds to be employed, and permitting uniform operating conditions in all kinds of weather. The distant signals are three-position, giving indications as shown by Figs. 41, 42, and 43. Indication 41 would be given with a train between the home and distant signals, 42 with no train between the home and distant signals but with the home at stop, and 43 with the home at proceed.

Fig. 14A illustrates an arrangement similar to 13A except that semaphore signals are employed with an overlap in both directions. The former is in the interests of visability, and the latter in the interests of following protection at passing points. All starting signals such as 1, 4, 5, etc., will be as shown by Fig. 30, changing to yellow upon the approach of a train. The home signals 6 and 7 will be shown by Fig. 32. Figs. 13A and 14A are about the same as regards permissible speeds.

Fig. 14B shows a scheme similar to 14A, except that distant signals are added and an overlap in one direction is employed. All distant signals give three indications as shown by Figs. 31, 32, and 33, and as described in connection with Fig. 13B. This arrangement permits high speeds to be maintained in all kinds of weather.

Coming now to single-track signaling in which the spacing of following trains is less than the distance between passing points, and is limited by intermediate signals as shown by Figs. 15 and 16. To space following trains on many lines the distance between sidings, as shown by Figs. 13A to 14B, would result in such serious delays to traffic that it could not be tolerated, and therefore means must be employed to permit closer following moves. Figs. 15 and 16 show how this can be accomplished by using intermediate signals. In Fig. 15 one pair of intermediate signals, 5 and 6, is used which will allow following movements as shown by trains A and B. By adding another pair of intermediate signals, 7 and 8, as shown by Fig. 16, following movements can be still closer as shown by trains A and B, and by adding more intermediate signals a still closer headway can be provided for. This method of providing for close following moves has the drawback that it is very expensive, especially where trains must follow each other as closely as certain classes of interurban traffic demand; and furthermore two trains can get into the same piece of single track head on, one of them having to back out, but of course the staggered intermediate signals will prevent collision.

The objections just named can be overcome by a system of single-track signaling in which the number of trains following each other between passing points is unlimited as shown by the scheme Figs. 20 to 29 inc., and which is known as the absolute-permissive-automatic signaling system. In this scheme opposing signals are electrically interlocked and overlapped in such a way as to guarantee against opposing moves into the same piece of single track at the same time, exactly as in the scheme shown by Figs. 13A to 14B inc. The distinctive feature of the scheme consists in the use of a "call-on signal,' shown by Figs. 36 and 39, so controlled that it will be displayed only provided both opposing high-speed signals, and the opposing call-on signal are at stop and provided a train is in the block having entered at the end where the call-on signal is displayed. In other words opposing train movements are prevented, following train movements are permitted by a signal that says "proceed, the block is occupied" and the whole thing is done automatically, hence the name "absolute-permissive-automatic."

In lieu of the call-on signal another position of the high-speed arm could be employed.

In the various figures illustrating this scheme the shaded signals show those under the control of trains and the wording under each will make them self-explanatory. Special attention is called to Fig. 22 which shows train C following B under a call-on signal. Also to Fig. 26 which shows signal 4 at stop indicating to D that another train is coming and that he must not attempt to leave his siding. Fig. 27 shows signal 4 at clear indicating that no more trains are following and that it is safe for D to back out and proceed.

Although not shown, distant signals can be used. The starting signals can be staggered. Siding signs would be used were there no distant signals, and the scheme can be applied to any of the situations shown in Figs. 13A to 14B. The call-on signal is not a new creation, having been in use for a long time and for the purpose of letting a train or engine into an occupied section. Heretofore it has been operated manually, whereas in this scheme its operation is automatic.

It is believed that the system just described admirably meets the requirements of those electric lines where close following movements are necessary.

Figs. 17A and 17B show two schemes for curve protection. Fig. 17A shows the signals located 2,000 ft. from the ends of the curve. The object in doing this is as follows: Assume two trains approaching, A from the right and B from the left. If B passed 2 before A reaches the overlap for No. 2, B will have a clear signal and A will be held at 3. If now 3 had been close to the end of the curve B could not have seen A in time to stop, whereas with No. 3 2,000 ft. away B will have a good chance to see A in time to stop. Likewise if A gets a clear signal. Locating the signals near the curve as shown is in the interests of economy where curve protection is the only kind of signaling to be done by a road for some time to come. When however curve protection is only a stepping stone to a more complete system, or if there are a series of several curves taking up a greater part of a given block, then the signals should be placed at the entrance to the block and in the place they will occupy permanently, as shown by Fig. 17B.

Figs. 18A, 18B and 18C show various methods of double-track signaling. Fig. 18A shows the three-position scheme largely used on steam roads. The signals would be in accordance with Figs. 31 to 33, inc., or Figs. 41 to 43, inc. This is by far the most satisfactory form of double-track signaling where the blocks are not too long, as each signal gives advance information as to the position of the next, etc.

Fig. 18B shows a less expensive scheme using two-position signals with an overlap. The signals would be as shown by Figs. 31 and 32 or 41 and 42. The overlap would vary in length from nothing up to that shown.

Fig. 18C shows still another scheme using two-position home and three-position distant signals. Its virtue lies in being able to locate the distant better with reference to the home when the length of the block is very great.

E. E. Downs, general manager, for the receivers of the Chicago & Milwaukee Electric Railway, Highwood, Ill., recently addressed to the Chicago "Record Herald" a letter, in which he says as follows: "I have read with considerable interest the editorial in your issue of Feb. 15, 1911, stating that the Harriman lines had operated their system during 1910 without a fatal accident to a passenger. This, of course, must be very gratifying to the traveling public and a source of satisfaction to every one connected with those lines. These comments by the 'Record-Herald' will do a lot toward inspiring public confidence in the management and operation of our great railroads. I notice particularly one paragraph in your editorial referring to the fact that if a small line could operate a year without a fatal accident to a passenger, the result would be considered in itself purely accidental. I do not agree with you in this statement. The Chicago & Milwaukee Electric Railroad has been in operation 13 years and the records of E. H. Vivian, the claim agent, who has been with the company during the entire period, show that during that time we have carried between 75,000,000 and 100,000,000 passengers without a single fatal accident to a passenger."