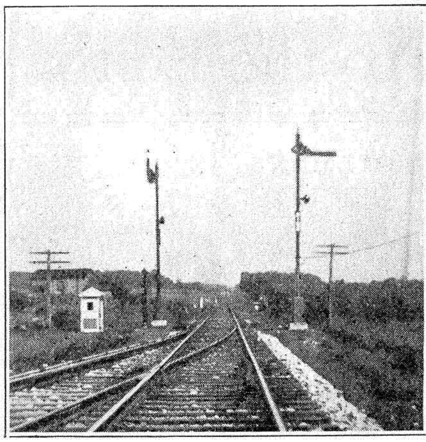
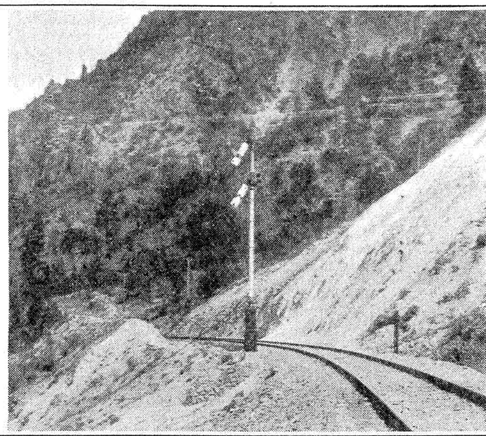


A. P. B. Signals at Switch. Telephone Booth at Left.



Automatic Block Signasl With Overlaps on Single Track

A. P. B. Signals Between Passing Sidings.

What Scheme of Signaling is Most Desirable?

The St. Louis Sectional Committee Discusses the Problem; Three Papers Outline the Advantages of the Schemes Used

THE St. Louis Sectional Committee of the Signal division, American Railroad Association, held a successful meeting at St. Louis, Mo., on Friday, August 20, in the assembly room of the railroad Y. M. C. A. building at Twentieth and Eugenia streets. L. S. Werthmuller, chairman, presided.

Three papers were presented at the morning session, the first being by A. R. Fugina, signal engineer, Louisville & Nashville, on "Absolute Permissive Block Signaling." This was followed by a paper on "Straight Automatic Block Signaling," as applied to the Union Pacific system, by A. H. McKeen, system signal engineer, after which E. E. Worthing, signal engineer of the Southern Pacific Lines, Atlantic System, presented a paper on "Straight Automatic Signaling" as developed on that system.

ABSOLUTE PERMISSIVE BLOCK SIGNALING

By A. R. Fugina

BEFORE considering the latest improved schemes for automatic block signals on single track roads it may be of interest to review the early developments and schemes used for automatic protection. The first facilities of this type were installed principally in multiple track territory. From the beginning it was readily seen that this arrangement would materially increase the capacity of the road. On the other hand, automatic signals for single track were considered more for protection; in fact, little thought was given to the possibilities of increasing the capacity of the track by their use. But within a short time it was found that automatic block signals on single track increased the capacity of track, especially when compared with manual systems of blocking.

The installation of automatic signals on single track progressed very slow until about 1910. In this connection it is of interest to note that the I. C. C. report as of January 1, 1910, records automatic signals on 6277.7 miles of single track and on 7960.0 miles of road, multiple track, or a balance of 1682 miles of road in favor of the multiple track. During the period January 1, 1910, to January 1, 1920, automatic signals were installed on 12,208 miles of single track as compared with 11,522 miles of multiple track road, leaving a balance of 686 miles in favor of the single track. The total automatic signaling in service as of January 1, 1920, is recorded as 18,486.3 miles of single track and 19,482.5 miles of multiple track. These figures indicate that the multiple track mileage still outranks the single track mileage by 996 miles of road.

Why Single Track Signaling Did Not Meet With Favor

There are a number of reasons why the use of automatic signals on single track has not grown more rapidly, but the one that perhaps hindered progress more than anything else was the shortcomings and defects in the overlap system as used with straight automatic signaling on single track. Under this scheme head-on and following movement protection is provided, but the head-on protection is limited, since it does not extend from passing track to passing track, while the circuit arrangement for following movements must be sufficient to provide much greater spacing between movements than is necessary or desirable.

There are certain inherent defects in this system which are objectionable. The one that is most apparent is that the signal indications permit two opposing trains to enter the single track between passing tracks, providing one of the trains overlooks or mistakes the meet order. With proper location of signals and overlapping the opposite trains will, of course, be stopped before coming into collision with each other, yet one of the trains will have to back up and clear the opposing train. Operating men soon recognized this defect, but in view of the fact that there was nothing better at hand it was necessary to put up with it in order to obtain the advantages that automatic signals offered.

Another defect which is not so apparent, and therefore not so well known by the men in the operating department, is the unreliability of the distant signal indication. When two trains approach a passing track from opposite directions one of them is likely to receive a clear distant signal indication, and under certain conditions both of the trains may receive clear distant indications, as a result of which the train, or trains, will approach the home signals, which in the meantime have assumed stop position, without being under control, and a collision may result. Serious collisions have occurred because of this unreliability of the distant signal indication.

The Louisville & Nashville had but a small mileage of the overlap system in service on its single track. Occasionally trains received improper distant signal indications when approaching passing tracks. These occurrences lowered the confidence of the operating officers, enginemen and trainmen in the reliability of the signal indications. The paramount requirement of any scheme of signaling is that the signal indications must be reliable.

A. P. B. Signaling

Signal engineers recognized the defect in the overlap scheme for single track blocking, and about ten years ago there was a scheme devised for overcoming the objections. The protective and operating advantages gained with this new arrangement were so far in advance of anything that had been known before that the system was generally accepted and installed on those roads that were able to spend the money to install and maintain automatic signals.

It is somewhat of an interesting fact that the requirements of electric railway interurban operation brought about the development of this scheme of single track signaling which not only overcame the defects of the overlap system, but which also provided the maximum safety and capacity of the track. This system is that generally known as "Absolute Permissive Automatic Block." It provides head-on protection from passing track to passing track, and permits following movements to be made with the minimum allowable spacing between trains. In signaling busy interurban railways it was found to be highly important to provide head-on protection from passing track to passing track, and that where the traffic was such that cars followed each other frequently it was also necessary to make the spacing for rear end protection as short as practicable. At the Railway Appliances Association exhibit at Chicago, in March, 1911, the General Railway Signal Company exhibited a scheme of signaling for use on interurban electric railways which met the requirements just mentioned, and the value of this scheme for use on single track steam railroads was at once so apparent that within a year it had been developed for this purpose. It was christened "Absolute-Permissive Block," meaning absolute spacing of trains from passing track to passing track and permissive spacing for following movements.

The A. P. B. scheme is an ideal one and its value cannot better be expressed than to quote one of the fathers of the scheme, that "for a given outlay, greater safety and more capacity can be obtained with the A. P. B. system than any other form of automatic block signaling."

Under the A. P. B. scheme, the leaving signals at the end of a passing track are positive signals, the general practice being to equip this type of signal with a square end blade and a marker light located vertically below the indicating light. The intermediate signals, as well as the entering signals to passing track or station limits, are permissive signals, these being equipped with the pointed end blade and a marker located diagonally below the indicating light.

Operation of the A. P. B. System

When a train leaves station *A* to proceed to station *B* it automatically sets the opposing positive signal at *B* and all intermediate opposing permissive signals to *stop*. While the train is moving towards station *B* it is protected from a following movement by a stop signal and a caution signal, the control of these signals being exactly similar to the control of signals used on double track. The overlap feature for following movements is eliminated, and this permits following movements to be made with spacing that is from one-half to one mile closer, depending upon whether it is compared with the single or double overlap scheme. The opposing signals automatically clear up as the train passes them, thus permitting a train that may be waiting on a siding immediately to move out and proceed in the opposite direction.

When the switch at a siding located between passing tracks is opened or the main tracks fouled all opposing signals for a movement from this point to either passing track are set to the stop position. As soon as the train that has been in the siding passes a clear signal it establishes its direction of traffic and all of the signals between the passing tracks assume their proper position. If a train, for any reason, wishes to return to the station from which it came, the following general rule will cover "Whenever a train passes a signal at clear, it establishes its direction the same as though it had not changed its direction of movement."

With the A. P. B. scheme, reliable distant signal indications are assured, and, therefore, trains approaching passing tracks will always receive correct information, providing the rules are complied with. It is customary to have a double caution indication for a train that approaches a passing track or station, provided the opposing train has reached the first track circuit in advance of the passing track switch. Thus the trains are given additional information when approaching stations; this increases the safety and enables the meet to be made more advantageously. Under the overlap scheme, the protection afforded at passing tracks is the weakest part of the system, whereas under the A. P. B. scheme this is complete. Better signal protection is also obtained for work trains that may be working between stations.

Apparatus Used and Flexibility of A. P. B.

The same kind of apparatus is used for an A. P. B. installation that is used for the overlap scheme. The circuits are quite similar, although somewhat more complicated. The system in general is much more flexible and readily lends itself to any special features that may be encountered.

The cost of installation is no greater and the cost of maintenance is on a par with the overlap scheme. A somewhat higher degree of skill and knowledge is required to maintain A. P. B., but the signal maintainer who is able to maintain the overlap scheme will find no difficulty in maintaining A. P. B. Experience shows that just as satisfactory results in signal performance are obtained from the A. P. B. as from the overlap scheme. One important feature in connection with the A. P. B. scheme is the use of telephones at all positive signals. These instruments are connected to the dispatcher's circuit so as to enable the conductor or the engineman to get into communication with the dispatcher providing the train is stopped by a positive signal which may be out of order. If the block is clear the dispatcher may order the train to proceed. On the L. & N. a special order form is used for this purpose; it reads as follows: "You may pass absolute automatic signal No. — in 'Stop' position and proceed under control to next signal, providing your movement is not restricted by train order or time table authority." The one who receives the order signs it and drops a copy into a box located in the telephone booth.

The Modification of Rules

The L. & N. rules governing the action which is to be taken when a train approaches an A. P. B. stop signal are as follows:

522—When a train is stopped by a block signal on single track it may proceed when the signal assumes the *Clear* or *Caution* position, or if this does not immediately occur, may proceed as follows:

Where other than the "Absolute Permissive Block System" is in use, flagmen must be sent in advance immediately. Train will wait five minutes after flagman has started and then proceed through the block, keeping a safe distance behind the flagman.

522-a—A signal with a square end arm displaying at night a white marker light vertically below the light indicating the position of the semaphore arm is known as an "Absolute" automatic signal (see plate 49). This signal must not be passed while in the *Stop* position without authority from the chief train dispatcher, "except," that, if unable to communicate with the chief train dispatcher, the train may, if time table and train order authority permit, proceed under protection of flag to the next block signal that is found at *Proceed* or *Caution*, as provided by Rule No. 522.

522-b—A signal with a pointed end arm, displaying at night a white marker light diagonally below the light indicating the position of the semaphore arm is known as a "Permissive" automatic signal (see Plate 50). After a stop has been made at a "Permissive" signal indicating *Stop*, the train may proceed with caution, expecting to find a train, an open switch, a broken rail or some other obstruction in the block, "except" that a train moving under protection of flag from an "Absolute" signal shall continue to proceed under flag protection to a block signal that is found at *Proceed* or *Caution*, as provided by Rule No. 522-a.

Other Operating Advantages

Besides providing safer indications and increasing the capacity of the track, the A. P. B. signals have other operating advantages which are quite as valuable and important. Under the overlap scheme it is necessary to flag the block when a signal is found to be out of order. This flagging is responsible for heavy delays to trains, as the train which has to be preceded through the block by a flagman will lose between 15 and 30 min., which in turn affects the movements of other trains, and numerous cases have been called to my attention by operating officers that the flagging of one block caused delays to the train in question, and to other trains, that ran as high as 1 hr. and 30 min. On an exceedingly busy piece of single track between Henderson, Ky., and F. S. Tower, Ind., frequent delays occurred with the old overlap scheme. About 3½ mi. of this stretch of track is on trestle, and in addition to the L. & N., the Illinois Central and the Louisville, Henderson & St. Louis operate trains between the points mentioned. When a train found it necessary to flag a block, the delay was multiplied by the fact that the flagging was done over the trestle. As a result, freight trains that were waiting to move at Henderson or F. S. Tower frequently were further delayed by the time of passenger or superior freight trains and it was the exception rather than the rule that these trains were delayed less than an hour, which often resulted in a "balled up" railroad. This trouble was increased when the trestle was covered with snow or ice due to thawing and freezing weather or sleet storms. At such times it was next to impossible for flagmen to walk the trestle. Finally the overlap scheme was replaced with the A. P. B. scheme, which effected a wonderful improvement in train operation. (A description of this installation appears on page 208 in the May issue of the *Railway Signal Engineer*.)

The A. P. B. scheme is a boon to dispatchers; they favor this system, especially those who have dispatched trains under both the overlap and A. P. B. schemes, and statements have been made by them that they would hate to have to go back to dispatching under an overlap scheme of signaling.

Dispatchers on the L. & N. do not hesitate to permit inferior trains to keep on running ahead of superior trains, providing they know that they can get the inferior train in the clear quickly and pass the superior train by, without undue delay to it. The superior train can close in more closely because of the A. P. B. scheme of control and this, coupled with information that the dispatcher obtains from the operators regarding the position of trains at the next passing track, enables the dispatcher to keep all of the trains moving with the utmost efficiency.

When a dispatcher is figuring close he frequently asks the operator to observe the position of the positive signal, so that he (the dispatcher) may know whether the train has left the next siding, at which there is no train order office. For example, consider stations *A*, *B* and *C*, with no train order office at *A* and *C*, and an office at *B*. The operator at *B*, by observing the positive signals, can tell at a glance whether a train has left for station *B* from either *A* or *C*. With this information the dispatcher is given an additional advantage, which enables him to move trains up another station, which could not be done otherwise; dispatchers on the L. & N. make use of this service daily and find it of great value.

On the line between Louisville, Ky., and Cincinnati, Ohio, two high class passenger trains in one direction exchange diners with two similar trains in the opposite direction. When one or both of the trains that are to make the exchange are off their schedule the dispatcher finds the information he obtains through the local operator regarding the position of positive signals invaluable in arranging for a better meeting point and it frequently enables him to prevent a heavy delay to one of the trains.

A. P. B. Signaling on the L. & N.

In 1913 the L. & N. made its first installation of A. P. B. signals between La Grange, Ky., and Cincinnati, Ohio, a distance of 82 mi. Considerable difficulty was experienced in convincing higher operating officers that this scheme was more desirable than the overlap scheme. Fortunately, the division superintendent, on whose division the new signals were to be installed, had become deeply interested in signaling and had studied the A. P. B. scheme so that he thoroughly appreciated its advantages, and he enthusiastically advocated an A. P. B. installation. In spite of all arguments, the management decided to install the old scheme. This decision was largely influenced by the fact that the A. P. B. system was new and had not been extensively tried out on steam roads. The principal objection was grounded in the fear of numerous delays to trains because of switching movements that might be made at station *B* when a train was about to proceed to *B* from station *A*, it being thought that the switching movement at *B* would set the positive signals at *A* to stop. About every road that first contemplated the use of A. P. B. worried over this same bogey, but there is absolutely nothing whatever to fear. Finally the management of the L. & N. gave authority to try out the A. P. B. scheme.

This installation proved to be highly satisfactory, and as a result the L. & N. has installed this type of signaling wherever any single track signaling was authorized. Five hundred and sixty miles of the A. P. B. signals are now in service on this road. As soon as the A. P. B. signals were placed in service their superiority over the overlap scheme was recognized and the division officers immediately began a campaign to secure authority to have the overlap scheme changed over to the A. P. B. system, and for several years now the L. & N. has not had any of the overlap scheme of signaling in service on any part of its system.

Some Appreciate the Value of A. P. B. Signaling

The introduction of the A. P. B. scheme of signaling is one of the great achievements in the science of railway signaling. But, as a rule, few appreciate the possibilities of this scheme of signaling. Railroad officers, and especially the higher ones, fail in this respect. On the other hand, however, those operating officers who have had the experience of operating with and without them really appreciate their value. They are great boosters. One superintendent has remarked that he sincerely believed that the installation of the A. P. B. signals over an operating section of his division had effected a much greater economy than any other improvement, and that he attributed to them the fine improvement in earnings that his division made immediately following their installation. He further stated, and this was supported by the trainmaster and dispatchers, that there have been periods in which the business over the division was so heavy that it would have been impossible to handle all of it without having the A. P. B. signals. Similar expressions by operating officers of other divisions who have A. P. B. signals in service substantiate these facts. Signal engineers of other roads advise that they receive the same kind of information from their operating officers. Even so, the installation of automatic signals has been remarkably slow. I attribute this more than anything else to the lack of information that the higher officers, especially the ex-executive officers, have relative to the economies effected by such installations.

How Signal Departments Can Sell Signaling

No concentrated study seems to have been made and no data, except of a very general nature, is available to show the economy of automatic signaling. The signal departments are as much, and probably more, to blame than anyone for not devoting more energy to this. After a signal installation is completed it is customary for the signal engineer to quit worrying about it except to keep it in good maintenance and operating condition. Instead, however, he should follow their performance from the operating point of view and should devote more time to analyzing operating results and savings effected, so that he may be in position definitely to inform the general officers what economies have been effected. It is a difficult problem to solve since so many of the savings effected are of an intangible nature—such as the increase of car and engine mileage, reduction of time of trains in running over the division, increase of capacity of track, reduction of overtime, elimination of wrecks, advertising assets, etc. However, it is hard to understand why very reliable data on these subjects cannot be secured if a consistent study is made. The Signal division of the A. R. A. is duty bound to lead in this study and I sincerely hope that it may have a separate committee to study the "Economies of Automatic Signal Installation." The committee on "Signaling Practice" is devoting some time to this study, but the subject is too large to be handled as a side line, since this is the really big subject before the Signal division, and incidentally before the A. R. A.

The Future Development of A. P. B.

As to the future development of the A. P. B. system. It is not understandable to me why we cling to the old methods of train operation that were developed many years ago, long before we knew of automatic signals and telephone train dispatching. Operating trains on double track by signal indications instead of written orders is no longer an experiment, as the extensive Erie installation has so well proven. In this connection very little has been accomplished for single track operation, and here lies another golden field that only awaits development. With the A. P. B. scheme of signaling, the problem is half-way solved and the next logical step is to develop it for operating trains by means of signal indications. Not until this is accomplished, and it will be in the near future, will signal engineers really be recognized and rank as valuable operating officers, insteads of being considered a necessary evil of limited specialized capacity.

STRAIGHT AUTOMATIC BLOCKING ON THE U. P. SYSTEM

By A. H. McKeen

THE first installation of automatic signals on the single track of the Harriman Lines was made in 1898. At that time little thought was given to the question of facilitating traffic; the most important consideration was to increase the safety of operation by providing a reliable means of maintaining a space interval between trains. The results of the initial installations from this standpoint were so satisfactory that further extensive installations of this type of signaling were made, principally on mountain grades, where train movements were heavy and the view obscure.

Increased Capacity of Track and Signal Arrangement

Such installations as these demonstrated conclusively that in addition to the protection secured, the movement of traffic on single track was materially expedited by automatic signals. It was found that "19" orders could be substituted for "31" orders in block signal territory, and the elimination of stops, especially of heavy tonnage trains, resulted in the movement of traffic being greatly facilitated. This practice has been continued with each additional installation of automatic block signals and is now in effect on 1852 miles of single track on the Union Pacific System.

Signals are of the two position type with overlap control and the arrangement is such that when the adjacent switches at stations are less than 4½ mi. apart, one set of intermediate signals is installed. When this distance is 4½ to 6 mi., two sets of intermediate automatic signals are installed.

The average length of block at the entrance of stations is 1¼ mi.; for starting signals at stations it is 2 mi. with a maximum length of 3 mi., and intermediate signals are spaced ½ mi. apart. Distant signals are located ½ mi. from the home signal approaching stations.

Comparison of Straight Automatic With A. P. B.

It is somewhat difficult to draw comparisons between straight automatic signaling and the A. P. B. system because of the variety of schemes under the name of A. P. B. As first designed, the A. P. B. system seemed to provide a flexible scheme of signaling, which, however, after being studied in the light of experience, necessitated revisions of the circuit plans to render the control scheme safe.

It is generally accepted as one of the principles of good signaling that distant indications should be displayed at reasonably uniform distance from the home signal. The A. P. B. system, in some cases, violates this principle by displaying a distant indication, varying from ½ mi. to as much as 2½ or 3 mi. from the home. The apparent benefit afforded by the A. P. B. system lies in temporarily reducing the length of block between following trains. This is accomplished by cutting off the overlap without at the same time providing adequate approach indication to the home signal as explained.

With the A. P. B. system, switching at the adjoining ends of adjacent stations cannot be carried on at the same time to the same extent as in the overlap system and obey the signal indications. If signals are obeyed, switching operations must cease prior to the opposing train's time at the other station, regardless of the distance between stations, or the class of the train. With straight automatic block, switching movements can be made at adjoining stations without delay to either train and such switching operations can be continued after the approaching train has left the adjacent station and until it has reached the overlap controlling the outgoing signal at the station where the switching is being done. The outgoing signal serves as an indicator to the switching train and indicates to the trainmen and enginemen whether or not the approaching train is in the block.

The absolute feature of A. P. B. as affecting opposing movements between stations, whereby one or the other of two trains will be stopped at a station, thereby obviating the necessity of one train backing up, would seem to be an exaggerated claim, due to the possibility of opposing trains entering the block simultaneously. Furthermore, in view of the extreme rarity of instances of this kind, this argument seems inconsistent. If such instances occurred with sufficient frequency to lend any force to the argument, it would indicate a laxity of operating methods and no first-class railroad would permit any such condition to exist on its system.

If all trains were run in one direction during certain periods of the day, the permissive feature for following trains might have some merit, but inasmuch as operating conditions require trains to move in both directions, it would seem that the permissive feature would only result in the bunching of trains at certain stations, where, unless ample side track room was provided, much delay would result in "sawing-by."

The Union Pacific System rigidly enforces the rule that when a home signal indicates "Stop" a flagman must precede the train on foot to the next clear signal. When a train is stopped by an absolute signal under the A. P. B. system the general practice is to secure authority from the train dispatcher to proceed, or if unable to communicate with the train dispatcher, the flagman must precede the train. The question then arises as to how far the flagman should precede the train when the absolute home signal at the outgoing end of a station is at stop and the next intermediate or permissive automatic signal is also at stop.

If the train picks up the flagman at the intermediate signal and proceeds under control it is liable to meet an opposing train that has been delayed a few minutes after entering the block on a clear signal. By establishing two different kinds of home signals, a complication in the rules governing trainmen in the observance of signals is created. Furthermore the train dispatcher does not always know to a certainty whether or not the block is occupied, and the correctness of such information could not be relied upon.

The A. P. B. system is necessarily more complex than straight automatic on account of the additional relays, line wires, track circuits, circuit breakers, etc. Dependence is placed on back contacts to restore the circuits. These features add materially to the cost of installation and maintenance, greater liability of failure and increased difficulty in locating and correcting failures. A maintainer will necessarily have to be above the average in experience and ability to maintain the required close adjustment of apparatus and successfully to locate and correct the causes of failure. Considering the simplicity of circuits, together with the minimum amount of apparatus required with straight automatic block signaling, the arrangement certainly tends toward lower costs of installation and maintenance together with increased reliability and efficiency.

The benefit of temporarily cutting off the overlap for following movements may be of some advantage where a block is much longer than the average, but where stations are close together and the block length therefore comparatively short, there appears to be no benefit in further reducing the block length. In cases where the block is long, the desired flexibility can just as well be secured by installing an additional set of intermediate signals.

S. P. SINGLE TRACK SIGNALING

By E. E. Worthing

SINCE the preceding paper by Mr. McKeen presented many of the details embodied in the so-called Harriman Lines' single track block system, it will only be necessary to dwell on the important points involved in the single track signaling as installed on the Southern Pacific, Atlantic System.

The principal object sought on these lines through the installation of automatic block signals is, not to relieve or modify the usual method of handling trains by time card and train orders, but to provide a check against the human error in the execution of the numerous and complicated rules of such methods; to protect traffic by the detection of broken rails, disarranged switches, etc. Automatic signals do not modify the usual operating rules, except in two particulars, namely: The 10-min. spacing rule under the train order system is modified to let trains follow one block apart, also the more general use of the No. 19 train order in lieu of the No. 31.

Why the S. P. Installs Signals on Single Track

The signal installation, individually authorized, on these lines are all confined to the single track. In following this practice, it is felt the railroad gets more for its money by affording more protection to traffic in general than by first signaling double track. Among the major reasons may be mentioned the following:

(1) In operating double track there is no hazard from opposing movements on the same track, whereas on single track this is one of the greatest hazards.

(2) On single track every switch is a facing switch for half the movements, whereas in usual standard double track construction substantially every switch is trailing.

(3) In meeting trains on double track as generally constructed, either by taking siding or crossing over, much better opportunity is provided for the flagman to protect both front and rear than on single track.

The arrangement of signals and scheme of overlaps is practically the same as Mr. McKeen described for the Union Pacific System. Since all blocks are provided with overlaps and all signals staggered, except at ends of passing tracks, it will be observed that there is no need for the caution indication, other than to regulate the approach to the station bound home signals. In fact, it will be evident upon a close study of the situation that a caution indication in connection with each home indication will be a hindrance rather than an advantage, since it would unnecessarily require train movements at greatly reduced speed for long distances.

In 700 mi. of such signaling in use on the Southern Pacific, Atlantic System, for an average time of 10 years not a single accident has occurred as the result of a butting or rear end collision, side swiping, derailment at misplaced switch, etc., where the signal indication was observed. This fact alone is ample testimony of the adequacy of the system is so far as protection to traffic is concerned, the object for which it was intended.

Some of the Disadvantages

Having now pointed out a few of the major advantages accruing from the use of the automatic block system, it is proper that it should be considered for its disadvantages, if any. The one and only major disadvantage coming within my observation is the delay to trains at stations. Obviously, trains should be free to proceed over the road to suit traffic requirements at all times, except when they are actually a hazard to the movement of some other train. In the early days no more signals were provided to space trains at stations than necessary. In fact, the track layout at many stations did not admit of the application of the standard station signal layout. As a result the main track through all of the larger terminals was left unsignaled and at the more important passing points insufficient provisions were made to permit the passing of trains or their closing up without serious delay.

The application of what may be called station intermediate signals, located between the station home signals, has to a large measure solved this problem. These signals, home, or home and distant, as required, are generally located with respect to inside crossovers or inside switches of lap sidings. For illustration, take an important way station on a curve with lap sidings. Say the east siding is 2,000 ft. long and the west one 4,000 ft. long, the inside switches of which are set just to clear. Let the combination passenger and freight depot be at the center of the 2,000 ft. passing track.

Assume now a very frequent train movement, an extra east has an order to meet a west-bound passenger at this station. The extra arrives at the west end and starts to head in at about the same time that the passenger arrives at the east end. Obviously, the passenger will either have to stand at the east end and wait for the signal to clear or flag down to the station and from the station around the curve until the next signal comes into view. Either procedure would result in 5 or 10 min. delay to the passenger train.

Again, assume two passengers have orders to meet at this station, the east-bound train to enter the east passing track. If the westbound train arrives first and drops down to the station to do its work it will cause the east-bound train to flag at least 4,000 ft., meaning a delay of about 20 min. These are cited only as illustrations of the many and varied movements at stations which result in delay to one train or the other, sometimes several, which I believe are not only common to the Harriman standard, but to all other single track schemes.

How the S. P. Has Overcome the Disadvantages

I have found the use of what I will call station intermediate signals to be the cure for a large portion of the station delays. At the station just described, one of the switches would be extended so that the fouling points of these switches would at least be opposite, but preferably still further apart. A pair of station home intermediate signals would be located opposite the fouling points and distant indications placed on the station bound home signals next in advance.

This arrangement will permit the east-bound extra to head in at the west end and at the same time let the passenger come up to the station, do its work and avoid flagging out of town. It will also permit the inferior passenger train to enter the east track without being stopped by a signal and then flagging 4,000 ft.

Long single passing tracks are usually provided with center crossovers. Here again we have a need for and an opportunity to use the station intermediate signals to good advantage. In this case it is necessary that the crossovers are arranged so that the first one reached by a train is the one which heads it into the passing track. Under this condition the signals are located opposite the center point between these crossovers, with distant indications on the home signals in advance, thus bringing about the same safe and flexible train movement as described with lap sidings.

The overlap or "Harriman system" actually does facilitate train movements in that, in block signal territory, operating rule 91 requiring trains to keep at least 10 min. apart is modified to permit trains to follow one block apart. It is also the general practice at intermediate stations to use form 19 train order in lieu of form 31, abviating the necessity of trains stopping to sign for orders. The track may be subdivided into blocks, as short as traffic requirements dictate, thus facilitating train movements in both directions.

Discussion

E. C. Pry, superintendent telegraph and signals, Southwestern region, Pennsylvania System, desired to know whether it was necessary for the L. & N. to change its operating rules when the A. P. B. signals were installed.

A. R. Fugina, signal engineer, Louisville & Nashville, stated that the operating rules on the L. & N. were not modified except as outlined in his paper. In Mr. McKeen's paper the statement was made that it is generally accepted as one of the principles of good signaling, that the distant indications should be displayed at reasonably uniform distances from the home signal, that the A. P. B. system violates this principle by displaying a distant indication in some cases from ½ mi. from the home signal and in others to as much as 2½ or 3 mi. from the home signal. Absolute permissive block signaling is used generally for close spacing of trains in order to gain capacity in track. On the L. & N. the average block is one mile and never in excess of 8000 ft.

L. S. Werthmuller, chairman, desired to know whether any of the roads modified their operating rules in connection with absolute permissive block signaling.

Mr. Fugina stated that he did not know of any roads that had to modify their rules to any extent.

Mr. Pry asked if A. P. B. signaling would increase the capacity of line in manual block territory, and Mr. Fugina stated that the increased capacity would undoubtedly be in the neighborhood of from 15 to 25 per cent.

F. C. Stuart, signal engineer, Elgin, Joliet & Eastern, stated that on the E. J. & E., the trains usually run in flocks, first in one direction and then in the other. Under this condition he believed A. P. B. signaling was of particular advantage, but where this condition did not exist he thought straight automatic block signaling was sufficient.

O. R. Unger, signal inspector, Missouri Pacific, believed that A. P. B. signaling was complicated, particularly because of the large number of relay contacts in use, which, from his experience with back contacts, was a source of trouble which resulted in signal failures.

J. B. Weigel, signal inspector, Louisville & Nashville, stated that the back contacts, which are metal to metal, have not given the L. & N. any trouble and that if that was the only drawback preventing the adoption of A. P. B., there should be no cause for worry. On the other hand, some trouble had developed on the front contacts, metal to graphite, particularly on those that are required to carry the heavier current for signal motor operation. Relative to the changes or revision referred to in Mr. McKeen's paper, that were made necessary on A. P. B. signal plans, it is logical to suppose that in the course of development of any scheme corrections and changes are made necessary because of the new situations that had to be met. However, the last revisions were made on August 8, 1916, which speaks very well of the A. P. B. system owing to its recent development.

Mr. McKeen related the experience that the Union Pacific had on back contact failures on its 600 miles of electric lighted signals. He said that after a relay has been in service a number of years the brass contact fingers have a tendency to "warp," so that one of the back contacts may not close when the relay is deenergized, because all of the load of the armature is carried by another back contact in the same relay.

Mr. Fugina: Relay contact trouble occurs on the front not on the back contacts. I think a pretty good indication of the service we are getting is our record of 76,000 movements per failure; our average is 40,000. Our line relays are 670 ohms, therefore, even though the contact resistance in the back contact be one ohm or ten, there is nothing to fear, for the relay will get sufficient current to operate it. If back contacts stick you are on the safe side.

Mr. McKeen: Our trouble has not been resistance, the trouble has been in that one of two or more back contacts did not close because all of the weight of the armature is borne by another back contact.

E. E. Worthing, signal engineer, Southern Pacific Lines, Atlantic System: The statement has been made that the A. P. B. system is inseparable from three-position signaling. My experience has been that two-position signaling can be used with the A. P. B. system.

G. S. Pflasterer, signal engineer, Nashville, Chattanooga & St. Louis. The statement was made in one of the papers on straight automatic block signaling that that system eliminated the "31" orders, but retained the "19." I am an advocate of handling trains by signal indication and believe that a signal system can be devised to eliminate the train order."

C. F. Stoltz, signal engineer, Cleveland, Cincinnati, Chicago & St. Louis: On one division of the Big Four there is a stretch of four miles of gauntlet track, where, in the past, 70 per cent of the orders on the entire division were required to move the traffic over this four miles of track. Now these train movements are handled by signal indication only.

Sub-Committee Reports—Fibre Insulation

The afternoon session was spent in discussing sub-committee reports. The first report was that of fibre for track insulation.

This sub-committee has been investigating the undercutting of end posts and A. M. Gilbert, signal supervisor on the Cleveland, Cincinnati, Chicago & St. Louis, who has been acting chairman of this committee stated that tests have been made on end posts that were undercut all around ⅛-in. It was stated that the principal places to undercut the end posts would be around the top and gage side of rail.

A. J. Kelly, supervisor of signals, Cleveland, Cincinnati, Chicago & St. Louis, felt that if end posts were cut in this manner those engaged in installing such end posts might get them in wrong.

It was pointed out that if end posts are cut down smooth when installed and held tight, the best possible results will be obtained.

Mr. Weigle stated that the L. & N. had that rule, but that it was not lived up to. He believed that undercutting would do the work.

Mr. McKeen thought that because of the many sections and weights of rail there would be an unlimited number of undercut end posts required to supply the demand. He stated that on the Union Pacific System there was a very strict rule that all end posts be cut even with the rail with a hack saw after they were installed.

W. D. Davis, signal supervisor, St. Louis-San Francisco, stated that if the section foreman is educated to the point where he feels that he is responsible for insulated joints and that he will be censured for failures, very good results will be obtained.

Mr. Kelly thought that there should be a division of responsibility and that the maintainer should have authority to call attention to bad joints needing repairs.

Mr. McKeen: For a long time the Union Pacific had the section foreman install and maintain insulated joints, but since the price of fibre has advanced it was found necessary to make the responsibility a joint proposition between the maintainer and the section foreman. In this way considerable material is saved, because maintainers can tell what parts are to be renewed and when such work is done the maintainer is present.

Mr. Unger: When the co-operation of the division engineer is secured the section foreman is bound to co-operate also.

Electric Lighting of Signals

Mr. McKeen stated that in 1912 that system had 180 miles of electric lighted signals. At first 2500 ft. automatic start was considered sufficient, but enginemen soon complained, because they found that they came within view of signal before the lamp lighted. A minimum distance of two miles is now used for the start, but when the view is limited the light is lighted before the engineman comes in view of the signal.

The question was asked regarding the comparison of failures between oil and electric lamps. Mr. Fugina stated that less than 5 per cent of failures was a conservative figure with the electric lighted signals. He stated that there are probably 38 oil lamp failures against one of the electric.

The sub-committee on Storage Batteries reported progress only.

Dry Batteries

The testing of the hot shot type of dry battery with the ordinary instrument for testing single dry cells indicates that such an instrument is not adapted to testing that type of battery. Mr. Weigle stated he had made a test with the ordinary instruments used for testing a single cell, but was unable to measure the current because the needle on the instrument went beyond the scale range.

Mr. Foster stated that each cell in a hot shot type of battery is of the same age and that the connections and assembly is such that individual cells cannot be short circuited as is the case with exposed cells. Battery made of individual cells may consist of cells, of various ages.

At this meeting of the St. Louis Sectional Committee there were about 70 members present, including 12 signal engineers. The next meeting will be held the third Friday in September and at that meeting the entire day will be devoted to the consideration of the application of current rectifiers to railway signaling. G. H. Groce will present a paper on "Electrolytic Rectifiers"; F. Ballman, chief engineer of the Valley Electric Company, St. Louis, Mo., will present a paper on "Mechanical Rectifiers," and C. A. Reid, chief engineer of the Leich Electrical Company, Genoa, Ill., will also present a paper on "The Mechanical Rectifier."

NEW CONDULETS

THE Crouse-Hinds Company, Syracuse, N. Y., has designed a new series of condulets known as the "New Mogul Series of Condulets," which are shown in their bulletin No. 1000N. These new condulets have been designed to meet the demand for a product having an unusually long cover opening and large wiring chamber. Their hubs have integral bushings and tapered threads. Fastening screw holes are located at the ends of the cover openings. They are made in eight types and each type has eight conduit sizes ranging from one to four inches. There are four sizes of composition and cast iron covers, each size being common to the two sizes of Mogul condulet bodies. The composition covers are made with from one to nine wire holes; also blank. These can be drilled by the user as required. The cast iron covers are made in two types with or without gaskets. The gasket is made of round rubber cemented into a groove in the cover. The cover fastening screws are furnished with and secured to the cover.