Speeding Up Train Operation With Signaling*

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THE story of the railroad has been one of constant change and improvement. Tracks, rolling stock and locomotives have been undergoing improvement almost continuously, and this has required that the other branches of railroading have had to keep abreast, or sometimes even ahead, of these developments. One of the outstanding developments has been that of the signal system. The first signals, while no doubt adequate for the requirements of their time, seem crude when compared to present-day devices.

Railway signaling includes not only the signal systems required for movement and protection of trains but, as well, the devices provided for the protection of highway users at railroad-highway grade crossings. The first highway crossing signals of the automatic type extensively used were bells. Highway traffic being horse-drawn and slow moving, bells were very effective as warning signals for indicating the approach of trains. With the advent of motor traffic, the question of protecting crossings began to assume a more serious aspect. It seems that every highway user became an expert in the matter, judging by the number and kind of devices that were proposed and tried out. In 1930 the Signal Section made a study and found 63 types of signals actually in service. In an effort to promote uniformity and standardization, the A.R.A., now A.A.R., organized the Joint Committee on Grade Crossing Protection, and largely through this committee and the organizations represented in it there was developed a national standard, the wig-wag and flashing light, which are now used all over America.

The barrier type of protection, first in the form of manually-operated gates and now as an obstruction in the highway, has come in for its share of attention. Manually-operated gates have been quite popular in cities and villages but are now giving way rapidly to some form of automatic signal. Non-yielding barriers forming an obstruction in the roadway have been installed at a number of locations but they cannot be said to have become very popular with either railway men or the highway users. Within the past two years there has been considerable

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activity and interest in the so-called short-arm gate. This is, in reality, an adjunct to the standard flashing-light signal with which it is used. It is well adapted for automatic operation, and, since it makes use of an acceptable automatic block signal mechanism and the gate arm blocks only the right-hand half of the highway, many railway officers and public authorities have looked with favor on its use.

The grade crossing problem is that of the mental attitude of the individual user of the highway rather than a problem in mechanics. Until we can get every user of the highway to recognize that every crossing is a possible rendezvous with death, and that he must look out for and obey the signs and signals provided for his protection, we may expect accidents. I think that one of the reasons that this problem is so much more serious now than it was in the good old horse and buggy days is that then there was at least one party concerned in the operation of the vehicle that had horse sense.

Signaling for Train Movements

The first signal systems were provided in the interests of safety. As train speeds were increased and density of traffic became greater, the need for more and better signals for safety purposes became more apparent. This led to the development and installation of better and more complete systems. It was finally discovered that a signal system could not only provide for increased safety but actually show a return on the investment required to install it, because trains would run faster and lose less time on the road if they were assured of safety. Signals are now installed for just two reasons—first, as always, safety; and second, to facilitate movement of trains.

Our first interlockings were brought over from England. They were of the mechanical type, manually operated. The development of power interlocking has been an American achievement and the English are now adopting some of our very latest types of machines.

The invention of the continuous track circuit in 1872 opened the way for the development of automatic block signaling. This invention, which is considered so simple today, was, in reality, a wonderful achievement and it is fundamentally indispensable in any system of automatic signaling. No satisfactory or adequate substitute has ever been found for it. Various types of signals were developed for use in automatic block signal installations. The result has been the present almost universally used light signals of the color-light, position-light and color-position-light type; not to mention the semaphore which is still largely used on lines that were signaled just before or about the time of the World War.

Operation of trains by the train order, manual block or token system is more or less dependent on the human element. In the automatic block signal method of operation,

*Abstract of paper presented before the Western Railway Club signals are automatically operated by the trains they protect. As pointed out previously, the continuous track circuit is fundamental in such a system. Not only will an automatic signal system economically and safely provide a space interval between trains but it will, as well, provide protection against broken rails, misplaced switches or other conditions which may cause the track to become unsafe for the passage of trains.

That automatic signaling has been effective, both from the standpoint of safety and that of economy, one has but to look at the record. On January 1, 1938, the Interstate Commerce Commission reported 94,883 miles of track in the United States as being equipped with automatic block signals. In no other way would it be practical, at least from an economic viewpoint, to operate some of our high-speed, heavy-traffic lines. With the advent of higher train speeds, the necessity for automatic signal protection has been even more apparent than when speeds were slower. Large sums have been expended to revamp the installations in service in order to provide adequate protection for the higher speeds.

Automatic signals can be adapted to protect any condition of the track which may endanger the passage of trains such as rock slides, highwater or burning bridges. Serious consideration should be given to providing more of such protection wherever required. It will result in increased safety, as well as speeding up train movements.

Train Control and Cab Signaling

Acting under orders of the Interstate Commerce Commission in the early 1920's, the railroads made extensive installations of automatic train stop and train control devices, spending in excess of $30,000,000 for installations alone. In my opinion, which I believe is shared by many other practical railroad men, much more protection could have been obtained by spending this amount of money for some other form of signaling. However, the development, experimentation and installation of workable train control systems did lead to the development of the cab signal method of signaling. Many such installations are now in service. From a train operation point of view, the cab signal is, in my judgment, the ideal signal. It is immediately responsive to changes in conditions ahead of the train and it is in the cab in plain view of the engineman where its indication will not be obscured by smoke, snow, fog or other unfavorable weather conditions and where it cannot be misunderstood.

Spring switches have been used on street car and interurban lines for years but on steam railroads, except in yards, their use did not begin until about 1920. At first used where slow speed was required for some other reason, gradually they were installed in high speed territory and operated in a satisfactory manner. They provide an ideal means of handling a switch over which the traffic is always one way in the facing direction, such as at an end of double track or the exit switch from a yard. The Southern has a very extensive installation of spring switches at passing sidings. It has been found that they very materially speed up train movements wherever they have been tried out.

Train Moves Directed by Signals

In 1851 the first train was dispatched by train order; in 1882 the first train was dispatched by signal indication, and in 1927 there was completed and placed in service the first installation of a system for dispatching trains by signal indication controlled from a central point in such a way that one control operator had direct control of the traffic over an entire district. This is the system known as centralized traffic control, more commonly now referred to as C. T. C.

The Interstate Commerce Commission and the Signal Section of the Association of American Railroads have each defined centralized traffic control as—"A term applied to a system of railroad operation by means of which the movement of trains over routes and through blocks on a designated section of track or tracks is directed by signals controlled from a designated point without requiring the use of train orders and without the superiority of trains." Many people think this would be a better definition of the system if the words "in either direction" were inserted after the first word "trains" so it would provide for "movement of trains in either direction over routes and through blocks." It is impossible for me to visualize a system worthy of the name which would not provide for either direction movement without written orders and without superiority of trains. I would earnestly recommend that the definition be revised along the line suggested.

While the record shows that the first use of signal indications for dispatching trains was in 1882, the first installation of anything of this kind on an entire district was completed by the Missouri Pacific in 1925 between Kansas City and Osawatomie, a distance of 50 miles. The signals and switches were controlled from nine telegraph offices, with locking of either mechanical or electrical type between levers and between levers and field functions. Traffic locking was provided between adjacent offices. Trains in this territory were operated under controlled manual block system rules. The operation of the system was entirely satisfactory as many of you who visited the installation know.

However, it was expensive to install on account of the line wires and other materials required to provide for the locking between levers in the offices and it was expensive to operate because of the number of offices and the number of men required to man them. At that time nobody had devised a better way or provided a simpler method of accomplishing the same thing. In the light of later developments, the system installed then between Kansas City and Osowatomie seems rather crude but it should be remembered that this was a pioneering job and made use of then standard and approved materials and practices. Insofar as the railroad was concerned, this installation resulted in greatly improved operation and the economies effected were greater than had been anticipated. Also, the necessity of providing an additional main track was indefinitely deferred. In addition to accomplishing the thing that the railroad set out to do, this installation proved beyond a doubt that movement of trains could be speeded up with safety over an extensive territory by signal indications and that switches and signals controlled from central locations would function reliably for such operation.

In 1927, the New York Central installed a system of signaling for operation of trains by signal indication between Berwick, Ohio, and Stanley. The territory consisted of 37 miles of single track and 3 miles of double track. Power switch machines were provided for passing tracks and certain other locations. The switches and associated signals were all controlled from one machine by one man located at Fostoria, Ohio, about 28 miles from Stanley at the north end, and 12 miles from Berwick at the south end, of the district. This was the first installation anywhere of what has now come to be called centralized traffic control. It differs from all previous systems such as the one I have just referred to on the Missouri Pacific in that there is no locking of any kind on or between the levers of the control machine. All locking essential to the safety of train operation is accomplished locally in the field, at the switches and signals. By eliminating locking from the control machine, it was possible to build a smaller and more easily operated machine and also to eliminate the necessity for a large number of line wire circuits which would have been required with a system using interlocking machines of a conventional type for control of switches and signals.

With the elimination of locking in the machine and all of the line wires except one for each control point, it was possible to extend greatly the territory which could be handled from one control office. Later development has made it possible to control all of the switches and associated signals over an extended territory over two or three line wires.

Following the completion of the New York Central installation and after it had had an opportunity to fully demonstrate in actual service that it would satisfactorily handle the traffic both with safety and dispatch, other railroads made similar installations. One of these installations on the Missouri Pacific between Kansas City and Atchison, a distance of 42 miles, was placed in service late in 1929. After it had been in service a few months we found that it was producing a saving of 18 per cent on the total investment, after allowing for all fixed charges and maintenance, as well as indefinitely postponing need for double track, which had been the only remedy previously suggested. So well has this system of operation met the requirements of our operating officers that we have 375 miles of it in service today.

Among the many outstanding advantages of C. T. C. I would like to refer to a few:

1. Promotes safety of train operation.
2. Return on investment. A check by the Signal Section of 25 installations on 18 railroads involving 453 miles of track has shown an average saving of 25 percent after deduction for all maintenance and fixed charges.
3. Facilitates train operation by eliminating delays due to stops for meeting and passing of trains.
4. Increases average freight train speed. It is safe to say that more than one minute can be saved by each freight train for each mile of territory involved.
5. Improves passenger train performance without adversely affecting freight train movements.
6. Reduces loss and damage to equipment and loading by decreasing number of stops.
7. Permits increase in train loading.
8. Tends to insure on-time arrival of trains at terminals. This is particularly important in the movements of commodities that must be in on time for the morning market or which it is essential to turn over to connections for quick delivery to an off line market. This one advantage is sometimes enough to justify an installation even though there be little saving otherwise.
9. Increases traffic capacity of line.
10. Provides for more intensive utilization of existing facilities and equipment and in many cases has indefinitely postponed the necessity for additional main tracks.

Operation by train order method makes it necessary for the dispatcher to forecast train performance long enough in advance so that orders may be transmitted and delivered to those trains affected in time for them to be acted upon by train crews. Frequently it is necessary for a crew to have several orders governing its movement in its possession at the same time and there is always the chance that one will be overlooked or misunderstood. With the C. T. C. system the signal indications are, in effect, the orders which govern trains. Each signal delivers its order as a train approaches it and the engineman is governed at that place by the information he receives there. He has nothing to remember and nothing to forget or overlook insofar as orders governing the movement of his train are concerned. When we were installing our first C. T. C. I had many enginemen come to me and inquire what they would have to learn and how they would operate under the new system. I told them to do just what the signals said and they would never get into any trouble. This appeared to be a great relief to many of them who had seemed to think there was going to be something very mysterious about the new system. To the extent that the time element of issuing orders is eliminated by C. T. C., more efficient dispatching is possible and the cause of safety is promoted. Delays on account of passes and meets by the train order system depend to a large extent on how closely the dispatcher can forecast the movements of the trains in his district; but regardless of how efficient or competent the dispatcher is, if one or more of the trains for which he has planned and issued orders falls down on its forecasted movement before the orders are executed, the resulting delay to all trains affected will usually be serious due to the difficulty of changing orders after they are once issued. With the C. T. C. system, the immediate control of each train's movement is made possible without dependence upon a system involving intermediate operators for delivery of orders and without regard to movements of other trains, except at locations where they are to be met or passed, so that the control operator may change meeting points merely by manipulating a few small levers on his machine whenever conditions make it desirable to do so.

It would be amiss of me were I not to mention the part that an efficient means of communication plays in the proper operation of a railroad; in no place is it more important than in connection with a system of operation by signal indication. Also, means are now available for the automatic OS-ing of trains into a distant office even though there be no complete signal system in operation. Telephone equipment used in connection with automatic signals now in place can be effectively used to convey information from a moving train to operators or dispatchers located at distant points and thus enable dispatchers to plan their next moves.

Developments in Interlocking

Automatic interlocking has been successfully installed to protect railroad crossings where no protection previously existed and, as well, to take the place of manually controlled interlocking plants. While a great many such plants have been installed in the past 10 years there are yet many locations where such installations will not only pay big returns on the expenditure but speed up train operation with safety. Such installations should be made with due regard to local switching requirements, number of train movements and speed of operation.

The consolidation of interlocking plants has received some attention during the past ten years, but I am of the opinion that there are yet many places it can be done to effect economy of operation and at the same time serve the interests of safety equally well as though plants were individually operated. Until the advent of centralized traffic control and relay type interlocking there were definite restrictions on the amount of territory that could be included in the control from one interlocking machine. An example of what can be done is found in what was done at Dayton, Ohio, where in 1932 one machine located at a central point was installed to control a territory that had previously been partially controlled by 5 interlocking machines and switch tenders. This made possible the transfer of 33 men to other duties.

Yard Operation

One of the problems affecting the transportation of freight from the consignee to the consignor is the movement of freight cars through yards at terminals where they must be inspected, sorted out and classified so they may continue on their journey with a minimum loss of time. It is evident that it does little good to move cars over the road between terminals in record time if they are to be allowed to set around in yards a long time. Classification was first done by what was called flat switching, then, in most of the larger yards, by gravity switching over humps. In case of gravity switching it was necessary to provide riders to operate hand brakes on cars after they were pushed over the hump. This was not only a hazardous occupation but involved much damage to equipment and lading; also, on account of the necessity of waiting for men to be returned to the top of the hump, there was a definite limit on the number of cars that could be classified in a given time. In 1924 the Indiana Harbor Belt made an installation of a retarder system on the hump at Gibson Yard which supplanted the hand brake operation by car riders. Not only did this installation eliminate the personal hazard but it demonstrated that a system of this kind could be used to increase production and materially reduce the cost of operation of a yard. A number of installations have been made since 1924 and a study by the Signal Section of the results from their operation has shown that a return of from 7 to 67 percent on the investment has been made. The average return on 16 installations according to the Signal Section has been 42 percent. These savings are not necessarily all at the yard where the retarders are installed as it is frequently found that switching at other yards can be reduced when retarders are installed nearby. Naturally, if there is business to justify full time operation of retarders the cost per car will be less than with part time operation; however, the possible savings involved warrant careful consideration of installing retarders where part time operation is all that is necessary to take care of the business.

Now that we have talked of so many material things, it would be well to say a few words about the signal engineer and the organizations that make all of these wonderful signal systems possible both from the standpoint of manufacture and from that of maintenance. The manufacturers have been alert to take advantage of every suggestion made by the railroad man to improve old devices and to design new ones to take care of new situations and changing conditions of train operation. The result has been that modern signal apparatus is extremely reliable and as near safe as it is possible to make it. In addition, these new devices, complicated as they may appear, are easy to maintain and simple to operate. It is significant to me that the causes found for signal failures today are just about the same as we had 25 years ago, the only difference being there are not so many of them now.

The signal engineer used to be sort of a glorified mechanic but he is now more and more an important factor in the operation of a railway. It behooves him to devote as much of his time as possible to the study of operating problems and make for himself a real place in the railroad picture. Surely no other railway employee ever had a better opportunity to show what can be done by his organization in the way of improved train operation.

Speeds have increased tremendously during the past few years and there are no indications that we have reached anything like the limit yet. One of the essential things needed to enable trains to be operated at high speed with safety and economy is an adequate signal system. We have all of the parts available and all that we have to do is to pick out the right ones, put them together into the type of system appropriate for the traffic available and keep the railroads in the race.

Alton Petition Denied

The petition of the Alton and the Baltimore & Ohio for permission to replace a mechanical interlocking plant at the crossing of their lines at Ashland, Ill., with an interlocking color-light signal combined with a swinging crossing gate, has been denied by the Interstate Commerce Commission without prejudice to the right of the petitioners to submit a new proposal providing for adequate protection. The change was opposed by representatives of the train and engine service brotherhoods, and other employee organizations on the ground that it would result in decreased safety of operation. The commission found that the situation here considered, in view of the surrounding circumstances, including the traffic involved, the physical characteristics of the track and the type of equipment used, did not justify the commission in requiring the use of the present plant or the continued use of derails at this crossing.

In one important respect, however, the commission found that the proposed change did not provide a satisfactory substitute for the present interlocking plant, and that in its opinion the installation as proposed would result in departure from standard signal practice and decrease signal protection at Ashland. The commission commented as follows: "The existing interlocking home signals located several hundred feet from the crossing on both railroads now provide definite stopping points for approaching trains, and those signals, together with the derails, prevent a train from entering upon the crossing when the route is set up for a conflicting movement, or if the crossing is occupied by a train on the other line. Under the proposed arrangement, these signals and derails would be removed on both lines. On the Baltimore & Ohio, stop signs would be placed at a point 200 ft. from the crossing on each side thereof. With the gate swung across the Alton track, when approached from the east the gate itself would display a red light and a similar light would be displayed at the top of the mast which carries the gate, thus providing a definite stopping point from this direction on the Alton. Approaching the crossing from the west on the Alton, the light on the gate would be invisible if the crossing were occupied by a train on the other line, and no definite stopping point short of the crossing is provided for Alton trains from the west under the proposed plan. In the absence of derails, an Alton train approaching from that direction could foul or proceed upon the crossing without passing a stop signal. We find that the proposed arrangement is contrary to standard signal practice and decreases rather than promotes safety of operation."