Non-Interlocking Non-Stop Grade Crossings

A Proposed Signal Layout to Control Train Movements Automatically at Intersection Points to Prevent Train Stops

By L. B. PORTER,

Assistant Signal Engineer, Chicago, Milwaukee & St. Paul, Milwaukee, Wis.

A GREAT deal has been said from time to time about the economies that can be effected through the use of interlockings. Although it is well recognized that the installation of interlocking plants increases the safety of train operation, this is not the main reason for their installation. The large number of non-interlocked crossings, junctions and terminals throughout the country, over which thousands of trains are moved daily with a reasonable degree of safety and comparative freedom from accident, proves conclusively that interlockings are not necessary from the standpoint of safety alone. It must, therefore, be concluded that the consideration of prime importance in providing an interlocking plant is the saving that will be effected thereby. Practically all of the deciding factors in favor of interlocking resolve themselves in the final analysis into the one big item of economy.

Elimination of Unnecessary Train Stops Means Reduction in Transportation Costs

The economy to be effected through the use of interlocking comes directly from the elimination of train stops. The elimination of unnecessary stops permits faster passenger train schedules, increasing the prestige of a road and permitting it to compete with rival roads on the basis of the same speed schedule. The elimination of train stops also reduces the fuel consumption and the wear and tear on equipment and results in a general improvement in train operation with a corresponding reduction in the time required for a train to get over the division. These last mentioned considerations are especially important in the case of heavy freight trains, as a stop often means damage to equipment, causing considerable delay.

Unfortunately, the cost of stopping and starting a train cannot be determined exactly. The loss in prestige and from unfavorable advertising by the traveling public, due to numerous unnecessary stops, cannot be measured in dollars and cents. The quota of general expense for repair and renewal of equipment, directly chargeable to wear and tear brought about by unnecessary stops, cannot be arrived at accurately. The extra fuel consumption for stopping and starting a train at a given point could be determined by actual test, but this, too, will vary, depending upon the tonnage hauled, the ability of the fireman and engineman, the condition of the locomotive, the curvature and grade of tracks and other local conditions. Apparently the general expense of stopping a train cannot be directly apportioned in any practicable way any more than can the cost of moving an individual carload of an entire train. While the factors in the general saving may be more or less variable, nevertheless the saving resulting from the elimination of unnecessary train stops is real and can be estimated with some degree of accuracy.

Careful studies, calculations and tests have been made at different times to determine the cost of stopping trains. Several years ago it was estimated that 45 cents would represent the average cost of stopping a train. This amount was arrived at after taking into consideration the difference in tonnage and speed of various classes of trains, and it was considered a conservative estimate for all classes of trains. Using this figure as a basis, it was felt that an interlocking plant would be a paying proposition where 20 or more stops per day would be avoided. Interest and depreciation charges, maintenance and operation costs for the plant were all included in the formula used. Undoubtedly the actual saving if it were possible to figure it, would more than verify this conclusion.

Today the cost of stopping the average train is much higher, but the cost of installation, maintenance and operation of a complete interlocking plant has also increased so enormously that it will require careful figuring to show any economy in favor of the interlocking, unless the traffic is quite heavy or the local conditions for stopping and starting trains are unfavorable. There are a great many non-interlocked, simple railroad crossings and junctions on second class divisions where the traffic is not heavy enough to warrant the expenditure for interlocking. There are also similar plants on these divisions where interlockings were installed several years ago when the circumstances were different, which, under present day conditions, are probably not being operated at a profit.

Substituting Automatic Signals for Interlocking

The main items of expense connected with an interlocking plant are the operators' salaries, tower supplies and maintenance of the movable parts of the plant. If these items could be eliminated there is no question but that it would pay to prevent unnecessary train stops at crossings or junctions, even though the traffic were comparatively light. Obviously it is impossible to eliminate these items and still retain an interlocking of the type which permits the passage of trains without stopping.

The question then arises: Would it be possible to substitute any other arrangement, less expensive, in place of the complete interlocking? It has been truly said that "A problem is half solved when correctly stated." The statement of this problem is: To provide a system of signal indications for governing train movements at railroad crossings and junctions, so arranged as to prevent simultaneous conflicting movements and not to require manual control except possibly during certain periods. There would be no objection to speed restrictions at these points, although the full train stop is to be avoided except where one train must give preference to another. The solution of this problem is: An automatic signal arrangement with selective controls for the signals and with certain modifications of standard signal circuits now in use.

The stopping of trains before reaching any railroad crossing or junction at grade is required by the law, unless certain safeguards are provided, in which event the state laws grant non-stop privileges. The following is taken from one of the state laws relating to stopping trains at crossings: "Every company operating a railroad shall cause all trains on such railroad to come to a full stop, not less than 10 nor more than 60 rods before reaching any railroad junction or crossing at grade, unless such stoggage is rendered unnecessary by an interlocking plant *or other device* approved by written order of the commission or by the court upon appeal." The statutes in other states are usually drafted along the same general lines as the one quoted.

It will be noted that an automatic arrangement of signals may be approved at the discretion of the railroad commission and that the different forms of interlocking heretofore used almost exclusively are not the only forms of protection that could be considered. The writer knows of one state where the commission's engineer has stated that an automatic signal arrangement would be approved in lieu of interlocking protection for the ordinary simple crossing or junction. Furthermore, several actual installations of this nature have been made in other states where the commissions have given their approval and the crossing or junction stop has been eliminated.

Application of Automatic Signal Arrangement at a Junction

As an example of what it would be possible to accomplish in the way of using an automatic arrangement in place of an interlocking plant, let us consider a simple junction of a single track line with a double track line, such as illustrated in Fig. No. 1. There are numerous junctions of this kind located at outside points, away from towns, where there is no station work, and as the double track line is equipped with automatic block signals, and as the distance to stations on either side of the junction is not very great, there is no necessity for maintaining a telegraph or block office at the junction point. The traffic on the branch line is of minor importance. In some cases it is of such a nature that there would be no objection to or hardship in having train crews handle their own switches. In other cases the train movement can be almost entirely confined within an eight or nine hour period, so that one operator can handle the switches

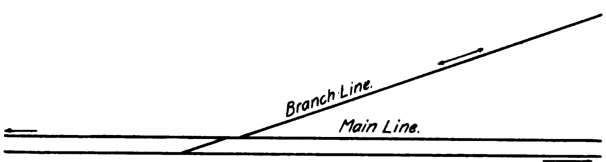

Fig. 1. Junction of Single With Double Track Line.

for the few train movements involved. Yet at present a complete interlocking plant operated by three levermen is maintained not because traffic on the branch line requires it; not because an open office is required on the main line; not because safety requires it; but because this is a junction point and the state law specifies that all trains must make the stop unless an interlocking plant "or other approved device" is provided, and the road cannot afford to stop its main line trains. Were it not for the semi-automatic features of the home signals and the objections to leaving an interlocking plant unattended, the routes on the main line would be left normally lined up during the greater part of the 24-hr. period and the tower would be closed.

Bearing in mind that the interlocking now in use is not required primarily to handle the switches for the branch line, but that its main function is to permit main line trains to pass without making the prescribed stop and to safeguard such movements properly, would it be possible to dispense with the interlocking and use automatic signals instead? An arrangement of signals similar to that shown in Fig. No. 2 is suggested.

The crossover and junction switches are hand throw and are operated by operators employed on one or more shifts as conditions may require, or by trainmen if the branch line traffic permits. Signal No. 2 governs movements from the main track to the branch line and clears up automatically when both crossover and junction switches are thrown. Signal No. 4 clears up when block sections *"B"* and *"D"* are unoccupied and the junction switch is thrown. Signals No. 1 and No. 3 govern main line movements and are controlled the same as standard double track automatic block signals in all respects, except that signal No. 3 (and its distant signal) will show CAUTION with a train approaching on the branch line in section *"C."* The crossover and junction switches must, of course, be in the normal position for the main line

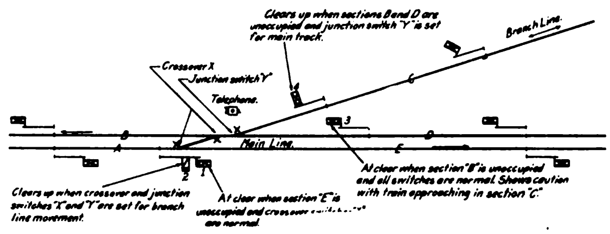

Fig. 2. Automatic Signal Arrangement at Junction

signals to clear. The selection of controls through the switches prevents the simultaneous clearing of conflicting signals and takes the place of an overlap. If desired, signal No. 4 could be made a normal-danger signal with a short clearing section, so that it would not clear up until a train had nearly reached it. This would have the effect of imposing a speed restriction on main line trains approaching the junction from this direction. Switch indicators would be provided on roads using this type of apparatus so as to prevent the throwing of switches in the face of approaching trains.

Trains on both the main and the branch line are operated under one dispatcher and under the same time card; therefore, a movement from main line to branch line *"A"* to *"C"* would be identical with any crossover movement in automatic block signal territory and would have the same signal protection. If the switches were handled by train crews, signal No. 2 would probably not be required. During the hours that an operator might be on duty at the junction there would be no difficulty in taking care of movements from the branch to main line, since he would be fully advised as to main line movements. At other times trains on the branch line would get information regarding main line movements from the last open office on the branch, and before making any move to come out on the main line at the junction, would get in to telephone communication with the dispatcher or operator at the main line station and first get the necessary authority for the movement. If the telephone communication should be interrupted for any reason, or signal No. 4 should fail to clear, the movement onto the main line would have to be made under the protection of a flag.

There would, of course, be other ways of handling the movements from the branch to the main line, such as requiring the lapse of a time interval after throwing the junction switch before a train fouls the main track so as to provide a longer overlap, or a track circuit overlap might be used for the main line as well as for the branch line signal. An electric lock could be provided on the junction switch, which would be controlled through approach sections on the main track, to prevent throwing the switch with the main line train approaching. A derail might be provided on the branch line to work in connection with the main line switch and the electric lock to insure branch line trains stopping back of the fouling point. However, if proper discipline is maintained, these additional features should not be necessary.

Advantages of the Automatic Arrangement

The proposed automatic arrangement would give practically all of the non-stop advantages of an interlocking plant for main line movements and at a much lower cost.

It would be possible to dispense with from one to three levermen and the cost of maintenance and operation would be much lower than for an interlocking plant. A smaller investment would be required for the automatic arrangement, which would reduce the taxes, the interest and depreciation charges. Delays to traffic due to the failure of the complicated electrical features of modern interlocking plants; and delays due to the difficulty of keeping switches, derails and movable parts of plant free from snow and ice, would be decreased. An automatic arrangement is usually more flexible than an interlocking plant. Taking all of these features into consideration, a conservative estimate of the saving would be from $300 to $800 per month in favor of the automatic arrangement, depending upon the number of men required to handle the switches.

Disadvantages of and Objections to the Automatic Arrangement

It is admitted that movements to and from the branch line may be somewhat handicapped under the proposed arrangement, especially if trainmen have to handle their own switches; but only junction points where facility in handling the branch line traffic is of minor importance are being considered in this discussion. The first and main objection to the proposed scheme perhaps would be that safety in train operation would be sacrificed, as derails could not be used with an automatic arrangement. Apparently there is a difference of opinion regarding the value of derails in main tracks. It is a well-known fact that there are a large number of interlocking plants throughout the country at crossings, junctions, yards and terminals, where no derails have been provided. At some of these plants the speed of trains is high, while at others it may be somewhat restricted. These plants without derails, the number of which is constantly increasing, cannot be considered unsafe by any means. On the contrary, the view seems to be gaining ground that the derails are no longer considered necessary, except at special locations. Indeed, it seems probable that derails have done more positive harm in causing unnecessary derailments, when no danger existed, than the good they may have accomplished in preventing accidents.

The function of the derail is two-fold: It has a moral effect on the enginemen in causing them to be more alert and ready to observe and obey the signal indication from the fear of the serious consequences of a derailment; it also performs the useful function of preventing possible collisions in case the engineman has lost control of his train and is unable to stop at the governing signal. It undoubtedly would be advisable always to retain the derail at certain locations where there are especially unfavorable conditions to be contended with, such as a descending grade or a poor view of the signal. At such points an automatic arrangement could not be used, but it would seem that under ordinary conditions in this day of advanced signaling practice, when trains are governed almost entirely by signal indications, when surprise tests are made regularly, and rules rigidly enforced, the main track derail could be dispensed with almost entirely.

Are the chances of accident any more numerous or would the consequences be any more grave were a train to disregard an automatic signal at a junction point where no derail is used than if it should disregard a distant signal governing the approach to a governing over a signal derail; or if it should disregard the CAUTION indication of an automatic signal, when running at 60 mi. an hr. two blocks behind a first-class passenger train that had stopped just out of view around a curve and the flagman failed to perform his duty; or where the automatic signal was at STOP due to a piece broken out of a rail; or where it was due to a misplaced facing switch or an open switch point? Would the consequences be any more grave than if the engineman failed to observe a train order signal, a staff signal, or a controlled manual signal and the train proceeded on its way against an opposing train?

The argument may also be advanced that an automatic signal at a remote point is more likely to be disregarded than a manually controlled signal; also that the proposed scheme would require occasional movements to be made under flagging protection and that this could not be depended upon. Now these are conditions depending upon the discipline a road maintains. However, the odds are in favor of there being no accident at the junction, especially if an operator is employed to handle all or most of the regular movements, as against the chances of an accident at an automatic signal governing movements into a station where considerable switching movements are made daily. To admit either of these arguments is to admit a fundamental weakness in the discipline that is maintained and that train operation under the automatic block signal system is not safe on such a road.

Application of Automatic Arrangement at Crossings

The use of automatic signals to govern train movements over a railroad crossing would involve some complications not encountered at the junction point, for the reason that in most cases the line crossed is owned by another company and train operation is entirely independent on each road, there being no common time tables in use, and trains on one road have no knowledge of the time of arrival of trains on the other road. There are train movements in four different directions to be taken care of, whereas, at the junction practically two movements only had to be considered, and one of these does not involve any special features. To prevent simultaneous conflicting movements at the crossing, full track circuit overlap protection in all four directions is necessary. The complications at the crossing are more serious as the traffic becomes heavier. But there is a certain class of crossings where it would be possible to work out an automatic arrangement that, for all practical purposes and within reasonable limits, would answer the purpose.

Take for an example a simple crossing of a single track road with a double track road, traffic on the double track road is heavy and it has been equipped with automatic block signals, while traffic on the single track is comparatively light. An interlocking plant has been installed and is maintained by the first-class road for its sole benefit, as the single track road would have no objection to making the crossing stop. The crossing may be at a remote point the same as the junction and the men who operate the plant are required for that purpose solely. While the plant may handle one or two passing track switches or a crossover, this is merely incidental, as the other passing track switches and crossovers on the division are not interlocked, and the main function of the plant is to avoid the crossing stop for the trains on the double track road. The traffic on the single track road often is of minor importance and in some cases it consists of the movement of one mixed train in each direction daily except Sunday. The writer knows of one case where it consists of only one regular train movement, down one day and back the next. Yet, in order to avoid stopping its trains, the first-class road has installed a complete interlocking plant, and because of its semi-automatic features and the objection to leaving it unattended, it is necessary to maintain three levermen to operate the plant continuously.

Looking at the matter from an unprejudiced and unbiased viewpoint, giving due consideration to safety, and bearing in mind the urgent necessity at this time of reducing operating expenses, it would seem possible and advisable to eliminate the derails and to substitute an automatic signal arrangement in place of the interlocking plant. If desired, an operator could be employed during the hours when regular trains on the second-class line were scheduled to arrive, who would handle the crossing signals so as to give preference to superior trains during the time he was on duty. The crossing signals would be equipped with number plates and operated as STOP and PROCEED signals, so that there would be no difficulty in closing the office at any time.

An arrangement of automatic crossing signals for a simple crossing of the kind under discussion, where traffic on one road is of minor importance, is shown in Fig. No. 3. All crossing signals stand normally at "Stop." Signal No. 1 clears up when a train enters the clearing section at "*E*," provided its immediate block is clear and track sections "*A*" and "*B*" on the other road are unoccupied and signals No. 3 and No. 4 are at STOP. Signal No. 1 is controlled through a stick relay in such a manner that after it has once cleared and a train has passed

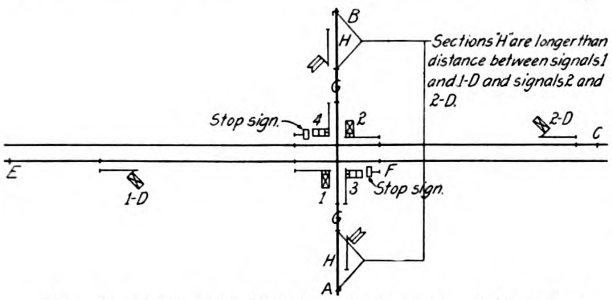

Fig. 3. Automatic Signal Arrangement at Crossing

distant signal No. 1-D at clear, the approach of a train on the single track line will cause this signal to indicate CAUTION only, so as to avoid tripping the signal in the face of a train. Signal No. 1 would, of course, in all cases be controlled to the STOP position by the track circuit between signals No. 3 and No. 4. Signal No. 2 is controlled in the same manner as signal No. 1. Signals No. 3 and No. 4 clear up when the train is on the short clearing section "*G*" (this control being directional), provided track sections "*C-D*" and "*E-F*" are unoccupied and signals No. 1 and No. 2 are at STOP. No signals are provided for the reverse current movements on the double track. When such movements are made, the regular crossing stop would have to be made. It will be noted that the simultaneous clearing of conflicting signals is prevented by overlap track sections and the control of each signal is carried through normally closed controllers on all conflicting signals.

The proposed arrangement could, of course, be modified in many different ways. In case an operator is employed during certain periods, some of the automatic control features could be replaced with manual control. If desired, the crossing signals on the double track road could be controlled through short clearing sections immediately in the rear of the signal, the same as proposed for the single track road, which would act as a speed restriction in requiring trains to come almost to a stop before the signal would clear. Or if desired, operative distant signals could be provided on the single track line together with preliminary clearing sections and full overlaps on both roads.

An arrangement of similar nature could be used at single track crossings, although it would, of course, be necessary to provide crossing signals for movements in both directions on both lines. The directional control features of absolute-permissive signaling could be used to a good advantage and the circuits could easily be combined with a standard single track automatic signal control scheme. It is not necessary to go into any of the details for the proposed layout, as the arrangement would vary, depending upon local conditions, the amount and nature of the traffic, and the standards used on the individual road. Standard automatic signal apparatus could be used, making it a comparatively simple matter to design the actual circuits. The advantages, disadvantages and objections applying at the railroad crossing would be practically the same as outlined for the junction point, although it is admitted that train operation at the crossing is more complicated and hazardous, consequently additional safeguards would have to be provided to meet the requirements.

Conclusions

The railroads of our country today stand committed to a policy of efficiency and economy. This policy is not due to local events on any one road, but it is the culmination of great forces that have been at work in our national life for the past few years. In line with this policy the signal engineer should, as pointed out in a recent issue of the *Railway Signal Engineer,* "Drop old established precedents, where necessary, and adopt any new device that will expedite efficiency." There are numerous non-interlocked crossings and junctions where the initial expenditure for an interlocking plant would hardly be warranted, even if it were possible to obtain the necessary funds, and the cost of after-maintenance and operation of the plant would overbalance the saving resulting from its use. A study of conditions at these points in many cases would show it to be possible to use an automatic signal arrangement, thereby promoting economy and efficiency. Where an interlocking plant would cost from $20,000 to $30,000, the automatic arrangement would cost from $4,000 to $5,000. There are also opportunities for reducing operating expenses at points in automatic signal territory where plants are now maintained. The main consideration is to eliminate the derail where this can be done with safety and to make the governing signals automatic in their operation. If this makes it possible to dispense with even one leverman or to eliminate some Sunday time, it will result in a considerable saving. In many cases the existing plant can be modified to accomplish this.

Permanency and Harmony of Design Are Well Illustrated in the Lackawanna Tower at Montclair, N. J.