

The advantages gained by this installation are: (1) Making available track 4 for run around movements; (2) The saving of accumulated delays during peak load

periods on the existing two outbound tracks; (3) The schedules have been made more flexible by this arrangement and the delay to certain trains eliminated.

# Train Operation by Signal Indications— Especially by Cab Signals

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**I**N my paper on the results of the test installation of train control on the Sunbury and Williamsport Divisions of the Pennsylvania Railroad, presented at the Meeting of the Signal section, September, 1924, a statement was made which was, in part, as follows:

"The wayside signals are two-position position-light and indicate Stop or Go. Combination of the cab and wayside signals gives us, therefore, Authorized, Restricted, Slow and Stop.

"The cab signals give good service and are as reliable as the wayside signals and it is my personal opinion that, if any additional safeguards are required or justified, in order to handle our traffic safely, expeditiously and economically, as required by law and desired by every one, the addition of these cab signals will, with the type and character of men who run our trains, provide as much protection as the complicated apparatus required for any system of train control and more protection than the straight stop with the permissive feature, excepting in the case of a train with an engineman gone suddenly crazy and the fireman not knowing it, and in the case of either control or stop, an engineman and fireman both absolutely incapacitated, a contingency less likely to occur than a failure of the apparatus to apply the brakes."

We are continuing the development of the three-speed continuous train control on the Lewistown branch, and we are proceeding with the installation of an automatic block system on the Baltimore-Harrisburg line, "using signals without moving parts spaced for future installation of continuously controlled cab signals and for trains running with closed throttle at maximum authorized speed . . . controlled by alternating current track circuits to reduce foreign current interference to a minimum, and including in the installation flashing lights . . . indicating the approach of trains" at many grade crossings. On this we are superimposing cab signals giving three indications and arranging for a straight stop with forestalling feature on the locomotive, the latter in accordance with the requirements of the Interstate Commerce Commission revised in July, 1924.

The cab signal will be the same as that in use on the Lewistown Branch, and will operate so as to show "A"—Authorized—when train is running in a clear block under clear signals; forestalling being required to avoid brake application on each change to a less favorable indication, so that, if one train is following another, and the engineman does not forestall, a stop will result: (1) when it passes an approach signal back of the leading train, having had an "A" cab indication before reaching the signal: (2) when it passes a stop signal and enters the block occupied by the leading train, having had an "R" cab signal before reaching the stop signal. In case No. 1, if the leading train clears the block ahead before the following train reaches the signal protecting that block, that signal will, of course, change to an approach signal and the cab signal on the following

train will at once change from "R" to "A," and, when passing the signal, back to "R." In case No. 2, as soon as the leading train clears the block occupied by both trains, the cab signal on the following train will change from "S" to "R" and, on passing the signal ahead indicating stop, back to "S." Should a rail ahead of a train be broken, or a switch open, or the track short-circuited in any way, the cab signal would immediately change to "S," and a stop result unless the engine man is very alert.

## Records of Performance

An analysis of cab signal performance, separated from train control performance, on the Lewistown Branch, during the 18 months from July 11, 1923, when the apparatus was placed in service, to January 10, 1925, inclusive, 5,337 trips, shows approximately 384 irregularities. That is one for every 14 trips, one in every 700 miles, one in every 840 sections. For the first nine months, there were 233, and the second nine months 151, showing that we have progressively developed and improved the apparatus and eliminated failures.

Of these failures, the roadside apparatus was responsible in the first nine months for 125 and in the second nine months for 72, a total of 197; the engine equipment in the first period for 108, and in the second period for 79, a total of 187.

The cab signal in service on the Lewistown Branch will regularly change momentarily when passing over the insulated joints between adjacent track circuits, the duration of this "flip" depending on the speed of the train, but, in any case, it is not of sufficient duration to be interpreted as a change in indication, it is thereby self checking. Only when it continues after the joints have been passed would it be observed by the engineman as a change in indication. This change is most noticeable on single track lines where direction must be established by the moving train as it shunts the successive track circuits.

The smaller number of failures during the last half of the 18 month period is explained by the fact that the "bugs" always present in a new development are gradually being eliminated. Improved methods of engine wiring and better grade of wire, as well as a better knowledge of what must be most closely watched in maintenance, are items responsible for this reduction. Improvements in the headlight generator, which are expected to result in a more uniform voltage, should still further reduce this trouble. Broken filaments or other defects in amplifier tubes and ballast lamps are inevitable but regular tests and improved knowledge of what service to expect will keep this trouble at a minimum.

## Advantages of Cab Signals

Many of the fixed signal units now display four aspects and, by combination of two units, additional ones are provided. The cab signal as at present developed gives only three. It may be substituted for the ordinary three-

position signal indicating Stop-and-Proceed, Proceed, and Approach Next Signal Prepared to Stop, but is incapable of displaying the aspects considered necessary on many of the railroads at interlockings, and it cannot be used as an adequate substitute for the method of signaling which gives definite information of the condition of three blocks ahead, or to indicate Approach Next Signal at Restricted Speed, an aspect frequently displayed approaching an interlocking with long crossovers; consequently, in the present state of development, a less favorable indication must be used on the cab signal at such points, but where an automatic stop is used with

the forestalling feature in the hands of an expert and alert engineman, it need not be anticipated that train operation will be greatly retarded.

The cab signaling we use has the same basic principles as the roadside signaling—that is, closed continuous circuit and the light signals without movable parts, and this is one of the reasons why the design can be considered as safe as that of the roadside signal, although, in its present development, it is more liable to so-called safe failures, it being subject to practically all the failures incident to the wayside signals in addition to these caused by defective apparatus on the engine.

## Dispatching Trains by Signal Indication

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**R**UNNING trains by signal indication instead of train orders, substituting signal indication for train order, presents the biggest opportunity for reducing costs offered the railroads in years. That's a pretty broad statement, but I make it with a very fair knowledge of what is being offered the carriers in the way of improvements to locomotives, cars and track, and I repeat it with emphasis that the facility you are now discussing: Substituting signal indication for train orders—will do more to put and leave money in the treasuries of your companies than anything now offered the railroads and the problem and opportunity is peculiarly yours.

Few people other than those who have had actual experience in moving trains understand or appreciate the intricacy of train rights and the details of advancing trains by train order.

The securing of the superior train, sending the order to all concerned, getting the acknowledgement, repeating it, reading it to the operator by the conductor, carrying it to the engineer, reading it to the conductor by the engineer, arriving at a mutual understanding of their rights and all before it can be acted on.

When the requirements of the trains can be anticipated and the trains orders issued in advance, this detail need not delay them, but it is often impossible to tell in advance when a freight train will be ready and in a discouraging number of cases so much time has been consumed getting the order that the train cannot make the move and clear some superior train, and the orders must be annulled or torn down and built up again, repeating the same routine.

Furthermore, and this does not appear in any record, only he train dispatcher knows how often he lets trains lay at sidings because by the time he could get out the order the train could not clear some superior train at the next siding, when again if it could move without this delay he could advance it at least one siding often making several hours difference in reaching the distant terminal.

Neither do many appreciate that these delays are progressive and that the ratio multiplies faster than the traffic. On light lines the necessity for train orders and the number of orders per train are negligible, but as the number of trains increases, the necessity for train orders increases and at an even greater rate, and so rapidly that in many places double track has been imposed long before the volume of traffic justified the expense.

There are doubtless some here who are asking themselves why the necessity for all of this red tape now that you have automatic signals? If this delay is so expensive,

why continue it? Why not simplify the system and cheapen the operation in that way rather than assume the expense of installing additional facilities, and the answer is that these details were all, every single one of them, developed in the interest of safety following accidents and years of study.

You must understand that what I have so briefly outlined are but a few of the highlights of the development of years and that for the first 70 or 80 years of railroading, many experienced operating men were constantly at work on this problem of providing ways and means to move first with safety and then with reasonable despatch, trains on single track railroads.

However, even this outline shows the principle around which train rules are built. First, clear the main track and forbid its use except on proper authority; then as trains are authorized to use it, protect them from one another and at the same time provide a way for them to find their own way about by giving them different values—i. e., superiority by class, by direction and by train order plus rules requiring inferior trains to clear superior ones.

The makers of these rules that have done so much to make transportation safe and practical, the makers of what we know as the Standard Code of Train Rules, have never had a tithe of the credit due them. For profound study of the thing to be done, of conditions to meet, of ways to meet them, of rules simple and explicit, the Standard Code has few equals.

You must remember, too, that the later generation of these rule makers are still in the saddle, largely as executives, and that their fellow executives have grown up in the same school and it follows that anyone offering a substitute for any part of these tried and proven methods of handling trains must know his subject and have something of real merit to offer.

This brings us to the question of what you have to offer as an improvement. Something as safe as the double order system, which is sponsored by the A. R. A. for handling trains on single track, plus the protection offered by modern automatics, and of course you would choose nothing less.

Can you meet these standards? Have you a substitute for train orders to offer your companies that will preserve all of the safety and eliminate the delays? And the answer is that with the help of the signal companies you can do both. In fact, you can do more, very much more. You can make lap orders mechanically different if not impossible, and if you care to go still further and include train control, you remove the last vestige of an excuse for train orders.