Results of Train Control Test on Pennsylvania

By A. H. RUDD
Chief Signal Engineer, Pennsylvania Railroad, Philadelphia, Pa.

THE first automatic stop in America was patented July 13, 1880, being invented by Messrs. Joseph Wood and Axel S. Vogt of the Pennsylvania Railroad This device with a glass tube on the locomotive so arranged as to strike a track trip was tried out on the middle division. The apparatus was modified to go on top of the cab in March 22, 1881, but this system was abandoned in 1883, after having stopped a passenger train in a tunnel on account of an icicle breaking the glass tube. The electro-pneumatic trips were installed on the New York Terminal, East and North River tubes in 1910 and half a dozen were placed out of doors. This equipment is still in use.

In 1912 the Cain-LeBarr apparatus was demonstrated near South Philadelphia and as it stuck clear, it was soon discontinued. The Gray-Thurber intermittent track circuit, insulated locomotive truck type was installed on 12 miles of track west of Pittsburgh in 1912, but discontinued in 1914.

The Union Switch & Signal Co. ramp type was placed on a track opposite from Gray Thurber installation in 1913, but was removed in 1915 and the manufacture abandoned. The Finnigan intermittent induction type was tested on the New York division near Elizabeth, N. J., in 1914. After several experiments it was abandoned in May, 1915, although efforts were made on further developments until 1917.

Arrangements were made with the Simmen Automatic Railway Signal Co., in 1914 for a trial near Philadelphia on the Maryland division. The General Railway Signal Co. acquired the rights to develop the system for the Brooklyn Rapid Transit Co., but declined to make a trial installation at its expense, and the project fell through.

As the Interstate Commerce Commission kept urging tests, in 1918 we applied for funds to try out the Union Switch & Signal Company's continuous control between Swissvale, Pa., and Brinton. The Railroad Administration refused the appropriation. Apparently government officials were not a unit as to the urgent necessity for train control. Tests of six devices and the attempted test of two more, covering a period of 37 years, were all undertaken and terminated (except the use of trips in tunnels near New York) prior to the issue of Order No. 13413. The Pennsylvania at least hardly merited the censure handed out promiscuously to the railroads for not attempting to develop an automatic stop.

The tentative Order No. 13413 was issued January 10, 1922. On February 8, the Pennsylvania presented a proposal to the Interstate Commerce Commission for an installation on the Lewistown branch and part of the Williamsport division. On February 21, Commissioner McChord wrote to our vice-president Atterbury in part as follows:

"I am authorized to say that the commission, after fully considering the matter, is of the opinion that the test of the device selected by the Pennsylvania for installation on its Lewistown division between Lewistown and Sunbury, Pa., should be completed by July 1, 1923, and that in the interim the work of installing an automatic train control device upon a passenger locomotive division of the Pennsylvania Railroad between Philadelphia and Pittsburgh, Pa., may be postponed. * * *

"The specifications and requirements laid down in the proposed order, the provisions therein relating to the filing of plans, reports, etc., with the commission on or before July 1, 1922, the requirements as to progress reports thereafter and all other provisions of the order, will apply to the installation on the Lewistown division.

"Appropriate modification will be made in the final order in accordance with the opinion of the commission herein expressed.

C. C. McCHORD, Chairman."

The commission, however, did not extend the time for finishing the installations provided in the first order.

Acting upon this letter, we immediately organized to undertake the work; a committee, consisting of representatives of the signal company, system motive power and signal departments, and regional motive power, operating and signal departments, was appointed and in less than two weeks—viz., on March 6—an inspection of the line was made by the committee and other railroad men, three representatives of the Interstate Commerce Commission, and three of the signal company.

On March 24, a full set of signal plans and list of engines to be equipped went to the commission, and on April 3, electrical equipment for the first engine was received. On April 26, we completed the cleaning of cinder ballast on the entire division by blowing it from under the rails by live steam from the engine, this apparatus having been especially designed for this purpose. The first engine was equipped with electrical apparatus and put in service on April 26, to test the ruggedness of the apparatus and the effect of the a.c. track circuits from Selinsgrove to Sunbury.

Work on the ground was started two weeks after Order No. 13413 was issued, and the first circuit was energized June 22, 1922.

An official inspection and test was made by the committee and manufacturers and Messrs. Harland and Mills, representing the Interstate Commerce Commission on October 11, 1922. Track and wayside apparatus was finished and all placed in service during May, 1923.

As a result of tests after October 11, 1922, several changes were made in the engine equipment. The installation being completed late in June, 1923, within the time desired by the Commission. The entire line was placed under train control operation and the use of block signals and train orders discontinued July 11, 1923 and it has been so operated ever since.

A request that the Commission inspect was made July 20, 1923, being refused by the Chief of Signals and Train Control July 25, 1923, on the basis that the period for intensive tests had expired, and it was still in the experimental stage." A formal petition for inspection made August 28, 1923, was sent September 12. Notice of denial by the Commission was received October 3, 1923. A second formal petition to the Commission for an inspection and approval was made June 5, 1924, being granted on June 21, 1924. The inspection started September 16, 1924, fourteen months after the installation was placed in service.

Petitions for an extension of time for the completion of the installations on other parts of the railroad covered by the first and second orders No. 13413 have been denied.

Reasons for Selecting the Type Installed

Order No. 13413 cited three systems of train stops, all of the ramp type, as in successful operation. The permissive feature was a component part of two of the three. The requirements of Order No. 13413 did not allow the use of the permissive feature. This left two

Digitized by Google

alternatives, i. e., straight stop or speed control. Consideration of the first was, of course immediately eliminated for reasons well known to all railroad members of this section as to require no further comment; they are, however, given in Appendix "A" to this paper. Nothing remained except train control. Consideration of ramps was eliminated for the same reasons that presumably caused most of the other railroads to take similar action; some of which are also set forth in the appendix referred to.

Our interlockings are signaled for three speeds. A considerable proportion of our main lines east of Pittsburgh are equipped with alternating current track circuits and both are standard for new work and renewals. The Union Switch & Signal Co.'s continuous track circuit control with three speeds and a.c. track circuits, and the development of which we had known about for some time previous, seemed to be that most available for our purposes. An arrangement was, therefore, entered into for co-operative development between the railroad, the signal company and the Westinghouse Air Brake Co.

The proposition to operate without signals was advanced by our operating vice-president. The analysis our committee made is well set forth in the Report of Committee-X, pages 52 to 55 inclusive of the Advance Notice of this meeting, and the conclusion reached was identical, namely, "The only wayside signals required are those located where trains may be required to stop and stay until authorized to proceed, or where desired to give orders or instructions". The installation is in accordance therewith.

A modified A. P. B. system is in use on the western half of the branch, and dispatchers remote control on the eastern half, while the double track section on the Williamsport division has the train control superimposed on the a.c. automatics and at the interlockings previously in service, using position-light signals.

The Lewistown branch was selected in order to give the apparatus the most severe test compatible with safe operation. Not knowing the effect upon traffic, and not wishing to have it condemned by the public on account of serious delays to passenger trains and perhaps accidents to freight trains, a single track line of light traffic was selected, in order that, if we did have freight wrecks, they would not affect trains on adjoining tracks and, if our service was hampered, the result to the general public would be minimized. We further realized that its operation on single track would be much more difficult than on the double track covered by the order and that, if we could accomplish this satisfactorily, the problems of three and four track operation would be readily solved. It was decided that, although not required for the operation of the branch, we would arrange the installation for three blocks down grade and two blocks up on the same track, restriction on curves, enforcement of slow speeds in conforming with local ordinances, automatic cutting in and non-automatic cutting out at ends of equipped sections, and in fact, that every complication and condition to be met on our system that we could think of would be reproduced, excepting only the effects on heavy freights.

Service and Reliability Compared With Automatic Signals

The cab signal consists of a box with three lights: S—slow; R—restricted; A—authorized speed; it like the fixed signals has no moving parts and is actuated by the three-position relay on the locomotive. This signal indicates the speed at which the train should be run, and under rules governing operation on the branch. Slow speed is not exceeding 15 miles per hour; restricted not exceeding 30 miles per hour for passenger trains and 20 miles per hour for freight trains, and authorized 40 miles per hour for freight trains and 60 miles per hour for passenger trains. We installed in addition a speed indicator to show how fast train was running. This was found unnecessary and removed.

The wayside signals are 2-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 enginman gone crazy suddenly and the fireman not knowing it, and in the case of either control or stop, an engineman and a fireman both absolutely incapacitated, a contingency less likely to occur than a failure of the apparatus to apply the brakes.

The engine signal apparatus is the culmination of 50 yr. of signal development. The pneumatic apparatus for actuating the brake apparatus is comparatively new and it is here to a large extent that future development must be made. It should, therefore, seem the logical and sensible course, if, as stated, any safeguards, in addition to our modern automatic signals and interlockings are justified by the facts, to first extend and modernize our automatic block signal systems, then install the continuous controlled cab signals, meanwhile developing the brake application by simplifying it if possible and then, if the proportion of accidents which these devices actually would prevent is large enough to warrant further additions, proceed to "paint the lily and gild the refined gold."

As for the pneumatic equipment: 12 locomotives were originally equipped with the centrifuge under the boiler; the thirteenth has since been equipped with the end-of-axle drive mounted on the front right end, and 2 or 3 are being equipped with centre-of-axle drive mounted at the middle of the pilot.

Failures and Improvements

We have had many days and some weeks with no failures. We have had very few failures to apply the brakes. We have had a good many brake applications where none was desired.

I understand that my testimony before the Interstate Commerce Commission at the recent hearings on second order No. 13413 gave the impression that our installation required constant changes and that in fact it was a failure. We have made a number of minor changes since the first apparatus was placed on the first locomotive just about two years ago, but more than half the locomotives are operating in service with practically all of the original design of equipment.

Important ones listed in appendix "C". We have made many improvements and we expect to make more, just as we have with practically everything on the railroad.

Effect on Track Capacity

The system has one point in common with all the others ever presented—it is absolutely interchangeable with whatever is interchangeable with it.

The Interstate Commerce Commission has iterated and reiterated that "the essential safety function of any au-

Digitized by Google

tomatic train-stop device is to stop a train where a dangerous condition exists ahead of the train, when the engineman for any cause fails to take proper action to stop", and requires that the stop device shall be operative at braking distance from the stop signal location if signals are not overlapped, or at the stop signal if an adequate overlap is provided. We have as yet had no ruling establishing a basis for this distance. Therefore, the effect is problematical.

We know that an overlap decreases track capacity to the extent of its length—whatever it is. We know that the straight stop without release, requiring each train with a home signal stop to receive an application at the distant signal, restricts traffic, and that if the permissive feature is applied it probably will not—this arrangement being somewhat analogous to installing approach locking and then providing a push-button for instantaneous release.

We know that our installation will not impede traffic as the first two arrangements mentioned will, and we know it is safer than the permissive feature, but we do not know what braking distance is, and would like to find out. Our track sections are laid out for braking distance with closed throttle for passenger trains at 60 miles per hour plus 20 sec. Our engine arrangement provides for 5 sec. for the engineman to acknowledge a change in signal.

We have demonstrated in practice what theory led us to suspect, namely, that a train will run further with an open than with a closed throttle and, in common with many other devices, ours does not close the throttle when brakes are applied. Unless some more devices are added to accomplish this, it is self-evident that, as the device is to function when the engineman does not, the blocks must be increased in length and, therefore, fewer trains can be run unless we can proceed on the assumption that a disabled engineman will always close his throttle before becoming disabled.

The Commission says in order No. 13413 quoting the Automatic Train Control Committee of the Railroad Administration: "A properly operated automatic block signal system adds to the capacity of a railroad by increasing the freedom and flexibility of train movements over it. This condition should not be unduly interfered with by the use of an automatic train control device."

The straight stop will interfere. With the permissive feature a smart engineman may absolutely annul its effect even if he misreads his signal, and may do so in every possible case except only where he misses a signal location entirely. It costs more money than the straight stop. Granted, however, that either is reasonably cheap and will get by the Commission, where is it to be located? Braking distance away from the danger point with an open throttle? Perhaps, yes, but for what speed? That is the crucial point.

With an engineman disabled, running on a slight down grade or even level track with throttle open, constantly accelerating for six, eight or ten clear blocks, what is safe braking distance with a service application?

Stops, as we see it, must be located a maximum safe braking distance for maximum authorized speeds and maximum speed governors must be placed on the locomotives to prevent their exceeding the speed for which the stops are located. The cheap device, in order to meet the one remote contingency for which it is designed, becomes expensive in that it gives less protection for the money involved than good speed control does for what it costs with all that it gives.

When continuous speed control functions properly, it restricts traffic less than any other system now on the market and under certain conditions may facilitate it—for instance, if installed on a line where passenger trains are run under absolute block signals ten miles apart, it will enable more to be run, but, if we can railroad with such trains ten miles apart, is it needed for this purpose, especially where automatics may do the same thing?

The Miller Train Control on the C. & E. I.

By H. H. ORR
Signal Engineer, Chicago & Eastern Illinois, Chicago

THE development of the Miller train control system on the Chicago & Eastern Illinois began in 1911 with the application of this equipment to two locomotives, one passenger and one freight, and the installation of four roadway ramps. That system was described by the Block Signal and Train Control Board as, "A mechanical trip train control system, controlled electrically and operated in connection with fixed signals and the usual form of electric track circuits, a ramp being located a short distance from the entrance of the block in position to engage a contact shoe on the engine."

In this first design a heavy shoe, hung on the right-hand side of the engine, was connected through bell cranks and links to the handle of the engineman's brake valve. This connection was completed through an electric magnet or slot so arranged that with the slot deenergized the lift of the shoe produced a corresponding movement of the brake valve. With the slot energized the connection between shoe and brake valve was broken.

The original ramp was an inverted channel located braking distance back of the signal and carried on the ends of the ties. Battery connection to ramp was controlled through track relay and signal circuit controller. That is, with the track relay for the block ahead energized and the automatic signal at proceed, battery was connected to ramp. Movement of the signal to stop position or the opening of the track relay broke this circuit and produced a deenergized or dead ramp.

With this arrangement when a train approached a proceed signal and the engine shoe engaged the ramp, current from the ramp energized the control slot magnet, preventing the upward travel of the shoe from operating the brake valve and applying the brakes.

With the signal at stop the engine shoe, as it was lifted by the ramp, received no current, the control slot magnet remained deenergized and the train brakes were applied by automatic movement of the engineman's brake valve to service position.

From experimental service of this original installation was developed an improved device which, while embodying the same fundamental principls, was designed and constructed so as to withstand engine vibration and so as to perform its operations more reliably and positively. The control valve and control slot magnet which had been carried in a separate housing were redesigned and mounted directly on the body of the engineman's running valve. The heavy engine shoe was replaced with a much lighter one

Digitized by Google