What Is the Future of Train Control?*

Reasons advanced for the belief that the coded-continuous system will be installed extensively

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THE purpose of this discussion is to consider the present status of automatic train control as it appears at the conclusion of an extremely active period of development, application, and operation, and to forecast, as far as that may be practicable, the probable developments of the future. The extent of automatic train control today makes it a factor of importance in railroad operation. Fifty railroads in this country operate some or all of their trains under its protection, 20,000 miles of equipped track carry these trains into 35 states, and over 9,000 equipped locomotives and electric cars are now operating over these tracks. Over 14 per cent of the locomotives now operating in the United States, and nearly 7 per cent of our track mileage are now equipped for automatic train control.

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Four distinct types of automatic train control equipment have been applied extensively by the railroads, either in compliance with the first and second orders of the Interstate Commerce Commission, or voluntarily: (1) automatic stop of the continuous type with forestaller; (2) automatic stop of the intermittent type with forestaller; (3) speed control of the continuous type, and (4) continuously-controlled cab signals. These four systems need no detailed description, except possibly the cab signal system without automatic brake applying equipment. With this system, two cab signal units are installed in the cab, one on the engineman's side, and one on the fireman's side. An audible device in the form of a warning whistle is arranged to blow at every change of indication downward, and it continues to blow until the engineman acknowledges his change of indication. Therefore, if the engineman is incapacitated and fails to take action, the fireman is apprised of the situation.

Comparison of Strictly Train Stop Systems

Considering each of these systems in turn, to what degree do they afford protection against the hazards of train operation? Taking first the intermittent automatic stop with forestaller, which system was intended to afford protection in the event of an incapacitated engineman, when the train passes a restrictive wayside signal, or when the engineman overlooks such a signal. This system does not prevent a reckless or a careless engineman from taking chances after passing the restrictive signal. This fact may lead to a hazardous situation, when a number of caution signals have been passed in succession, and the expectation that the next signal will be a caution or clear signal, approaches certainty in the mind of the engineman. This hazard is eliminated when a continuously-controlled cab signal is associated with the train stop system, because no engineman, in his right mind, would drive on toward the next signal at stop, while the signal in his cab told him positively and continuously that the next signal had not cleared.

Consider then the automatic stop system with the continuously controlled cab signal, which does all that is claimed for the intermittent stop, and in addition has other advantages of great value. This system provides continuous information for the engineman in his cab, thereby removing all question concerning the signal in advance, making it inconceivable that the engineman, after passing the caution signal, will proceed at high speed, while the signal in advance remains at at the position indicating stop.

Maximum protection is obtained in the hazardous situation which may arise when traffic conditions in advance become more restrictive after the train has passed a signal location, such as may occur when a switch is opened in advance of a train. With the continuous system, under such conditions, the cab signal changes immediately, and the brakes apply automatically if the prescribed action is not taken by the engineman.

Increased traffic capacity results, because a train may resume speed at once when restrictive traffic conditions in advance clear up, since the engineman receives an immediate indication of the change, even though the signal in advance cannot be seen. For these reasons, when the train stop is supplemented by a continuously-controlled cab signal, the value of the system is greatly increased.

Speed Control Is a Benefit

With the automatic speed control system, the hazards of carelessness, recklessness, or bad judgment in speed are recognized, and automatic means are provided for enforcing prescribed speed limits under all signal aspects. Therefore, to the automatic speed control system with the continuous cab signal, we can credit all that we have claimed for the preceding systems, plus the additional advantages accruing from the enforcement of speed restrictions.

Some operating officers have been concerned mainly with the risks attendant upon high speed and have insisted that a high-speed limit be enforced by the automatic equipment. Others have placed emphasis upon the necessity for caution in approaching the occupied block or the "stop" signal. Having obtained the enforcement of a low-speed limit in approaching the occupied block or stop signal, they have been satisfied to allow the engineman to use

*Abstract of paper presented before convention of the Air Brake Association at Chicago, April 30, 1929.

his own judgment while running under clear signals.

With an automatically enforced high-speed limit which prevents excessive speed, and permits proper signal spacing, and a low-speed limit which insures safety in approaching the danger point, operating conditions on some roads have led to the use of an intermediate speed for turnouts, and for operating at a medium speed for a certain distance after passing the caution signal. This has proved of value in a number of installations. Thus we find speed control systems with one,—two,—or three-speed limits, and each system may be justified by actual operating conditions. To the extent that carelessness, recklessness, and bad judgment on the part of the engineman are factors in train accidents, the additional cost of speed control equipment may be justified.

Among other advantages of speed control are the following: First, a more even speed under clear signals, with no danger of running at unnecessarily high speed, and a consequent reduction in wear and tear on rolling equipment, and fewer hot boxes. Second, with the enforcement of a low-speed limit, when approaching and passing the automatic "stop-and-proceed" signal, the train can proceed past the signal, under the speed limit without stopping. In other words, trains can be kept moving, with less delay and at lower cost.

Cab Signaling an Additional Safety Facility

We have considered the degree of added safety brought into railroad operation by the intermittent automatic stop, by the continuous automatic stop with cab signal, and by the continuous speed control system with cab signal. In listing the types of automatic train control equipment now employed in this country, we included installations of cab signaling without automatic brake-applying equipment, these installations being, of course, of the continuous type. The ideal train control system will have two functions: First, to provide information, by which the engineman can handle his train properly; and second, to stop the train automatically or reduce its speed in the event that the engineman is unable, or for any reason, fails to handle his train safely.

An early recognition of these principles resulted in the use of a cab signal on the locomotive as part of the first continuous system of automatic train control. Cab signals continuously controlled and constantly visible have since formed an intimate part of the continuous system of train control and have shown so many operating advantages and elements of increased safety, that the use of continuously-controlled cab signals without the addition of automatic brake control now merits serious consideration. Such installations are now being made by the Pennsylvania on its main line between New York and Philadelphia, Pa., and also between Philadelphia and Washington, D. C.

The continuous system of cab signaling has all the control elements essential in a train control system. Consequently, cab signaling may be installed and later converted, if desired, to include the automatic stop or speed control features with no change whatever in the wayside equipment, and with but the addition of the brake-applying device on the locomotive.

Function of Wayside Signals

It will be agreed without question that the whole purpose of the wayside block signal system is to convey information to the engineman; information which he can translate for the safe and prompt control of his train. With the present reliability of the block signal system, if collisions occur, the cause will usually be found either in a failure of the engineman to translate the information given by the wayside signal, because of fog, storm, mistake or carelessness, or in a failure of the engineman to act promptly through errors of judgment. It can be shown by the records that, where wayside block signals are in use, by far the greater number of accidents are the result of the first cause and not of the second; in other words, it is lack of correct information and interpretation by the engineman that is the principal cause of accidents involving collisions.

If lack of information *in the cab* causes most of the collisons, then the logical thing to do is to bring the information into the cab where it cannot be hidden by fog or storm, nor misinterpreted by a competent engineman, nor missed entirely by a careless one. If lack of information in the cab is the cause of most of the collisions, where wayside block signals are already in use, then it will be evident that on such roads the greatest safety, per dollar spent, will be obtained by supplementing the wayside signal with the continuously-controlled cab signal.

The importance of information afforded by the cab signal in reducing the hazards of train operation is shown by an analysis made of the public reports on 15 outstanding collisions occurring in this country during the year 1923 to 1927 inclusive. Of these 15 accidents, the reported facts indicate beyond all reasonable doubt that 14 of them would have been avoided had the engineman and fireman received the information provided by the continuous system of cab signaling. It is for these reasons that cab signaling is brought into this discussion, and it is apparent that in considering the degree of added safety brought into train operation by the various systems of automatic train control, we must place the continuously-controlled cab signal well toward the top of the list.

The installation of automatic train control, and the operation of the equipment through the trial period has naturally resulted in many developments of importance. Among these developments has been a very general recognition of the value of continuous-controlled cab signaling as a system for expediting and safeguarding railway traffic. Considering continous cab signaling as a system, 4,100 locomotives and electrically-propelled cars are now, or very shortly will be, operating with all signal aspects displayed in the cab before the engineman or motorman.

Features of Code System

Another development of outstanding importance is the continuous equipment capable of displaying four indications in the cab, and known as the code system. The code system is so called because the signal indications aboard the locomotive are controlled by coding the track circuit current; that is, by alternately opening and closing the circuit supplying the electric current to the track rails. The number of interruptions per minute, or the "code," determines which of the four signal indications will be displayed in the cab of the approaching locomotive.

The code system can be universally applied; that is, it is a continuous system which can be applied on an electrified road with either direct or alternating-current propulsion, or on a steam road, with any of the well known types of wayside signaling equipment. With four indications available, the code sys-

tem can be applied to any scheme of signaling from the most elementary to the complete three-block indication system which requires in the cab the four indications: "Proceed," "approach-restricting," "approach," and "stop."

What of the Future?

With about one in every seven locomotives in this country now equipped for automatic train control or cab signaling, with the trial period for this equipment definitely over, with much practical experience now available to determine the operating economies and added safety afforded by the various systems, what may we expect in the immediate future? A recent editorial in *Railway Age* says:

"A new basis has been established for the installation of automatic train control, differing radically from that existing since 1922, when the first order of the Interstate Commerce Commission was issued. The railroads are not to be ordered to install any more train control at this time, according to the decision of the commission on November 27, 1928. Evidently, the commission considers that its previous orders have accomplished their purpose of forcing extensive development of automatic train control. However, the report does not give complete relief from further activities regarding train control. The carriers are expected to undertake studies and tests to bring about standardization of train control devices, so that they may be used in joint track and terminal areas. Further they are in no way relieved from the responsibility which rests on them to provide additional protection where needed in territory now protected by automatic signals. This leaves the roads free to use train control, cab signals or other means as they see fit to secure additional protection on dense traffic lines. * * * The Bureau of Safety is definitely instructed to keep in touch with future developments and report to the commission."

There can be little doubt concerning the purpose of the commission in thus placing in the hands of the railroads, the future development of automatic train control. It is reasonable to assume that action will be expected along the following lines: First, studies which will determine the degree of added and comparative protection and the economic value of cab signaling and automatic train control in its various forms. Second, studies and tests which will lead to decisions as to the extent to which standardization of train control devices is possible or desirable, particularly with respect to what shall be done where the trains of several roads operate over a common section of track. Third, study and consideration will doubtless be given to the following factors:

(a) The greater regularity, with safety, of train schedules in bad weather, when the continuous system of cab signaling is employed, either with or without automatic brake-applying devices. The improvement in the regularity of train movements in unfavorable weather has been a very noticeable result wherever the continuous cab signal has been installed.

(b) Saving of time and money, and reduction in wear and tear on equipment, by the elimination of the stop at the "stop-and-proceed" signal, made practicable by the use of speed-control equipment.

(c) Reduction in wear and tear on rolling equipment and in the number of hot boxes, etc., by leveling out freight train speeds, and the decrease in the hazard of excessive speed, when speed-control equipment is installed.

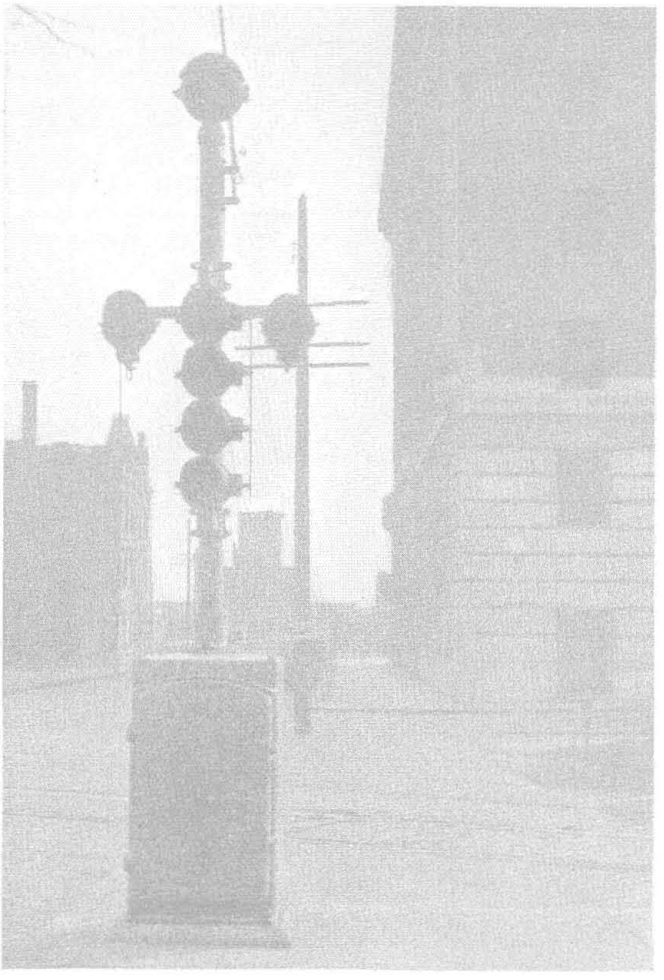
(d) The reduction of train accidents which might be expected to follow the installation of cab signaling or automatic train control. For obvious reasons, comparisons of accident records before and after installing train control must cover a considerable period of time before the results can be obtained.

Looking Ahead

Out of the observation and study of operation of the automatic train control equipment now in service will come, I believe, the following: General and universal recognition of the economic and safety value of the continuously-controlled cab signal. There is unmistakeable evidence, already, that the development of cab signaling is accepted as a distinct advance in the art of railway signaling and train control. The Interstate Commerce Commission in its report of November 27, 1928, states:

"Cab signals are without a doubt an important development in the art of signaling. They place the signal indication immediately in front of the engineman where it cannot be obscured by snow, fog, smoke, or other obstructions, and, where a combination of visible and audible indication is used, it is without a doubt a valuable addition to the signal system."

There are already under way, voluntary installations of the cab signaling system which will doubtless be followed by others on lines where experience and study show that the increased safety, increased traffic capacity, etc., obtained thereby will warrant the investment. These installations should increase the traffic capacity of the divisions upon which they are installed, by permitting prompt acceleration, when restrictions in advance are removed. Furthermore they would provide the highest degree of safety by giving protection when traffic conditions in advance change after a train accepts a clear or caution signal; they would bring about an improvement in the regularity of train schedules, or better "on time" performance, and, since it is a universal system interchangeably operative over all roads, these installations would readily permit of interchangeable operation under the conditions of cab signaling on some roads, cab signaling supplemented by the automatic stop and forestaller on other roads, and speed control in its several forms on still other roads.



Highway crossing signal at industry tracks of Manufacturer's Railway, St. Louis, Mo.