Four Recent Train Control Studies

Progress to Date, Possibilities From a Signal View and the Effect on the Mechanical and Transportation Departments

A MEETING on Automatic Train Control was held in Chicago, on October 23, under the auspices of the railroad section of the Western Society of Engineers. The papers presented at this meeting covered the development of automatic train control with a brief description of the systems in service or under test at present; train control as it affects the mechanical department; its relation to signaling and the results to be expected from the transportation standpoint. W. J. Eck, signal and electrical superintendent, Southern railway, presented a paper on "Developments to Date and Installations." C. F. Giles, superintendent of machinery, Louisville and Nashville, talked on "Train Control from the Mechanical Standpoint." T. S. Stevens, signal engineer, Atchison, Topeka & Santa Fe System, discussed "Train Control from the Signal Engineer's Standpoint," and A. W. Towsley, assistant to the vice president and general manager, Chicago, Rock Island & Pacific, treated "Train Control from the Transportation Standpoint." Abstracts of these papers are presented below.

THE DEVELOPMENT OF AUTOMATIC TRAIN CONTROL

By W. J. Eck,

Signal and Electrical Superintendent, Southern Railway, Washington, D. C.

THE desirability of some form of control to safely bring a train to a stop independently of the driver in case of conditions endangering the train, was recognized in the very beginning of railroading. No feasible method of accomplishing this result seemed possible however, before the general adoption of the power brake. The knowledge that the opening of the brake pipe line and the escape of the compressed air to the atmosphere, would cause an application of the brakes was immediately recognized as affording a means for automatically stopping a train independently of the action of the engineer. All train control devices have been based on this feature of the air brake system.

The majority of the inventors have considered that the opening of a valve in the brake pipe line was all that is necessary for a successful train control. It involves much more however, particularly in the case of heavy freight trains. There are more than 5,000 patents on file in the U. S. Patent Office on the subject of train control and only about a score have been considered worthy of service tests and development under actual railroad operating conditions.

In 1888, Axel S. Vogt, of the motive power department of the Pennsylvania Railroad devised the first automatic stop used in this country. It was of the plain mechanical trip overhead contact type, consisting of an arm so mounted upon the signal mast that when the signal was in the "STOP" position the arm would intersect the path of a glass tube mounted on the locomotive cab. This tube was connected into the air brake system so that any attempt to pass the signal improperly would cause a fracture of the tube and the application of the brakes. With the signal in the proceed position the arm was removed from the path of the tube.

Shortly after it was placed in service a tube was broken by icicles hanging from the roof of a tunnel and a passenger train was brought to a stop within the tunnel. The passengers were rescued only after some difficulty and no further installation of this device has been made upon steam operated lines.

In 1891 the Rowell-Potter System, a mechanical trip contact, ground type, train stop was installed on the Boston Revere Beach & Lyan. It was entirely mechanical in construction and operation, power being obtained by means of levers operated by the moving train and stored in coil springs. The same system was installed in 1893 on the Intramural Railway at the World's Fair at Chicago, and upon various other railroads, notably the Chicago, Milwaukee and St. Paul in 1902 and on the Chicago, Burlington and Quincy in 1908. The installations on the two steam roads just mentioned were of limited extent for test purposes and no extensions of the system were ever made.

Early Permanent Installations

The first permanent installation of automatic stops so far as known was made on the Boston Elevated Railway in 1899. It is still in use and consists of a controlled mechanical trip ground contact worked in conjunction with electro-pneumatic block signals. A similar installation was made on the Interborough Rapid Transit New York in 1903, also upon the Philadelphia Rapid Transit and the Hudson and Manhattan in 1908.

This device consists of a lever arm operated by compressed air in conjunction with the signal system so that the arm is raised above the track when the block is obstructed. This arm engages the handle of a valve in the brake pipe should a train attempt to pass a signal indicating STOP. The opening of this valve causes the brakes to be applied. A speed control feature devised by J. M. Waldron was added to the Interborough installation in 1912 which has materially increased the capacity of the road over that formerly existing with the plain automatic stop.

In 1910 the Washington Water Power Co. installed, on 29 miles of a single track electric interurban line, an automatic block signal system with automatic stops. The device was similar to that originally used on the Pennsylvania Railroad, viz., a glass tube mounted upon the top of the cars and positioned so as to be broken by an arm attached to the block signal in case the signal is passed improperly when in the stop position. As there are no tunnels or overhead structures on this line its use here was not objectionable.

The Pennsylvania Railroad in 1911, in connection with the terminal improvements undertaken by it upon entering the City of New York installed a system of automatic stops to protect trains using the tunnels under the Hudson river and throughout the electrified zone extending to Manhattan Transfer, N. J. This automatic stop is of the mechanical trip type electrically controlled. The valve in the brake pipe and the trip upon the ground are of special design and so arranged that ordinary obstructions along the track will not operate the air valve.

Permanent Steam Road Installations

The next year, 1913, the Miller Train Control Company's intermittent electrical contact type automatic stop system was started on the Chicago & Eastern Illinois. This was not only the first permanent, but up to the present time it is the most extensive installation on a steam railroad in the world. It is now in service on a double track division between Danville, Ill., and Dolton, a distance of 107 miles.

With this system an automatic application of the brake is effected when approaching a signal indication "STOP" by means of control valve and shoe carried by the engine engaging with a de-energized ramp. When the shoe comes in contact with a ramp it is raised and unless the electrically operated control valve is kept closed by current pick up from the ramp the engineman's brake lever is moved to give a service application of the brakes. An audible signal is sounded in the cab each time the engine passes a ramp. No speed control is used, although it can be provided if desired. A push button is provided so that the brake application can be forestalled at any time deemed necessary by the engineman.

There are 189 ramps, one of which is located braking distance from the signal at the entrance of each block. These are controlled by the indication of the signal and the condition of the block in advance. Only one ramp is used for each block without preliminary or caution indication. Ramps are located on the right hand side of the track and govern in the direction of traffic. They are about 180 ft. long made of "T" iron with leg upward, and are supported on the ends of the ties so that the top of the ramp is 6-in. above the top of the running rail and 50¼ from the center line of the track.

The engine apparatus consists of two elements, a combined contact shoe and primary valve attached by insulated brackets to the engine frame or the forward right hand tender truck, and a control device in the cab which operates the engineman's brake valve. The shoe is of the vertical lifting type, adjustable to engage the ramp. The shoe assembly may be placed in an inoperative position.

The engine control consists of a cylinder in which is fitted a piston, the stem of which is attached to the engineman's brake valve. This piston is moved whenever the contact shoe engages a de-energized ramp thus moving the brake valve handle to the service position. There is no source of electrical energy on the engine and the engine circuit consists of but one wire between the contact shoe and the control valve. Roadside battery is connected to the magnet of the control valve through the ramp and contact shoe when passing an energized ramp.

The Chesapeake & Ohio, in 1916, undertook the next permanent installation on a steam railroad in the United States by installing the American Train Control on 21 miles of single track between Charlottesville and Gordonsville, Va. An extension of this installation to Staunton, Va., a distance of 39 miles is now being made and is practically ready for service at the present time.

In 1915 the American System was the subject of an experimental trial upon the Maryland and Pennsylvania. It was then known as the Jones system and as such was tested by the Bureau of Safety of the I. C. C. The installation on the Chesapeake & Ohio however, has been materially improved from the form originally tested.

The engine apparatus consists of two contact shoes of the vertical lifting type attached by insulated brackets to the forward tender trucks, one on each side. An electromatic valve is operated through contacts on the spindle of the shoe so that when the shoe passes over a de-energized ramp it causes a brake application. A cab signal giving a clear and a caution indication by means of electric lights is also controlled by contacts on the shoe. A circuit reverser for transposing the circuits for backward operation of the engine, a battery and a reset key for releasing the apparatus from the ground after a brake application completes the equipment. Practically all of the locomotives operated in this territory are provided with the device.

In the original installation the ramps on the roadway are located in pairs in advance of the signal one on each side of the track, the one on the right in the direction of traffic, being used for the stop and the one on the left for the caution indication. The control circuits have been specially designed to meet local conditions and are a modification of those used in single track automatic block signaling. The fixed signals along the roadway are of the light type, the day and the night indication both being given by colored lights.

AUTOMATIC STOP AND TRAIN CONTROL SYSTEMS TESTED ON AMERICAN RAILROADS

Name	Type	Where Tested	Year
Buell	Insulated truck	Southern Ry.	1906
Bulla	Ramp	E. P. & S. W. Ry.	1919
Clark	Inductive	Pere Marquette	1921
Clifford	Auxiliary Track Circuit	Erie	1922
Fox (A. H.)	Inductive	New York Central	1913
Finnigan (G. P.)	Inductive	I. R. T. Co.	1911
Gen. Safety Appl. Co.	Ramp	Spokane Inland R. R.	1919
Gray-Thurber	Insulated truck	Penna. Lines	1911
Gollos	Ramp contact	C. G. W. Ry.	1912
General	Ramp contact	B. R. T.	1912
Harrington	Overhead trip	Erie	1908
Induction Sig. Co.	Inductive	New York Cntral	1913
International	Mechanical trip	D. L. & W.	1912
Julian Beggs	Ramp contact	C. N. O. & T. P.	1916
Jones (D. C.)	Ramp contact	Southern Ry.	1910
Jones	Ramp contact	Maryland & Pa.	1913
Lacroix	Ramp contact	Staten Is. R. T.	1911
M. V. All-Weather	Inductive	Raritan R. R.	1922
Nevins-Wallace	Mechanical trip	B. & M. R. R.	1919
Orcutt	Ramp type contact	B. & A. R. R.	1919
Otis	Ramp	Canadian Pacific	1920
Patterson (H. D.)	Inductive	New York Central	1909
Prentice's	Wireless	Canadian Pacific	1911
Ry. Auto Safety Appl. Co.	Mechanical trip	Pere Marquette	1911
Safety	Ramp contact	Hunt'g'n & B. M. R. R.	1912
Sanor & Conkell	Third Rail	W. & L. E. R. R.	1913
Shadle	Ramp contact	C. I. & W.	1919
Simmen	Ramp	A T & S. F	1908
Simplex	Insulated engine wheels	B. R. & P. R. R.	1921
Schweyer	Inductive	P. & R. Ry.	1918
Sindebrand-Woticky	Track circuit	N. Y. C. & H. R.	1913
Steigelmeyer	Ramp	Big Four	1909
Union	Ramp contact	D L. & W.	1913
Warthen (H. J.)	Overhead trolley	B. R. & P.	1911
Webb	Ramp contact	Erie	1922
Wooding	Ramp contact	D. L. & W. R. R.	1916

The Chicago, Rock Island and Pacific in 1919 started the installation of an automatic train control system manufactured by the Regan Safety Devices Company, Inc., between Blue Island, Ill., and Joliet, a distance of 22 miles. The device is of the intermittent electrical contact type with speed control. Ramps are installed along the right of way in connection with the three position upper quadrant signals already protecting the tracks in this territory. These ramps are 120 ft, long and located 150 ft. in rear of the signal, they are made of angle iron with a copper insert and mounted upon cast iron supports bolted to the cross ties. The ramps are connected into the signal circuit so that their removal will result in the signals displaying the stop indication.

The speed circuit controller consists of a centrifugal governor arranged to open and close a circuit at any predetermined speed. This governor is bolted to the end of one of the axles of the pony truck.

The electro-pneumatic valve operates in response to an electromagnet and controls the brake pipe pressure and the reservoir supply to the engineman's brake valve. When the magnet is de-energized, the valve causes a service application of the brakes; this cannot be released by the engineer but he can further decrease the brake pipe pressure to apply the brakes in an emergency application. The shoe mechanism consists of a shoe stem and a circuit controller attached to the forward tender truck. The shoe picks up current from the ramp of the proper characteristic to acuate the locomotive apparatus and to control the train consistent with the indications displayed by the automatic block signals.

The system is designed to make an application of the brakes when any of the following conditions exist: (A) When a train passes a signal in the caution position at an excessive speed. (B) Whenever a train exceeds a predetermined speed while running in a caution block. (C) At a stop signal, or when a block is occupied.

Acts of the I. C. C. and Recent Tests

The Interstate Commerce Act of 1920 empowered the Interstate Commerce Commission to order the installation of automatic train stops or train control that would comply with the Commission's specifications and requirements upon the lines of any carriers subject to the Act. To assist in carrying out the provisions of this act and at the request of the Commission a joint committee representing the various sections and divisions of the American Railway Association was appointed and started work in September 1920. All existing installations were investigated and arrangements were made with the New York Central and the Southern Pacific for the installation of types of train control for test purposes that have not heretofore been fully tried out under service conditions.

Upon the Southern Pacific, the National Safety Appliance Co., has installed between Haywood, Cal., and Halvern, a distance of 4½ miles a system of intermittent inductive train control. This system was tested by the Interstate Commerce Commission on the Western Pacific at Oroville, Cal., in 1919. Material improvements have been made recently and the system is now under observation by representatives of the Joint Committee.

A permanent magnet of laminated steel, located between the rails is installed at each indication point. This is neutralized by a suitable coil energized by a roadside battery when the block is unobstructed. The locomotive apparatus consists of magnetic valves mounted under the tender in such a position as to come within the field of the track magnets. An air valve controlling the brake application is connected to the magnetic valve by suitable piping. No electrical energy is required on the engine.

In operation the field of the permanent track magnet is normally in position to act on the engine magnets, neutralize their field and permit the attached valves to open and produce a stop by allowing the air valve to open the brake pipe to the atmosphere. If no stop is necessary, the neutralizing coil is energized and deflects the magnetic field of the track magnet so that it will not act on the engine magnets.

On the New York Central the tests are being made upon the apparatus of the Sprague Safety Control & Signal Corporation. The installation consists of equipment on one locomotive and about six miles of track in a very busy electrically operated section near New York City. The system is of the intermittent non-contact induction type, with speed control, cab signals and a recording device. Electrical energy from storage batteries is used for neutralizing the normal danger track magnets when the block is clear. This is controlled by the relays of the wayside signal system so that the track magnets are not neutralized when the block is obstructed and by their influence upon the engine receiver cause the display of the proper signal in the cab and the application of the brakes.

Two brake application magnets are used in each block, one near the entrance and one at approximately braking distance from the stop signal. These together with a reset magnet at the exit end of the block are located between and some four or five inches below the top of the running rail. The engine equipment includes the receivers for picking up the magnetic inpulse, the relays for transmitting the received impulses into action, the valve assembly for controlling and effecting the required brake application, the speed control mechanism and the cab signals. Other than the impulses received from the track magnets all electrical energy used on the engine is supplied by a storage battery charged by the headlight generator. The installation has been under observation for some months by the Joint Committee and official tests will be started soon.

The Interstate Commerce Commission issued its now famous order No. 13413 on June 13, 1922, requiring automatic train stop or train control devices upon 49 carriers. Installation on one passenger locomotive division on each of the lines to be completed by January 1, 1925. The matter is being handled actively at the present time and it is expected that work will be started at an early date on many of the lines specified.

The Pennsylvania railroad and the Chicago & North Western have already announced that they will make an experimental installation of a practical nature, to determine the characteristics of the system selected under the various operating conditions met in railroad service previous to its installation on the very large scale required by the I. C. C.

The Pennsylvania Railroad has under construction at the present time the automatic train control system developed by the Union Switch & Signal Co., and the Westinghouse Air Brake Co. The test installation will extend from about one mile from Lewistown, Pa., over a single track line for 45 miles to Selinsgrove Junction, thence over a double track line to Sunbury, Pa., the latter portion being now equipped with a.c. track circuits and automatic position-light signals.

Wayside signals will be installed where not now in service, approximately one half of which will be controlled by the train dispatcher and the other half of the single track line by a modified absolute permissive block system controlled by trains. This system is unique in that it provides continuous control, all other installations of any material size being of the intermittent type; that is the indication is transmitted to the train from the roadside apparatus only at definite points. The indication thus received continuous as the controlling factor in the operation of the train until the next indication point is reached when it may be continued or changed depending upon the indication there received. However, continuous control systems, provide full speed control and transmits the indication to the cab of the locomotive at all times thus giving immediate indication of any change in conditions in the same block or of the block ahead.

This result is effected by means of an alternating current circuit imposed upon the rails in addition to the usual track circuit. The circuit uses the two rails in parallel and is supplied through resistance coils from line wires. No ramps, magnets or other apparatus on the ground other than the regular running rails are required for conveying the indication to the train.

Each engine is equipped with collecting coils positioned, one over each rail, storage battery, amplifying device, dynamotor, relays, speed control apparatus and brake operating valves. The amplifying device consists of one or more vacuum tubes, such as those used in wireless telephone work and they have the property of amplifying the small current picked up from the track by the collecting coils. This amplified current operates the speed indicators and other apparatus on the engine. The speed control apparatus consists of a centrifugal governor driven from an axle. It controls a series of valves primarily controlled by the electro-magnetic valves.

When the engine coil is passing over the track in the rear of a clear block its coils are influenced by the magnetic field around the rails, thus generating a small current which is strengthened by the amplifier until it is capable of energizing a three position relay. When a block preceeding a stop signal is entered the polarity of the special track circuit is changed, which causes the display of a caution indication in the cab and enforces the control of the speed through the brake apparatus. As the train proceeds it passes a point on the track between which point and the signal all current is cut off from the track. The induction relay is then de-energized, causing the brakes to be applied to bring the train to a stop at the signal.

The Chicago and North Western has announced that contract has been signed with the General Railway Signal Company for an intensive test of their intermittent inductive train control with inert roadside elements. This system requiring no energy on the roadway or physical contact between engine and roadway parts. The roadside element consists of a "U" shaped laminated iron core with a coil winding which may be opened and closed by the contacts on a relay in the signal system.

The engine equipment includes a pair of coils mounted so as to pass directly over the track element, a storage battery, relays, an electro-pneumatic valve and means for applying a service application of the brakes through the engineman's regular brake valve.

When the signal is in the stop or caution position the coil on the track element is opened by the signal relay. In this condition the current normally flowing in the engine circuit is greatly reduced when the engine passes an indication point. This reduction in current causes the electro-pneumatic valve to operate and applies the brakes. It can be arranged, if desired, so that the application will not take place at the caution signal if the engineman acknowledges the signal by operating a lever, thus indicating that he has seen and understands the indication of the signal and will properly control his train. The acknowledging valve cannot be tied down to permanently cut out the device.

The speed control is obtained by determining the safe speed at any given point and locating two induction points on the road a corresponding time distance apart. If the train consumes less than this time going from one point to another showing that the speed is too high for that location the brakes will be automatically applied. If the train is going slower than the designated speed the brakes will not be set.

The systems that have been described include only the most prominent of those that have been installed on an extensive scale for regular service; in addition there have been many experimental trials of various devices made upon railroads of the United States, during the past thirty-four years.

TRAIN CONTROL FROM A SIGNALING VIEWPOINT

By Thomas S. Stevens

Signal Engineer, A. T. & S. F. System, Topeka, Kan.

AUTOMATIC train control is a subject about which we have no practical knowledge and, therefore, the only thing we can do is to theorize. In so far as signaling phases are concerned the subject seems to call for different treatment if we decide that automatic train control development shall be made in connection with wayside signals or that the automatic train control, together with some form of cab signal, shall be used as a complete signaling scheme.

If wayside signals are to be used and the only purpose of automatic train control is to check the performance of the signals and the actions of the enginemen, those intermittent devices which have only two positive indications with a speed control, which is only local and momentary, may work up into first class devices. By positive indications I mean those which are not dependent on time element devices or the speed of the train.

If, however, we propose to make automatic train control pay by developing it into a complete signaling scheme, something more than is provided by these devices will probably be necessary. It would appear that at least three indications or controls are required. Stop and proceed, of course, with the addition of a low speed control of some character which should be continuous in its effect until replaced by a proceed indication.

Possibility of Eliminating the Wayside Signal

Whether wayside signals are used or not it is reasonable to suppose that train control will undoubtedly be the governing factor eventually. Because of the necessities it seems safe to assume that the ultimate development will tend to leave the control of the train in the hands of the engineman rather than that the actual brake application for the different indications will be made automatically. The probable function of the automatic train control will be to check the engineman by stopping the train if proper procedure is not taken. If this is finally proven to be true, it seems essential that information should be provided in the cab so that the engineman may be advised of the condition of the automatic train control apparatus and so be able to control the speed of the train properly in order to avoid being checked. This information may be given through medium of a signal, whistle, or indicator of some kind, but any of these will in effect be a repeater of the wayside signal. Except for the fear of failures during the first few years of development there seems to be no justification for the duplication of indication which will result if wayside signals are used as well as the necessary cab indication which would appear to be necessary whether wayside signals are installed or not.

It would seem advisable for a number of railroads to approach this subject with the idea of developing something which would take the place of wayside signals as well as provide an automatic check on the actions of the enginemen. This treatment is attractive from many standpoints:

(1) It would, of course, be far cheaper to install without wayside signals than with them.

(2) The cost of operating will be less because the necessity for holding signals clear during 24 hours regardless of whether the protection is needed or not will be eliminated and only the necessary power to properly protect a train which is actually operating over the railroad will be used.

(3) The question of back ground will be solved because the indication will be given in the cab.

(4) Signaling against traffic on double or multiple track railroads can be undertaken with far less cost because the clearance problem is eliminated.

Railroading generally will not be as flexible with automatic train control because the speed of operation will be prescribed, but this prescription will be of the same extent regardless whether wayside signals are used or not.

Train Stops at Signal Are Ineffective

Granting that automatic train control is successful there seems to be many advantages which can be obtained from its use. If proper analysis is made of the effect of signal indications given by automatic signals, it will be found that the only indication which protects the rear end of a train is that which prescribed some form of low speed after stopping at an automatic signal. The stop in itself has never been of any use. Operating officials have been afraid to eliminate the stop because of the fear that a proper low speed would not be maintained without the stop. Probably the fear was justified but with a controlling device which definitely takes care of the proper rate of speed, it would seem that all stops for automatic signals could be eliminated.

Rear flagging in completely signaled territory has been retained due to the same fear with reference to the action of the engineman even after passing an automatic signal at stop in the proper way, and this fear is natural because of accidents which have happened after a train has actually stopped at a signal or picked up a flag. Under automatic train control it would seem possible to eliminate rear flagging or at least to shorten the distance because the speed of the train will be taken care of definitely and positively by the automatic control.

Considerable experience has been obtained from some of the installations already made with reference to the possibilities of mounting certain classes of devices properly on engines. The experiments, however, have not covered a sufficient length of time, nor been of sufficient diversified character to allow of definite suggestions as to the solution of the engineering difficulties involved.

A Few Problems to Be Considered

Ramp devices seem to present the least difficulty in connection with the methods necessary to provide the requisite indications and controls. A simple change of polarity is all that is needed to bring about the different speed controls. The electrical problems involved can easily be understood by any signalman who has maintained automatic signals. The problem in connection with this type of device seems to be the integrity of contact during inclement weather and the proper construction and installation of the ramps so that impact shocks will be properly taken care of and the ramps securely protected against damage by dragging equipment.

With the inductive devices which provide full clearance there is the problem of insulation, which has always been a difficult one to take care of with apparatus which is practically underground. Most of the inductive devices involved principles which will require additional education of employees. With all of the ramps and intermittent inductive devices there will be a big problem with reference to the maintenance of track, because all of these devices interfere more or less with the present scheme of taking care of the roadway structure and station platforms.

The installation of this type of device will have to be made very carefully because there seems no really good way at present devised to take care of derangement of the apparatus. By somewhat complicated methods the actual removal of a ramp or intermittent inductive device can be protected against but at the present time it seems possible for sufficient derangement to occur to render the device inoperative without any check being possible.

With the continuous control devices which use central energy, the big problem seems to be the integrity of the power supply. This problem exists at the present time in connection with all installations of signals controlled from a central point, but failures of this character where wayside signals are involved can be taken care of by orders and, therefore, business can be moved more readily than will be possible, perhaps, under automatic control. In at least one of the devices an amplifier is necessary which is a more or less delicate instrument.

The solution of these problems is undoubtedly certain and after all is done and said about the transfer of an impulse from the track to the engine, the big problem appears to be the proper control of the air brake apparatus.

Whether the air brake control apparatus can be actually made automatic or whether it must always be a check on the actions of the enginemen, is perhaps the one phase of automatic train control which will require the most study during the period of development. If we endeavor to replace the flexibility of human action by something which is automatic it will necessitate the same brake application regardless of the length of the train, grades, curves, or the condition of weather and rail. It would seem probable that the final development would be to provide proper indications as to the allowable speed with the requirement that the engineman should keep within certain limits under certain conditions to prevent the automatic train control having any actual effect on the air brakes themselves.

A few of the highly debatable questions on train control at this time are:

Whether intermittent or continuous control will prove more efficient and flexible;

Whether the control points of intermittent devices should be located at the signal or at braking distance from the signal;

Whether the actual stopping of the train should cause the air brake control to be set to a prescribed low speed and thus a positive proceed indication be required;

Whether an indication should be provided on side tracks which would inform the engineman as to the occupancy or not of the main line;

Whether simple apparatus with overlaps is preferable to slightly more complicated devices which would either decrease the overlaps or eliminate their necessity;

Whether it is desirable to introduce the necessary complications to insure that the indications of the signal should be properly checked by the automatic train control, and those of the automatic train control in turn checked by the signals.

These statements are placed before you as possibilities rather than facts. It would perhaps be best for the art if those engaged in the work of making the first installations should carry out their first viewpoint rather than that some uniform plan should be arranged for and followed, because in this way only can the different ideas, which must prevail in connection with this subject, be proven and the knowledge so obtained be useful some time later for an intelligent discussion of the possibilities with reference to this last ditch in the proper control of trains.

I have said that automatic train control is the last ditch. This is a true expression in so far as the present developments are concerned. Properly analyzed academically all of the previously used systems for control of trains are safe.

The order system is safe. It is complicated and therefore hard to understand, but if its provisions are properly observed no accident should occur. Manual block, treated academically, is the safest method of moving trains. It is flexible and provides the best means of handling trains without orders. Automatic signals, the next development, provide a safe means of moving trains by signals in so far as protection of this nature is concerned.

Apparently all of these have failed to a more or less degree because we are now proposing to supplement, check or displace these schemes by automatic train control. It will not do all that some of its advocates claim. It will probably be subject to the same extent of mechanical failures as is experienced with other automatic devices. Man failures will be transferred from the human beings operating trains or signals to other human beings who are responsible for its manufacture, installation and maintenance. Whether train control will prove more effective than past schemes will be dependent on the care and study which is accorded its manufacture, installation, maintenance and operation.

ADVANTAGES AND DISADVANTAGES OF TRAIN CONTROL

By A. W. Towsley

Assistant to Vice-President and General Manager, Chicago, Rock Island & Pacific, Chicago.

THE advantages and disadvantages of automatic train control are known after one has had an opportunity to observe the various devices after they have been tested. The advantages secured from successfully operated train control systems are, in my estimation, (1) safety; (2) eliminating interruptions, that is, long interruptions to traffic; (3) increasing productiveness of track or in increasing the number of trains to be run with minimum interruptions.

An automatic train control that will minimize delays to traffic when properly and correctly installed is all that is desired. Therefore, when it increases the productiveness of traffic it is a great advantage.

The disadvantages are the possibility of tying up power at terminals because of the many interruptions or reported failure of the mechanism to operate. This may result from the engineman failing to report the failure of the apparatus because there is no check on its operation. We are getting only 43 per cent productive service out of freight locomotives. Anything that increases the time of unproductive service is a disadvantage. Any stoppage of traffic, no matter for what cause, is a disadvantage to carriers because of the slowing up of train service to the public.

The advantages of train control are many more than the disadvantages. The speed control is another excellent thing and one of the good advantages of train control because if the engineman does not perform his work, this performs it for him and does not take away from him the initiative to perform his functions.

TRAIN CONTROL FROM A MECHANICAL STAND-POINT

By C. F. Giles

Superintendent Machinery, Louisille & Nashville, Louisville, Ky.

ASIDE from the expense of the initial application of an automatic train control device to a locomotive, proper and adequate maintenance will undoubtedly prove the most vital and perhaps the most difficult factor to contend with from a mechanical standpoint. The modern locomotive, representing such a large capital investment, must necessarily be handled and placed in serviceable condition at terminals with all possible dispatch so as to minimize the unproductive period of time during which this investment remains idle. It goes without saying that every additional device applied to a locomotive requires a certain amount of care and attention, more or less proportionate to the intricacy of the mechanism, the intensity of use or the importance of its function. Additional devices tend to retard the prompt completion of the work of inspection and repairs to locomotives at terminals. Therefore, unless such devices effect economies at least commensurate with the time and labor expended for their proper maintenance, they will prove to be a burden and a distinct loss to the railroads from a financial standpoint.

The only device on a locomotive today to which the maintenance and inspection of the automatic train control may be considered as being comparable is the automatic air brake equipment. In this connection, educational plans and the organization of forces have proved necessary to insure the successful maintenance and operation of the automatic air brake. The methods used for instructing and training the employees must also be carried on regularly and constantly to effect satisfactory results in the operation of the air brake equipment by the engineman, upon whom devolves the making of emergency repairs on the line with the least possible delay, and to insure proper inspection and repairs to the apparatus on the part of the shop and engine house mechanics specially assigned to this work.

It appears only reasonable to predict that somewhat similar methods, more or less extensive in their scope, will have to be inaugurated to care for the inspection and maintenance of the automatic train control apparatus successfully when applied to locomotives. However, the insurance of the successful operation of the latter device will quite probably prove more difficult of attainment than the air brake, for the reason that no occasion may arise for the automatic train control to function during one or many complete trips, and consequently no reports from the enginemen concerning its operative condition can be anticipated; whereas, the condition of the air brake equipment, which is regularly operated on every trip, can and must be reported on intelligently by enginemen after arrival at terminals.

Thus, in the case of a locomotive equipped with an automatic train control device, it is quite apparent that a complete and extensive test of the latter must necessarily be conducted on arrival at, and before departure from, each terminal to determine whether it will perform the important automatic function that may be required of it on the following trip satisfactorily and unfailingly, and to locate and repair any defects that may exist in the equipment.

The extent of the shop maintenance required will, in a measure, depend on the nature of the particular installation, the number of locomotives equipped, the type of device selected and the extent of train control that is desired. Nevertheless, it is obvious that additional forces of expert employees will have to be assigned to maintain this important and intricate mechanism properly, in addition to keeping accurate and infallible records of its conditions so that such records may be produced whenever required for any cause. The additional work of repairs and inspection demanded of this equipment will tend materially to increase the time required for the completion of repairs to locomotives held at engine terminals for that purpose.

GENERAL DISCUSSION OF AUTOMATIC TRAIN CONTROL

THE general discussion of the papers presented on the subject of train control was opened by H. G. Clark (assistant to president, C. R. I. & P.), chairman of the railroad section of the Western Society of Engineers.

J. A. Beaumont (Regan Safety Devices Co., Inc.): Automatic train control should result in less failures and stoppage of trains and decreased delays in freight train movements. It is not in the experimental stage. The induction type has not been recommended by the Interstate Commerce Commission in its order. This type of device may stand at some time, but not in its present state is it developed to that point, whereas the ramp type has been.

H. R. Safford (vice-pres., C. B. & Q.): Probably no device relating to safety and operation in railroading has been approached with as much caution as train control. It was hard at first for railroad men to realize that a substitute should be provided to operate when the human mind fails. We do not want to think that a mechanical substitute should be providel to replace human intelligence. The problem is to get a device that is durable and reliable with the organization available for its maintenance. It is my thought that the highest type of construction and highest type of care will be required to obtain a device which will operate successfully.

C. A. Dunham (sig. engr., G. N.): What is required in train control today is a device to bridge the gap between the automatic block signal system and the air brake device on a moving train. There is a great difference between speed control and the simple automatic stop. Some roads, no doubt, have traffic and speeds which warrant the adoption of a speed control device. However, this does not prove that such conditions prevail on all of the 49 roads listed in the commission's order and that all of these carriers should be required to install a system of this kind.

C. A. Lyon (Regan Safety Devices Co., Inc.): For three years I have maintained train control apparatus. The labor used in the maintenance are ordinary shop mechanics who secured the jobs by bids. These men have trained themselves, as due to the arrangement with the shop crafts organization no other than foreman have a right to teach these men about any device. At various times the crews were changed, with no serious results evident in the maintenance of this apparatus. Up to the time of the recent strike there was a surplus of labor used on this work. Since the first of July the time of two men only has been devoted to the maintenance of the 20 sets of locomotive equipment (on the Rock Island).

In order to facilitate the maintenance, all apparatus should be accessible. Experience has shown that equipment can be so designed and installed as to last from shopping to shopping of a locomotive.

F. W. Pflegimg (sig. engr., U. P.): Evidently the railroads were worried for several years about the application of train control devices; however, when the recent I. C. C. order was issued the railroads decided to go ahead with the application of train control. It seems that the tables are now turned and the various manufacturers are hard put to furnish apparatus that will meet the very evident requirement of actual operation on the railroad.

A. J. Brookins (Bourdette-Brookins Train Control Company): In my opinion, the transmission of the controlling impulse from the roadway to the locomotive is far less important than the actual operation of the device used to control the air brake equipment. I believe that there should be more latitude in the selection of equipment and those desiring to try the simple stop should be allowed to do so; if others wish the speed control let them try it. The audible signal also should be installed for an extensive trial. In this way a varied experience would be available and a middle ground of development established. By such a program of trials and experiments a multitude of difficulties in the progress of train control would be eliminated.

B. W. Meisel (Regan Safety Devices Co., Inc.): In the study of the development of automatic train control it is very evident that the most important problem is the operation of the apparatus to control the air brake system rather than to develop equipment for the transmission of the impulse from the wayside equipment to the locomotive. If the engineman is not alert the train control apparatus will stop the train. However, under most operations the device will not hamper the engineman from controlling his train in the most efficient manner. The remark made to the effect that there was no indication or operation of the apparatus during service except when the train is stopped is somewhat in error. I wish to state that the major parts of the apparatus must operate at the entrance of each block section. All of the electrical and mechanical equipment up to the actual operation of the air valves controlling the real application of the apparatus must function after the locomotive passes from one block section into another. In this way it will be seen that the apparatus is tested numerous times in passing over the road.

F. J. Sprague (Sprague Safety Control and Signal Corporation): Train control will offer a greater track capacity on one or two tracks with or without signals, normal clear or normal danger, with steam or electric propulsion. Track capacity will also be increased by operating trains either way on both tracks.

The big problem of train control is the maintenance of the apparatus. It is our hope that the train control apparatus will not be required to operate except at infrequent intervals; normally the engineman can control the train with a nicety of manipulation and judgment of train length, air supply, etc., that cannot be duplicated by a mechanical device. Train control if properly engineered may tend to increase rather than decrease track capacity.

Certain basic requisites are fundamental in any system of train control which will enable it effectively to meet the conditions of modern railroad operation. Specifically, a system should:

Be applicable to any single or mulptiple track railroad, with or without automatic signal equipment; and in the case of the former, regardless of whether a. c. or d. c. normal danger or normal clear signals are used, with or without interlocks and overlaps.

Be suitable for any road, regardless of the kind of power used, whether steam or electric; and in the latter case uninfluenced by the kind of current or type and location of conductors.

Not encroach upon the clearance lines of rolling stock or track equipment; or be limited by extraneous equipment along the right-of-way; or interfere or be interfered with by snow plows or dragging equipment.

Be unaffected by climatic extremes, proof against interruption by water, snow or sleet, and subject to a minimum of depreciation.

Provide distinctive cab signals and full block protection, as reliably as any wayside signal.

Provide speed limitation, regardless of signals, on tangents and curves where required, and insure slowing down to safe running speeds on entering a caution block.

Not reduce track capacity, but, on the other hand, increase it, especially in adverse weather.

Make possible operation in either direction on any track of a multiple track railroad.

The engine equipment should be:

Applicable to all types of road engines, passenger and freight, and once installed be a matter of no concern to the engineman as to adjustment, upkeep or replacement.

Unaffected by shock, jar and vibration, and proof against roadway dust and changes in atmospheric humidity.

Readily replacable, at least as easily as the standard parts of the regular brake equipment.

Of such character that a locomotive may be used interchangeably in all kinds of train service, and with any kind of braking which may be required.

Subject to speed control, that is, to a proper co-ordination of the elements of train speed and the braking power of equipment.

Engine and track equipment should be as nearly as possible foolproof and demand the minimum of upkeep and attention, both as to time and special knowledge required; and all necessity for adjustments by the engineman should be eliminated.

Finally, the system should be a friendly mentor and guide for the engineman, aiding, not unnecessarily opposing, him, and a thoroughly reliable but unobtrusive partner in the operation of his engine, which, while interposing an effective shield between him and disaster, will leave, within all proper limits, the handling of the train subject to his judgment.

Comment on Papers Presented*

By A. G. Shaver

Regan Safety Devices Co., Inc., Chicago.

Installations of automatic train control have been in service on railroads under practicable operating conditions sufficiently long to demonstrate their usefulness and reliability. The fact that a train can be safely stopped automatically or can have its speed efficiently controlled automatically is not debatable in view of the records for such performances extending over a period of several years under the variety of operation conditions existing on the usual railroad. Theorizing may be indulged in as to the elegance or convenience of this or that method or feature, and it is good so to set the imagination at work, because that is the means for attainment of progress and precision, but in view of the evidence before us there is now no need to speculate as to whether the essentials of automatic train control are practicable and efficient.

That I may not be misunderstood, I would define the essentials of automatic control to be: Means for automatically stopping a train; means to permit it to proceed after being stopped, and means to restrict its speed under certain conditions.

In its application and use automatic train control involves two different engineering departments of the railroad, neither of which usually has any particular interest or part in the business of the other. It has not been necessary for a motive power man to know how to signal a railroad in order to build and maintain a locomotive, nor has it been necessary for a signal man to know much about a locomotive in order to equip a railway line with a signal system. With automatic train control it is different, both the motive power and the signal departments are concerned, and the lack of fully appreciating this fact, perhaps, has been quite a drawback in train control progress.

It has been shown that for systems already installed and in regular operation the locomotive equipment can be looked after by the regular roundhouse forces; and there is nothing about the track appliances which a good maintainer's helper cannot do. To get good service it is, of course, necessary to understand the working of the apparatus and its diseases in operation, but a knowledge of these is soon acquired since the maintaining forces are already familiar with railroad equipment of a similar sort.

The major part and the important part of the train control system is the equipment on the locomotive. It is essential that it be properly applied and that it be given the same high order of inspection and maintenance as that now given by most railroads to their automatic block signal systems.

Although, generally speaking, that part of the train control system located on the track is simple and easily installed and maintained there is the problem of its proper application to serve best the operating and traffic conditions of the railroad. No matter how good and efficient a train control system may be, it will not best serve a railroad if improperly applied. The important function of a train control system is to keep trains moving safely, and already there are systems which will do this.

As has been suggested in one of the very able papers with automatic train control in use on the railroads what will be the necessity for trains to stop for stop automatic block signals and for rear flagging to be continued? It is evident there are other advantages to be had from the use of automatic train control than that of safety only.

*Abstract of written discussion presented to chairman of the meeting.

Train Control on the C. & N. W.

IN COMPLIANCE with the Interstate Commerce Commission's order of January 10, requiring the installation of automatic train control on 49 railroads, the Chicago & North Western has awarded the General Railway Signal Company of Rochester, N. Y., the contract for the installation of automatic block signals with train speed control from West Chicago, Ill., to Elgin, a distance of 12 miles.

From West Chicago to Wayne, there is five miles of double track, the balance being single track. The double track will be equipped with Model 2A, direct current signals located on bridges and the single track will be equipped with the absolute permissive block system, Model 2A direct current signals being mounted on masts in the usual manner. The system of automatic train control will be the General Railway Signal Company's train speed control as described in the *Railway Signal Engineer* for March, 1922, page 105.

The installation will be of special interest due to the nature of the track and the varied classes of traffic which operate over it. Fixed limited speed is to be imposed at certain locations, as approaching the end of double track and interlocking plants, i.e., there are certain fixed speed limitations that are in effect which will be enforced through the use of pairs of inductors constructed without windings. The speed control scheme generally contemplates the use of three pairs of inductors governing the approach to stop signals which force the deceleration of train to insure a safe stop. Speed will be so tapered as to handle the trains as they are normally handled now, automatic braking being used only when speed limits are exceeded.

There is an interlocking plant a short distance from the West Chicago station from which it has been customary, under certain traffic conditions, to advance trains to the station on "Call-on" signals. The limited speed indicated by the "Call-on" signals will be enforced by the application of pairs of inductors suitably placed between the interlocking plant and West Chicago station.

The speed control and receiving apparatus for freight and passenger locomotives will be identical except for the timing of the time element contactor. Locomotives that are, under certain circumstances, used in both passenger and freight service will be equipped with time element contactors that may be automatically adjusted for either class of service.