Train Control Developments

G. R. S. Automatic Train Control

THE General Railway Signal Company, has made several important developments in its train control equipment during the past few months. The information in this article does not cover the entire train control system of this company but is considered as supplementary to the article published on pages 105 to 108, inclusive, of the March, 1922, issue of the *Railway Signal Engineer*. Developments which have since been made in the speed control equipment, as being installed on the Chicago & North Western and other roads, is described in detail below.

This is a system designed to limit the speed of a train to any degree at any point. The fundamental principle consists of a time element device on the locomotive, operating in combination with pairs of inductors placed along the right-of-way, the spacing of the inductors determining the speed at which a train may pass the point in question without an automatic application of the brakes. The closer the spacing, the lower must be the speed while greater spacing permits of higher speeds.

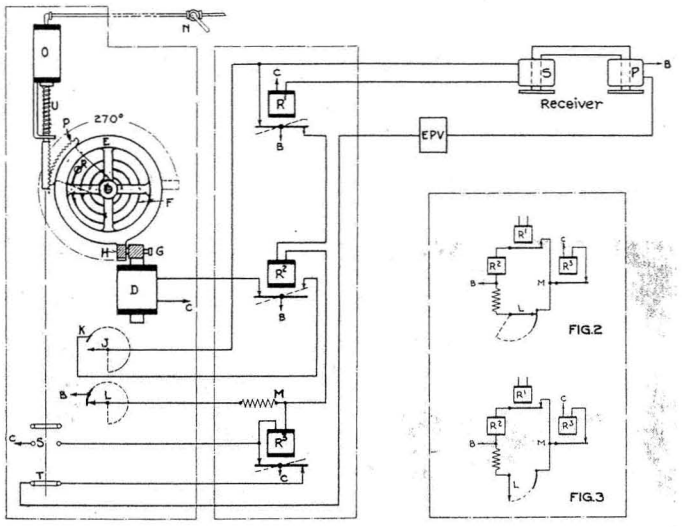

FIG. 1

Figs. 1, 2 and 3, Diagram of the Apparatus and Circuit Connections on the Locomotive

Circuit plans, Figs. 1, 2 and 3 illustrate the principles involved. The control is transmitted from the right-of-way on to the train through the medium of the receiver in the manner described in the March, 1922, *Railway Signal Engineer*, Fig. 1, page 105.

Relays Are Controlled By Balance Wheel

Upon passing an inductor on open circuit, as shown in Fig. 1, herewith, relay R^1 is opened, as indicated by the dotted line. This, in turn, de-energizes the secondary relay R^2 which in turn de-energizes magnet D; this then allows the balance wheel E, impelled by the spiral spring F and kick-off spring G, to swing approximately 270 degrees. In doing this the spiral spring first unwinds and then winds up in the opposite direction, prepared to cause the balance wheel to swing back to a position closely approximating its position of rest, as shown in the drawing; in fact, far enough to be under the influence of magnet D which in the meantime has become re-energized.

This balance wheel is of the same principle as the balance wheel in a watch, on which the accuracy of the timing of a watch is based. It is found that the time of the swing of this balance wheel is very accurate under extreme variations of temperature and shock and is independent of the battery voltage or other conditions.

As soon as the balance wheel starts rotating and armature H is away from the influence of magnet D, a contact JK, operated by the shaft of the balance wheel E, is made. The making of this contact then picks up relays R^1 and R^2 and re-energizes magnet D. The entire cycle takes place before contact BL is broken. This contact BL likewise being operated by the shaft of balance wheel E.

It will be noticed that relay R^3, which in turn directly controls the electro-pneumatic valve, is fed through two circuits, namely, BLM through its stick contact to common, and also BR^2M likewise through the stick to common. In order, therefore, that relay R^3 may drop and cause the application of the brakes, it is necessary to have both the circuits BLM and BR^2M open simultaneously. As stated above, the first impulse transmitted to relay R^1, starts the time element device E in operation, but the relay R^1 is picked up and the circuit BR^2M is made before the circuit BLM is opened and therefore relay R^3 is not de-energized. If, however, before reaching the next pair of inductors, the swing of balance wheel E has not been completed, circuit BLM will not be made and the opening of R^1 will deprive relay R^3 of current, therefore it drops and the air brakes are applied.

If, however, the train speed was such that upon reaching the second of a pair of inductors, the time element device E had completed its swing and closed circuit BLM, then the opening of relay R^1 would not deprive R^3 of current and there would be no application of the brakes. In other words, given a pair of inductors on the right-of-way, if a train passes from one inductor to the other and consumes the proper amount of time there will be no brake application, but if it operates too rapidly there will be a brake application. The arrangement shown is accurate to within a fraction of 1 mile an hour. The system in principle is perhaps more clearly illustrated by Fig. 2 and 3, the relay and contact designation being the same as in Fig. 1. It will be noticed that in Fig. 2 the relay R^3, which in turn directly controls the electro-pneumatic valve, is a stick device controlled through two multiple paths BR^2M and BLM. Passing the first inductor opens relay R^1 and thereby starts the contact L in operation. Relay R^1, however, being reset or picked up again before contact L opens its circuit does not deprive relay

R^3 of current If, however, as shown in Fig. 3, contact L is open when the next inductor is reached, the opening of relay R^1 will deprive relay R^3 of current which will drop, and remain open until it is manually restored.

Assuming the application of the brakes to have taken place, the train must stop in order that the engineman or fireman may dismount and effect the reset. The resetting is done through pneumatic means by operating valve handle N, Fig. 1. Operating this handle introduces air to a cylinder O, which operates a rack and in turn the sector P. The outer end of the spiral spring F being attached at R to this sector, is the medium through which

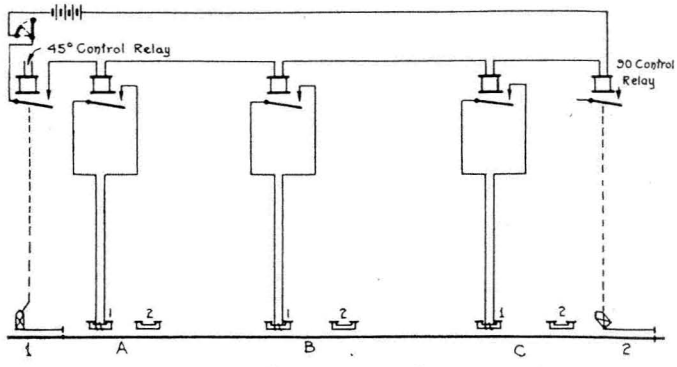

Fig. 4, Wayside Circuit Showing Connections with Signaling System

the wheel E is caused to swing up against magnet D, as a result of the operation of cylinder O. In normal operation, the sector P remains stationary, the balance wheel E operating independently of it.

It should be understood that subsequent to receiving the automatic application of the brakes, the balance wheel E will swing back and forth, finally coming to rest in a mid-position, and that therefore some means must be provided, controllable from a remote point, to push armature H up against magnet D in order that the system may be reset conveniently, and furthermore, relays R^1, R^2 and R^3, all having been de-energized, will likewise have to be picked up. This whole operation is effected through the medium of the cylinder O. This cylinder, in addition to moving armature H up against magnet D, will, on its way over, momentarily close contact JK through the medium of balance wheel E, which in turn will pick up relays R^1 and R^2, thereby re-energizing magnet D, which in turn will hold armature H when it is pushed up against the magnet by the action of the cylinder. When the cylinder is clear over, contact S is closed, which picks up relay R^3, thus completing the reset.

In order to be sure that valve N will not be left in the reset position, thereby cutting out the train control, a contact T is operated by the cylinder O which takes current off the electro-pneumatic valve, thereby putting on the brakes. The brakes remain on until, and unless, handle N is moved back to its normal position, thereby permitting the spring U to push the piston, rack P and spring support R, back to normal, after which the EPV becomes energized by the closing of the contact T and train operation may be resumed.

Tapered Speed Controlled By Spacing of Inductors

Figure 4 shows the wayside circuit, together with a set of inductors designed to force the speed of a train down to a very low point before it reaches the stop signal. In other words, it is the "tapered speed control" application to the system of intermittent inductive control.

A pair of inductors A, is placed near the signal and close together, so that if signal 1 is at stop, the speed of a train passing this point must be very slow to avoid an automatic application of the brakes. A pair of inductors B, is placed further back and further apart, necessitating that the speed of the train at this point be below a certain rate which is higher than that imposed by inductors A. Likewise, a pair of inductors C, is placed still further back and spaced further apart, which permits a higher train speed at this point than at B, without causing an automatic application. Pair C is placed braking distance away from signal 1, based on the equipment most difficult to stop. Therefore, a train approaching signal 1 at stop, must be governed by the caution signal 2 and must reduce speed properly to avoid being stopped.

The inductor 1 of each pair has a winding controlled by a line relay in series with the 90 degrees control relay, this relay being closed whenever signal 1 is at caution and the block ahead unoccupied. When the circuit is closed, inductor 1 has no influence on the train control apparatus and therefore only a single impulse will be received on passing any pair of inductors, thus resulting in only a single swing of the time element device and therefore no application of the brakes will result at any speed. If it is desired to provide a fixed speed limit, it becomes necessary only to install a pair of inductors, neither of them having windings. A train passing this point must therefore always be under the speed determined by the spacing of these inductors in order to avoid an automatic stop. By this means the normal speed of a train can be limited to any desired amount at any point and a fixed speed restriction may be enforced wherever desired.

Provision for Difference In Speeds of Freight or Passenger Trains

Referring again to the balance wheel of the time element device, it will be noted that if this wheel is weighted in some manner, that it will swing more slowly. This

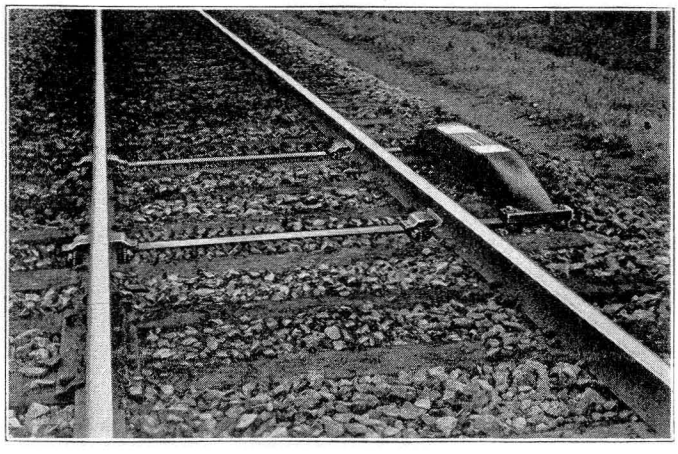

Fig. 5, An Inductor Clamped to the Rails

is actually provided for by means of a magnet which holds a ring in suspension. A tongue is on this ring and there is a groove on the balance wheel, E. When the magnet is de-energized, the ring will drop on to the balance wheel E and thereby increase its inertia, resulting in a slower swing; use is made of this to provide for the lower speeds of freight trains. By opening a circuit the proper speed control for freight trains is made effective and by closing the circuit, provision for passenger train speed control is effected. In other words, if a passenger train is limited to 60 m.p.h. at a given point, freight trains could be limited to 35 m.p.h. It should be noted further that the normal speed limit may be varied to suit local conditions. For example, if there is a momentum grade, freight trains may be permitted to "spurt" when

approaching the grade, in order to avoid the necessity of reducing tonnage, increasing power or using helpers, etc., and this may be done without improperly raising the speed limit at other points.

Inasmuch as it is a very simple matter to clamp a pair of inductors to the running rails, temporary speed restrictions can be enforced easily and held in force until such time as the inductors are removed or respaced. By the use of three inductors together, two wound and one unwound and by suitable selecting means for the wound inductor, three different speed limits may be provided

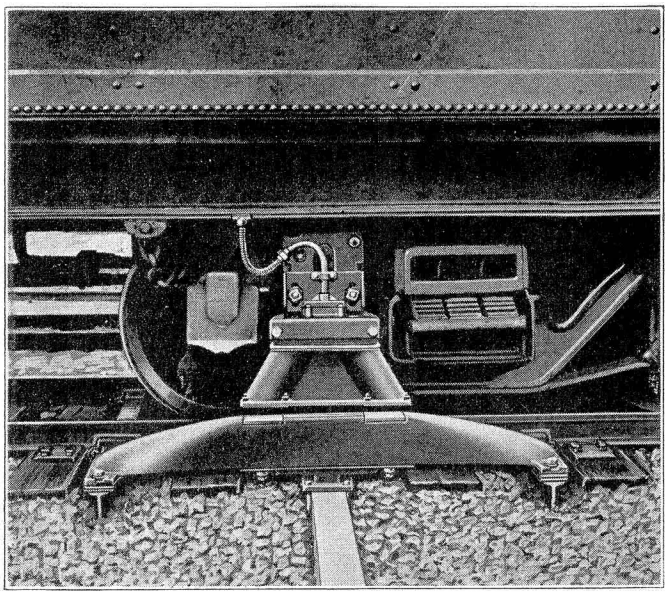

Fig. 6, A Receiving Element on a Locomotive, Standing Over An Inductor on the Track

for, or the speed limit may be eliminated entirely with both circuits closed.

Fundamental Parts Described In Detail

An inductor in place clamped to the running rails by means of insulated cross members is shown in Fig. 5. The housing is in a single manganese steel casting with the inductor magnetic circuit and coil mounted inside it. Figure 7 shows the relay box with the relays and time element device as called for by the circuit plan Fig. 1. The three relays are mounted on a common bakelite base protected by a sealed cover with a glass opening. The photograph also shows the top view of the time element device and through the opening in the plate, the holding coils M, Fig. 1 and air cylinder O, of Fig. 1. The terminal board shown at the lower right-hand corner of the inner housing is provided to receive the incoming cable. The relays, time element device and terminal board are all mounted on a common cast iron base held by four screws. Therefore, it is necessary only to remove the four screws and disconnect the cable and the air connection in order to remove the entire relay and time element unit. It will be noticed that there is an inner and an outer housing, the inner housing being floated against the effect of friction in all directions, to cause it to ride without severe jar or shock. The relays and time element device are separately covered and are inside of the containing box, which in turn is held within the outer box. Two dead air spaces are provided in order to eliminate condensation or moisture occurring on the operating parts.

The electro-pneumatic valve is shown in Fig. 8. The coil of this valve will be seen by reference to circuit plan, Fig. 1. It will be observed that the main frame is independent of the valve chamber below and of the casing above. This construction permits the removal of the valve chamber for inspection, without disconnecting the pipes. The valve may be located high in the air-brake system and kept warm so that there is little possibility of moisture collecting in the valve; should any collect, it could not freeze. It is well known that water and moisture may be present in almost any part of an air brake system and if it is in an exposed position to the cold, it is quite likely to freeze.

The brake valve handle actuator in place is shown in Fig. 9. This actuator has two cylinders with differential pistons, the small cylinder is fed by air direct and the large cylinder is fed by air through the medium of the electro-pneumatic valve. When the electro-pneumatic valve is open, the small cylinder pushes the piston over and causes a brake application. When the electro-pneumatic valve is closed, the large cylinder receives air, and overcoming the small cylinder, releases the automatic application. The initial movement of the piston, as the result of an automatic brake application, disconnects the handle from the valve proper so that a full service application of the brake is applied, irrespective of anything the engineman can do.

When the automatic application is released, it becomes necessary for the engineman merely to move his valve handle to the service position, at which time the handle and valve become reconnected and the brakes can be controlled in a normal manner. The system does not

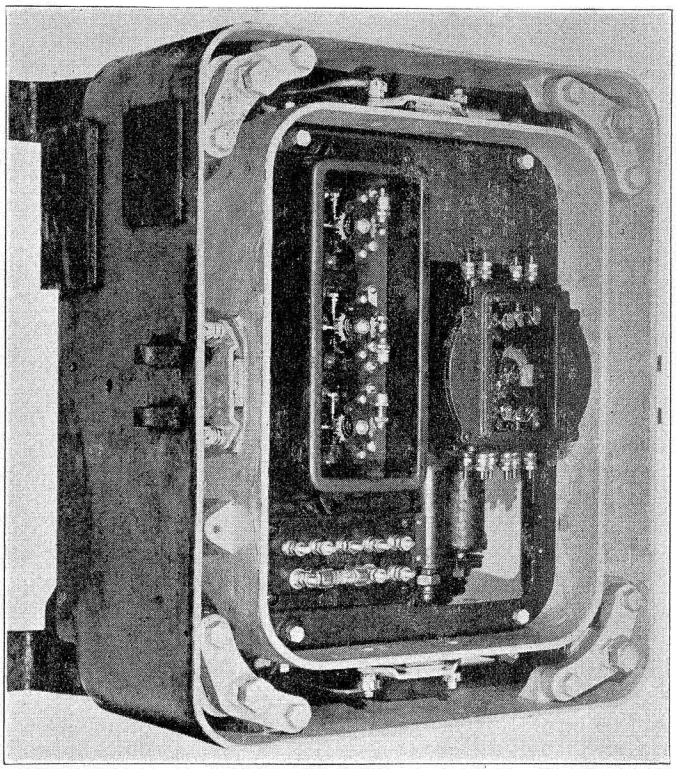

Fig. 7, Box with Relays and Time Element Device

prevent the engineman making an emergency application if necessary.

In applying this device, it is necessary to remove only the brake valve handle and assemble the actuator with its handle in place. In other words, it is not necessary to do anything to modify the internal construction of the air brake apparatus in any degree.

By the application of a small device (not shown) on the top of the actuator, which can be set and locked in either the "freight" or "passenger" position, it becomes

possible, as the result of an automatic application of the brakes, for the valve to be disconnected from the brake valve handle for passenger service, as explained above, but for freight service the valve is not disconnected from the brake valve handle. This arrangement, when set in the "freight" position, permits the engineman, by exerting pressure against the brake valve handle, to modify an automatic application. This action may be very desirable in case the automatic application should come on at a time, place and under loading conditions, which might

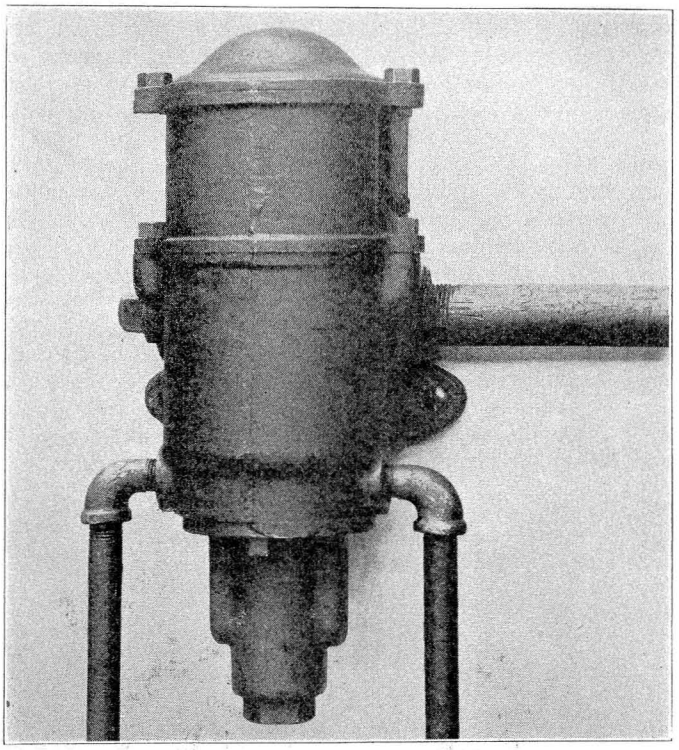

Fig. 8, The Electro-Pneumatic Valve May Be Taken Apart Readily

result in a buckled train. This attachment gives the engineman an opportunity to regain control of the brakes in case the application may result seriously. This feature is optional and may be provided, or not, as required.

Summary of the Advantages Claimed

In conclusion, the following features are claimed for this system as described above:

1. A means is provided of limiting the speed of a train to any desired rate at any point.
2. A means is provided for eliminating the control automatically at a given point or making it effective, depending on the conditions ahead, or the speed control can be left effective at all times, thereby providing a fixed speed limit.
3. A way is provided for controlling the speed of freight and passenger trains. This is an important feature because if it were impossible to control the trains differently, then the passenger trains would have to be limited to freight train speeds, or freight trains would have no control. The limiting of normal speeds becomes desirable where the maximum speed which a train can attain is much higher than the speed for which the system is installed. For example, if a system is installed, based on 60 m. p. h. for passenger trains, and a train should be running at 80 m. p. h., the braking distance would be so much greater that protection would be largely lost or greatly reduced. By having the controlled speed for freight and passenger trains different, there is greater efficiency in tapering down train speed on approaching a stop signal.
4. By placing a pair of inductors close together, the system becomes, in effect, an automatic stop effective at very low speeds. In this connection it often happens, especially on double track, that a system may be reconnected to give a full block overlap without materially influencing traffic capacity. In such a case it becomes necessary to use only one pair of inductors, which are placed at the signal in order to obtain full protection and this permits a train to move up to its stop signal without interference. The system may be used as a simple automatic stop or can be converted into tapered control at any point on the line by the use of two or more pairs of inductors. Thus with the same engine equipment the wayside apparatus may be installed to give anything from a simple automatic stop up to full tapered speed control.
5. In passing through a caution block, if an engineman reduces the speed of his train properly the train control will not act and therefore the train is permitted to resume normal speed should the signal next in advance assume a less restrictive position.
6. No manual operation other than that now performed by an engineman is necessary in making a move-

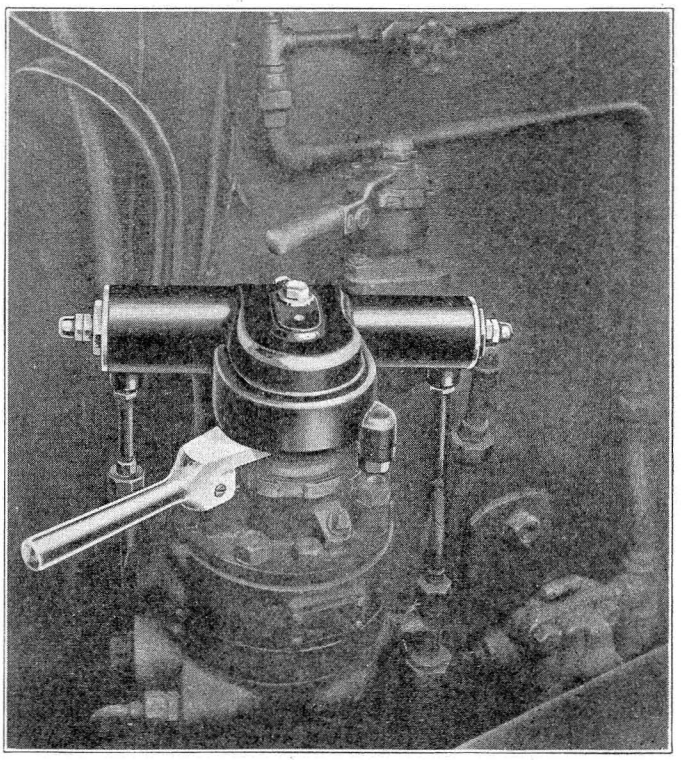

Fig. 9. The Brake Handle Actuator in Place on the Engineman's Brake Valve

ment against traffic or into or out of unequipped territory.

7. By the use of an automatic reversing switch and an extra receiver on the engine, trains can operate either forward or backward under protection of the train control.

The United States Civil Service Commission announces an open competitive examination for the Federal Civil Service for the position of radio engineer at from $4,000 to $5,000 a year, associate radio engineer at from $3,000 to $4,000 a year and assistant radio engineer at from $2,000 to $3,000 a year. Further details may be had by applying to the headquarters of the commission at Washington, D. C.