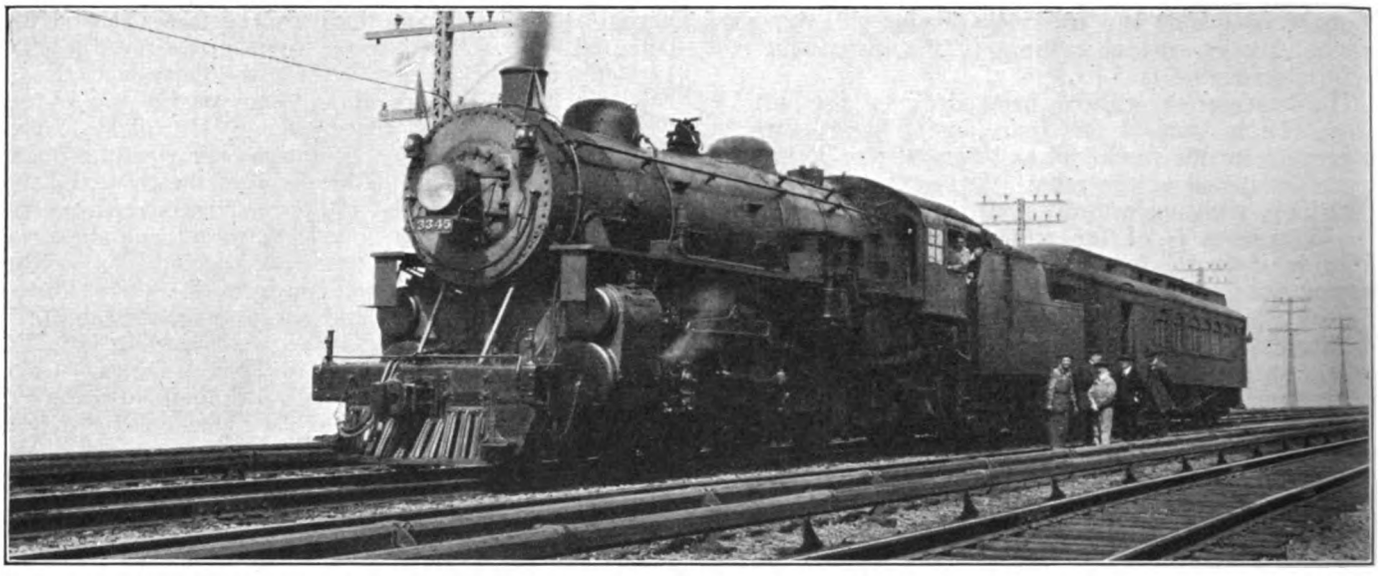
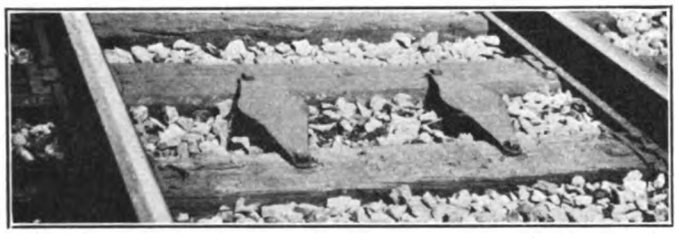


The Train Being Used on the New York Central to Test the Sprague Train Control System

The Sprague Train Control System

TESTS of the train control system developed by the Sprague Safety Control & Signal Corporation are now being carried on for seven hours a day, six days a week, on a section of the New York Central, between Ossining and Tarrytown, covering six signal indications on eastbound track No. 2. This is about 30 miles from New York. All other trains are temporarily excluded from this section and several hundred recording operations, under varying conditions, are made each week. Electric locomotives and multiple unit trains which take direct current from a third rail, with a traffic rail return, are operated on this section of the road. The automatic block signal system is normal clear and the rail circuits are alternating current.



The Two Pole Pieces of a Brake Application Magnet. The Permanent Magnet Which Connects Them Is Underneath the Ballast

The Sprague System of auxiliary train control, in the words of Frank J. Sprague, who is responsible for its development, is not an automaton in the place of an engineman, but an auxiliary system of train control which, while fully protecting the train and re-inforcing the engineman's intelligence, leaves him practically undisturbed in the handling of his train so long as he performs his duty.

All apparatus on the track, as well as on the locomotive, is operated on the normal danger plan. Assuming a train in the block section approaching the block to be protected (which may or may not be occupied by a preceding train) it encounters two normal-danger, brake-application magnets, one near the entrance end and one at the critical point in the block, and there is a differential reset magnet near the exit end.

The brake-application magnets are of the permanent magnet type with neutralizing coils wound on the two ends or pole pieces, while the reset is simply an electro magnet. All of the magnets are controlled by the track circuit relay of the section in advance, the brake applying magnets being normally alive and the reset dead.

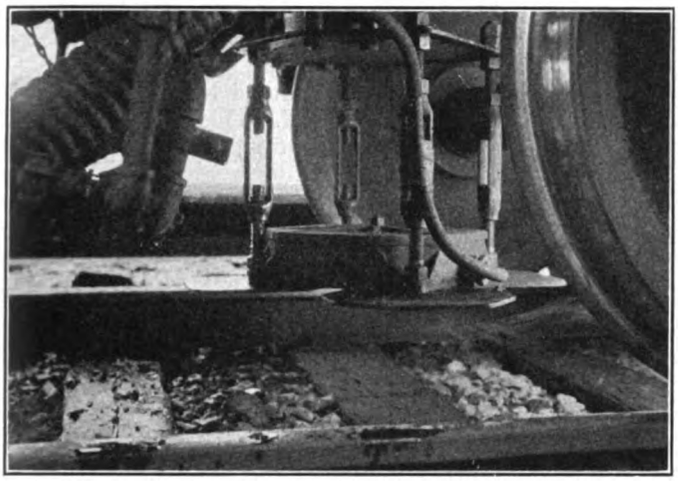
When a train enters this approach block, and the block ahead is clear, the application magnets are made inactive by the neutralizing coils, thus permitting the magnetically responsive receiver on the locomotive to pass through the space over the magnet poles without being affected. If the advance block is not clear then the application magnets will remain normal, or active, and the magnetic receiver on the locomotive is subject to their influence. The reset magnet then is inert.

The track magnets are endorsed for protection in sealed manganese steel casings which are supported in the ballast, between adjacent ties, by extension arms resting upon and secured to the ties. The application and reset magnets are placed at right angles to each other in the center of the track, the application magnets being parallel to the ties, and the reset magnets parallel to the rails. This insures proper registration and operation of the apparatus on the locomotive regardless of the direction of motion or heading of the locomotive. The faces of the magnet poles are between four and five inches lower than the tops of the running rails.

A Reset Magnet

Where direct current is used for signaling the clearing, or neutralizing current, can be taken direct from the signal batteries, but where alternating current is used the clearing current is, preferably, supplied from storage batteries which are maintained by a trickling charge from a. c. supply. Under normal conditions no current is used

on any of the track magnets when the track is clear, and current is used on the group of three magnets associated with each block only when a train is passing through such block and the next block in advance is clear. The amount of current thus used is, therefore, about 4 watts per magnet, and the average total of energy required on



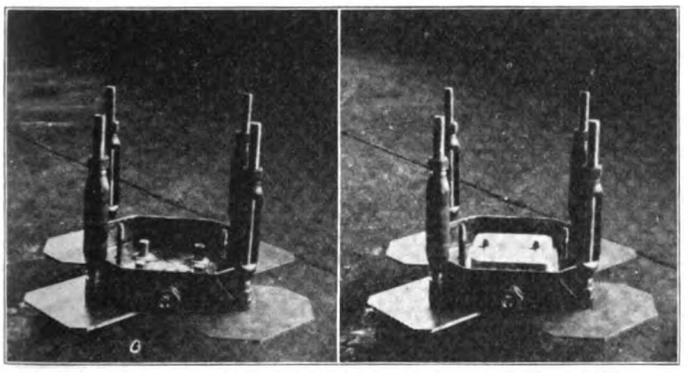
The Receiver Under the Forward End of the Tender

a division, expressed in kilowatts, is one-eightieth multiplied by the number of locomotives in service on the division, or roughly, 1 kw. for each 80 locomotives.

Locomotive Equipment

A double receiver is hung under the forward end of the tender on adjustable supports. This receiver is composed of two pairs of flat iron collector plates attached to the bottom of a non-magnetic box. These plates are from three to four inches higher than the tops of the running rails, thus making the distance from the track magnet to the receiver about seven or eight inches.

The magnet flux from the track magnet is carried,



Magnetic Receiver Without Cover Before and After Floating Coils Are Installed

through movable iron cores within the receiver box, to a floating receiver in which this flux is concentrated on one or the other of two moving armatures of small mass.

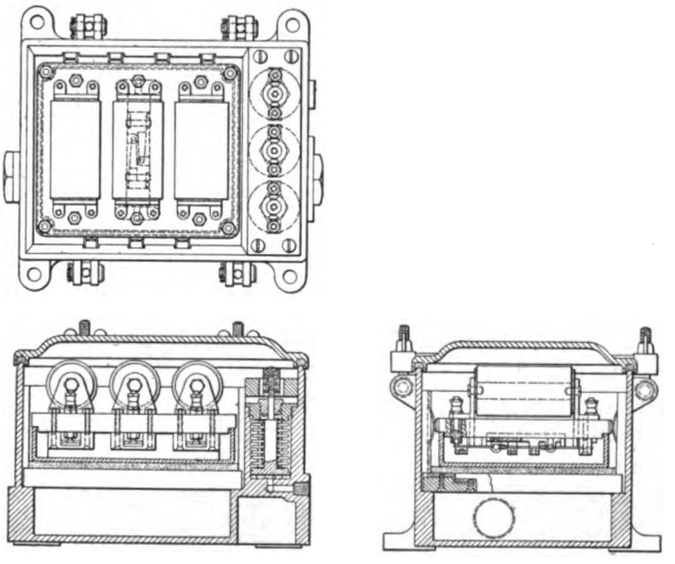
Relays

The application magnets affect one armature while the reset magnets affect the other. The tops of the pole pieces are eight inches in diameter, and when a locomotive is running at a high speed the receiver will pass over the track magnet in less than 1/100th of a second. During this time the small armature in the receiver breaks contact momentarily.

The momentary breaking of contact by the armature in the receiver is translated into action by relays mounted in a box located on the running board. Dependence is placed upon "interval" instead of "time" spacing, and the brake applications are primarily controlled by three interlocking relays—primary, secondary and reset—in series with the contacts in the locomotive receivers and operating in conjunction with other contacts under the co-ordinated control of train speed and manual braking. The relays are of the single coil type, mounted on a common base, and each has two reluctance gaps in series, which are spanned by gravity—and spring-retracted armatures making self-centering pressure contact only; no back contacts are used.

The two armature contactors, being of like electrical connection, are joined, and since the reluctance gaps are in series the making and breaking of the two contacts are practically simultaneous. The armatures and moving contacts, after fixed adjustment, are sealed, and provision is made for automatic connection with the relays through external contacts—four on one side and three on the other—which two sets of contacts are staggered so as to insure one possible connection.

The unit so assembled rests upon a cushioned base in



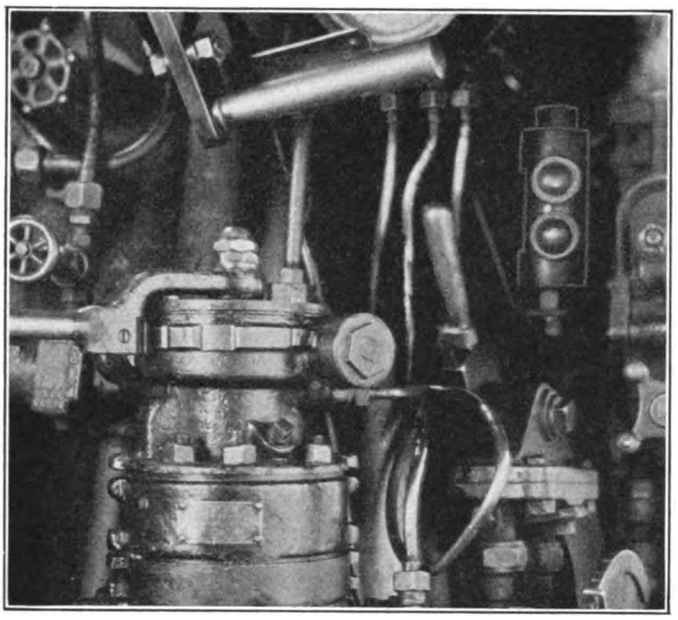
Plan and Sections of the Relays and Relay Case

a cover-closed relay box in the bottom of which is a common terminal board for the various control circuits, with automatic spring connections, and at the end of which are contained three air pressure-operated contacts shown in the general schematic drawings.

Valve Assembly

The impulses picked up by the receiver and passed on by the relays, result in influencing the action of two pilot control valves located underneath the cab on the fireman's side. The function of these control valves is to establish an opening to atmosphere from one or another of the piston chambers which control the movement of a ported slide valve. The operation of this valve will, as may be determined by a selector valve, effect any required combination of measured and limited light and heavy service and emergency brake applications under speed control, with or without enforced stop if the automatic brakes come on, or with the privilege of proceeding under limited speed until released. The operation of this valve assembly may cover any one of a number of different possibilities, depending upon the conditions of train make-up and of operation met in practice. Under usual conditions of operation, caution and stop signals will cause two brake applications, called primary and

secondary. The character of these two applications is governed by the selector valve. Primary and secondary braking may be used in any combination, for example as follows: 10-lb. and 25-lb. reduction; 25-lb. reduction and

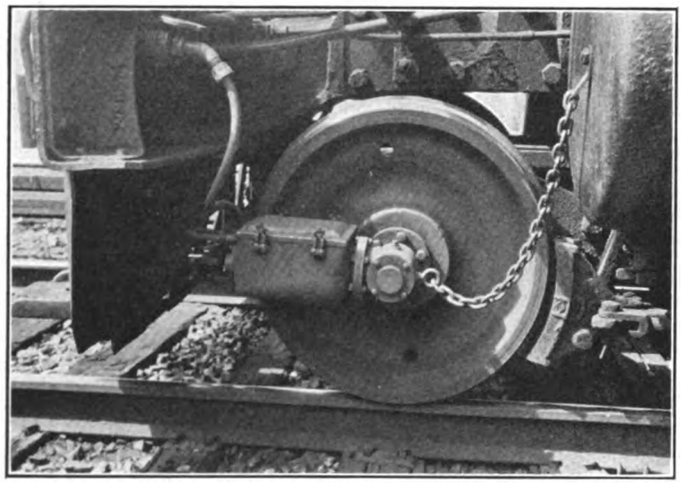


The Special Head for the Engineman's Brake Valve and One Pair of Signal Lamps

emergency application; nothing and 25 lb., and so on. The valve assembly is applicable to any kind of standard brake equipment.

Speed Control Mechanism

The speed control mechanism is carried on the front end of the locomotive, one end of it being supported on an extension of the forward truck axle. The other end



The Speed Control Mechanism

has a spring-suspended nose support. The drive is by enclosed bevel gearing running in oil, while the governor assembly is carried in a dry chamber in which there is a centrifugal governor, a small air cylinder and fixed and movable end-contact steel brushes.

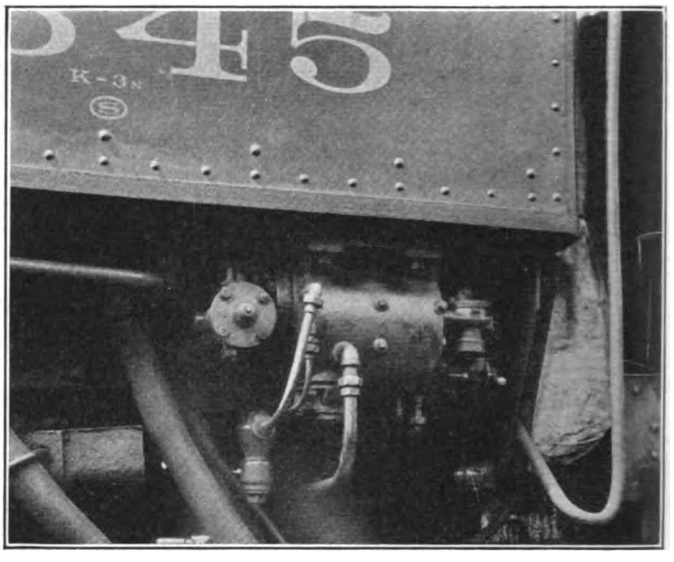
A single flexible air hose and a flexible electric cable, terminating in a standard coupling, are attached to the free end of the speed control mechanism. The air hose is connected to the engine brake system. The whole constitutes a combination of a speed-responsive device (not an odometer) and a brake-responsive device, by means of which the necessary co-ordination may be automatically secured to prevent unnecessary operation of automatic braking.

The remainder of the equipment on the locomotive consists of a small storage battery and the headlight generator for charging the storage battery; a manually and power-operated engineer's valve interchangeable with the standard valve; and two pairs of signal lamps, one on each side of the cab.

The engineman's valve is operated by air-oil pressure when a track impulse is received. This pressure is used to move the handle of the valve to lap position, the actual braking, other than manual, being accomplished by the automatic valves under the left side of the cab. The green lights show when the equipment is in running order and the block ahead is clear, and the yellow ones when the relation between speed and manual braking makes it safe to proceed under control.

First Impulse

When application contact 21 is momentarily opened, relays P and S are de-energized and drop their armatures P-1 and S-1. The dropping of P-1 opens stick con-



The Valve Assembly

tact 27 and the circuit of the primary pilot valve coil PPC, with resultant primary brake application. The dropping of armature S-1, while opening the stick contact 29, does not then break the circuit of relay S because the additional stick contact 31, controlled by armature R-1 of reset R, is still closed. The re-closing of contact 21 immediately energizes relay S and picks up armature S-1.

The application of pressure to the engineman's brake head puts pressure on the BHC switch, opens the reset circuit, breaks green lamp Gr, de-energizes reset relay R, drops armature R-1 and breaks contacts 31 and 32, relay S remaining energized through stick contact 29. There is, therefore, a condition established in which, instead of P, S and R being all active, as in normal running, P and R are opened and S is still alive.

The movement of the brake head pistons opens BHX to atmosphere and closes circuit from relay P through speed brush 9 and cylinder contact N to negative line through brush 11 and switch Sw. This response is permissible only when cylinder contact N, which is normally shifted to the left with increase of speed, is moved sufficiently far to the right to permit brush 9 to make con-

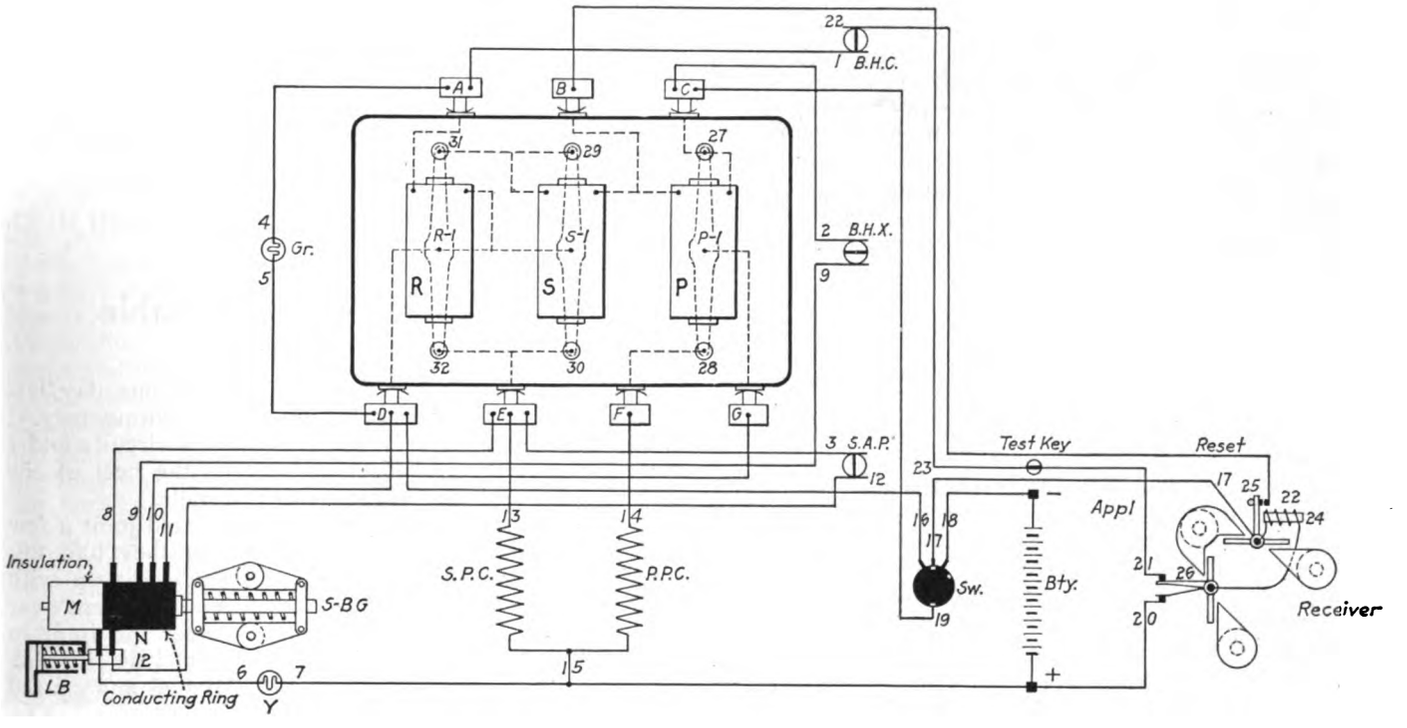
tact with cylinder N. Under these conditions relay P picks up and there is now established these conditions: P and S active and R dead, BHC being meanwhile closed on release of brake head pressure, relay contact 22, however, being left open.

Second Impulse

On second impulse from the track the contact 21 is again momentarily opened and P and S again de-energized, but this time (contact 31 at reset relay R being now open) the dropping of armature S-1 opens the stick contact 29 of relay S, and this relay therefore remains dead, although contact 21 has closed; relay P can be restored as before. The condition of the relays now is: P alive and S and R dead, and two of the four circuits, 8-3-30 and 32, in parallel and connected through 13 to through contact 31 all circuits, relays and pilot valve coils are restored to normal condition. If only one application impulse has been received, the reset contact on the receiver simply restores R and Gr to an active condition, S already being energized.

Operation

On entrance to every block the cab signals indicate whether or not the next block in advance is occupied. If the signal at the entrance of the advance block is at caution, then, on passing over a live distant magnet, the green light disappears, an audible warning is given and a service brake application is initiated, this being light or heavy, depending upon how the selector valve is set. The yellow proceed light appears if braking is sufficient to forestall secondary braking at the home magnet.



Bty .....Battery.
SW .....Main switch.
P, S and R.....Primary and secondary pilot valve coils.
PPC and SPC...Primary and secondary valve coils.
MN .....Speed-brake controller.
26-25 .....Application and reset armatures.

Gr and Y.....Green and yellow lights.
BHC and SAP..Contacts operated by pressure in brake head cylinder and straight air pipe.
BHX .....Contact operated by absence of pressure in brake head exhaust.

A Complete Diagram of the Electrical Circuits and Connections on the Locomotive

the secondary pilot valve SPC, are opened, leaving the control of SPC through brush 8, or movable brush 12 and the switch operated by SAP.

Brush 12 and brush 6, connected to proceed light Y, are moved to the left by pressure in the locomotive brake system in the same direction as NM is moved by the centrifugal governor. If SAP is opened then the final control is on brush 8, but if SAP is closed the control is shifted to brush 12, that is, to a co-ordinated position depending upon speed and braking. Contact 6 breaks before contact 12, and hence the yellow light Y becomes a warning and proceed light.

Reset Impulse

On receiving a reset impulse, contact 22 is closed by armature 25 and locked closed by holding coil 24, which is a part of the receiver. Relay R is, therefore, made active; contacts 31 and 32 are closed by R-1 and green lamp Gr. is lighted, while S is likewise re-energized and

The engineman's brake handle will be moved to lap position, but it can then, with effort, be pushed back to the release position, against the brake-head operating pressure on the motor pistons, which pressure will then be promptly released if the train is not running above the predetermined caution entrance speed. If the engineman is attending to his duty he may, therefore, forestall actual braking of the train or he may promptly release his brakes in response to a change in roadside signal indications. The automatic service brake application may be augmented or diminished manually at will. If the selector valve has been set for no primary brake application, as may be required in the movement of slow freights, then only an alarm will be given if the speed is under control.

If the engineman, while approaching the home magnet, makes a service brake application, the yellow light will appear in the cab whenever there is sufficient braking to insure reducing the speed to "control" speed in a suit-

able distance after passing a live home magnet without automatic secondary braking. If the danger condition persists when passing the home magnet a second service braking will be initiated, which may likewise be released by the engineman, but conditions are established for an immediate or subsequent secondary brake application, according to the speed and braking conditions which then or thereafter obtain within the block.

If when getting the second impulse at a live home magnet the locomotive is running without braking and below the determined control speed, say 15 or 20 miles an hour, as indicated by the yellow lamp, and so continues until reaching the reset magnet, there will be no secondary brake application, but if the speed is increased and goes above the control speed before passing an active reset magnet, the brakes will be applied.

If the engine when passing a live home magnet is running below the predetermined speed limit, say 45 or 50 miles an hour, and the train as a whole is being properly braked under a manual or automatic service application, the secondary braking will not take place; but if the brakes are released before reaching the control speed, then a heavy service or emergency braking will occur, depending upon the setting of the selector valve. The secondary brake cannot be released, however, until it has completed its function, no matter how short the initial impulse or whatever the engineman attempts to do with his brake handle.

When the speed has been reduced to "control," the brakes may be released, but if the speed is later increased above the low limit before passing an active reset magnet, the secondary or emergency braking will again take place.

If the engine when passing a live home magnet is running above a predetermined high speed limit then there will be an uncontrolled secondary braking which cannot be released until its function has been completed.

When running above a predetermined allowed maximum speed on a clear track, a service brake will come on, regardless of the roadside signal indication, and the train speed must be pulled down to a safe caution block entrance speed to have the pressure on the engineer's brake handle released before passing a reset magnet. If under these conditions a train, having had a maximum speed brake impulse and not having been pulled down to a suitable speed, should enter a caution block, then it will get a secondary braking at the first application magnet.

If under any conditions the secondary brake has come on, the predetermined set of the selector valve will determine whether the train can proceed under control on the engineman's initiative alone, or whether the train must first be brought to a stop and require the co-operation of the engineman and fireman outside of the cab to release the brakes.

When passing over a live reset magnet the engine relays will be restored to normal position, ready for response to the next live application magnet, no matter whether there have been one or two application impulses received, and if none has been received the reset impulse will have no effect on the apparatus. The reset only restores the control relays to normal; it has no effect on the brakes. If, however, when passing the reset magnet it is not energized by the clearing of the home signal, the reset will not act and the allowed speed will be held down to the control limit, but the train may proceed into and through the next block under control.

If the conductor unlocks a control switch he can temporarily give to the engineer and fireman the privilege of joint action to establish an early reset, if and only when the proceed cab light is in evidence. In interlocked or other special territory an additional reset magnet may be installed to permit earlier acceleration in case the signals go to clear, and provision can also be made, subject to the positive control of the train conductor, so that simultaneous co-ordinated action by an engineer and his fireman can reset the relays to normal.

The response to the service brake impulses, and to the secondary brake impulses when exceeding the speed limits, as well as to the resets, is exceedingly rapid, and both brake controls are operated on closed circuits.

Sections under speed control, as for example, dangerous curves or bridge or crossing approaches, may be treated as permanent signal blocks, each being provided with one or more permanent application magnets to initiate service braking at the proper point if the speed is excessive, or later if it is augmented, and a permanent reset magnet after the curve is passed. Portable magnets may also be used for wayside emergency conditions control.

The brakes once applied, the actuating pressure on the brake valve handle persists until the speed is reduced to a predetermined limit, which is individual to each class of locomotive.

All of the electrical connections in the apparatus are shown in the diagram.

This train control system was developed by the Sprague Safety Control & Signal Corporation, 421 Canal street, N. Y.

An Unusual Case of Trouble

By Pete Bogg

I was called to a crossing bell location one day last winter, the bell being reported as ringing continuously. I found the trouble to be in one of the track circuits and I traced it to an insulated joint between the heel of the switch point and the frog on the lead rails.

The section men had repaired this insulated joint a few days before the failure occurred. After they had finished repairing the joint they had shimmed it up with a piece of board which had a nail in it that was bent over flat. The section men got the shim under the joint in such a way that the end of both rails rested on the nail, which formed a metallic path for the current and caused a short on the track circuit.

Publicity For Signaling

Local newspapers and national journals should be encouraged to publish news items on important signal construction. We are indebted to W. H. Arkenbaugh of the National Carbon Company for calling our attention to the following item published in the Christian Science Monitor of May 11:

Great Northern's New Signal Work

St. Paul, May 11.—The Great Northern road will have 1,075 miles of main track equipped with automatic block signals with the completion of this season's improvement program. A contract for $500,000 of block signal installation to be placed this coming summer has been awarded the General Railway Signal Company. Signals are being installed in Minnesota, Montana, Idaho and Washington. The new features include the elimination of separate primary battery vaults by the substitution of individual storage batteries in the base of the signal housing.

The signal department is also installing unique automatic plants on the Mesabi iron range, one of which is for the protection of a single track bridge where signals controlling the movement of opposing trains will be automatically operated by the trains themselves. At several points long distance, low voltage switch throwing devices are being installed. These permit the interlocking operator to throw a switch a mile or more away from the interlocking plant, and so avoid the danger and delay occasioned by forcing trains to stop and some member of its crew throw the switch.