Some Points to Consider in Selection of Train Control

By E. L. Adams

In view of the recent proposed order of the Interstate Commerce Commission to require installations of automatic train control on a number of railroads, it may be well to touch on some points which should be considered by those studying this subject. The installation, maintenance and operation of any automatic train control scheme will require the operating, engineering, motive power and signal departments to work in much closer co-operation than is necessary in connection with almost any other apparatus or device now in use.

Operating officers may find it necessary to revise some of their rules and methods to comply with the demands of the particular type of train control that may be adopted. The engineering department will have to consider clearances and the relation of the apparatus installed on the roadway and locomotive to other parts of the track and structures. The motive power department must consider the application of the apparatus to the locomotive and the effect of its operation on the braking of trains. The signal department will have to tie the control into the signal system and should be the one to co-ordinate all of the interested departments.

All interested departments must work together in deciding on the system which should be used; after which the incidental details can be worked out. The maintenance and operation will most directly concern the motive power and signal departments. These two must necessarily work together very closely in order to obtain satisfactory results. In addition, the operating department will have a very large share in making the operation of the scheme satisfactory.

In general there are two types of control—intermittent and continuous. Intermittent control, as its name signifies, is such that the control is effected intermittently at certain predetermined points and the control in effect just after passing one control point may or may not be maintained until a stop is produced or another control point passed, depending on the extent to which the control is carried. Continuous control operates throughout the protected section of track so that every change from a safe to a dangerous, or from a dangerous to a safe condition ahead, is at once transmitted to the control apparatus on the locomotive.

The various train control devices may be divided into two general classes: One, when actual physical contact is required between the apparatus on the roadway and that on the locomotive; the other, where physical contact is not required. These have been classified further by the Automatic Train Control Committee of the United States Railroad Administration. With either of these two classes of control the device used may be such as simply to produce a stop when conditions require or may in addition control automatically the speed under predetermined conditions.

It is not the intention to discuss the relative merits of the schemes of control, or of the various devices that have been tried out with more or less thoroughness. It is more the object to call attention to some of the questions that must be considered before adopting any device.

The first question that must be answered is—"To what extent are we going to control our trains?" A device may be installed that will operate to open the line automatically and keep it open until a stop is produced, when conditions ahead are such as to require a stop. Such a device will operate at any speed and for any class of train with any number of cars. It may be arranged so that it will operate regardless of any action of the engineman, or it may be considered safe to add apparatus so that the operation may be prevented either by the engineman alone or by the engineman and fireman acting together. Then, if for any reason such action is not taken, the stop will result. In any event after a stop had been produced, there will be no control of the speed in a permissive block.

More complete protection and perhaps better operating conditions may be obtained by adding to the device apparatus which is governed by the speed of the train, and arranged so that the train line will be opened only when certain definite speeds were being executed. Such speeds depend on the condition of the block or the indication of the signal ahead of the train. Any of these arrangements can be provided with either intermittent or continuous control schemes. It seems that the operating officers must be the ones to decide that question, after considering, with the air brake experts, the effect on the braking of trains. In fact, it comes to the question of whether the engineman can be depended on to handle his train according to prescribed rules, provided he knows what the conditions are ahead.

The next question to decide is whether a device requiring physical contact between the apparatus on the roadway and that on the locomotive, or one that does not require such contact is to be used. With any device requiring physical contact, either the roadway apparatus must extend inside or the locomotive apparatus outside of the established clearances. Existing clearances must therefore be looked into very thoroughly in connection with this type of device and may be a determining factor in some cases.

With non-contact devices, clearances do not need to be considered. Decision as to the type of device should depend on reliability, adaptability, cost of operation and maintenance, first cost.

The air brake expert must consider the effect on the braking of trains when the train line is opened and held open continuously until a complete stop is produced or, if speed control is used, until the speed is reduced to a predetermined rate. This means that instead of making a definite reduction of brake pipe pressure sufficient to reduce the speed to the required rate in the distance available and then lapping the valve as the engineman would do, the brake pipe pressure drops continuously from the time of application until the prescribed rate of speed is reached. This may, in some cases, result in an emergency application at low speed. Another important point in connection with braking is the effect of bleeding the train line on grades, thus leaving the train without air. Another condition which may arise is an automatic application with an uncontrolled reduction at low speeds. When this happens on a long freight train that is drifting, the results will be more or less disastrous, depending upon a number of conditions.

The relative location of the stop indication point and the signal or stopping place presents some difficulties. In this connection it must be decided whether the automatic application shall be made after the engineman has demonstrated that he has not stopped at the place he should have stopped at or that he is not going to stop at that place. In other words, shall the stop indication point be located at the stopping place, or at braking distance from it? If the track element is placed at the signal, an overlap of at least braking distance must be provided. This would ordinarily mean a full block overlap which would present some difficulties at interlockings and on single track. If the stop indication point is located at braking distance from the stopping place, this distance must be the longest that is required in which to stop trains. Slower or lighter trains would then stop at varying distances from the required stopping point. Such a condition might mean a change in the rule regarding stops at signals.

If the requisite that the "Indications of the fixed signal depend on the operation of the track element" be enforced, then with the stop indication point located at braking distance from the signal, a train might stand close up to a clear signal and a following train approach and receive a clear indication at the indication point just in the rear of the standing train. The approach indication point should, of course, be located a sufficient distance from the stop indication point to reduce the speed to that required at that point.

A full block overlap would undoubtedly reduce the capacity of the road. On single track a number of complications would be introduced, especially at sidings.

If the stop indication point were located at braking distance from the signal it would effect the capacity of the road only to the extent that extra stops might have to be made or on account of the increased distance that the train proceed at a low rate of speed after stopping.

When all main tracks and all locomotives are equipped with automatic train control it will be necessary that the roadway apparatus on all roads either work with or not interfere with engine apparatus on all other roads in the United States. This is because of the fact that the effect of overlapping joint track actually extends over the entire country. If this is not done it will be necessary to restrict the locomotives of some roads or divisions to a given territory.

During the development of the art it may be advisable to ignore this to some extent with the idea that original installations will be of an experimental nature that may ultimately be entirely changed, and the only way to detremine the best scheme is to put a number in operation for comparison.

Finnigan Automatic Train Control

GEORGE P. FINNIGAN of Richmond, Va., who made extensive experiments on the Interborough Rapid Transit Lines in New York City, in 1910 and 1911, and later for two years on the Pennsylvania Railroad between New York and Philadelphia, is still in the field, and his design of train control apparatus, which was the first to employ a permanent magnet on the roadway, is well known to many signal engineers. He has no installation in service at the present time, but he has favored us with a drawing which illustrates the main principle of his system. This we shall briefly describe.

The permanent magnet is fixed in a wooden box, at the level of the ties, and surrounded by cement. The box is about 5 in. by 6 in. and about 4 ft. long, extending from the center of the track to the end of the tie at one side. The winding of the electro-magnet on the roadway surrounds a laminated pole piece which extends upward, the top of the outer case being at a height 1 inch lower than the tops of the running rails. This winding is energized by the track relay of the section to be protected.

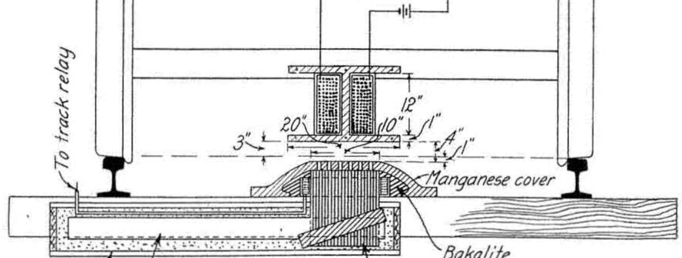
The iron bar shown in an inclined position clamps the pole piece to the permanent magnet. This apparatus is fully waterproofed.

The collector coil on the locomotive passes at from 4 in. to 6 in. above the roadway box. This collector coil is a part of a closed circuit, energized by a battery consisting of a single dry cell, which controls the Finnigan automatic air valve, shown at the top of the drawing. The inductive resistance in this circuit, shown at the right of the drawing, is adjustable and its function is to determine at what speed the train may pass a control point without an application of the brakes. The roadway apparatus is, of course, located full braking distance to the rear of the entrance of the section to be protected.

Assuming a train approaching a control point when the track relay governing this roadway magnet is closed (section ahead clear), the current in the electro-magnet diverts the lines of force of the permanent magnet so that they do not affect the engine coil (at any speed).

With the governing track relay opened (section ahead occupied by a train) the flux of the permanent magnet causes the application of the brakes. It acts on the engine-carried collector coil and affects the engine circuit according to the speed of the train, the number of turns of wire in the collector coil, and the number of lines of force from the permanent magnet cut by the engine-carried coil.

Assuming that trains are not to be stopped unless they are moving at five miles an hour or over; assuming also that at that speed the train generates 1½ volts and that



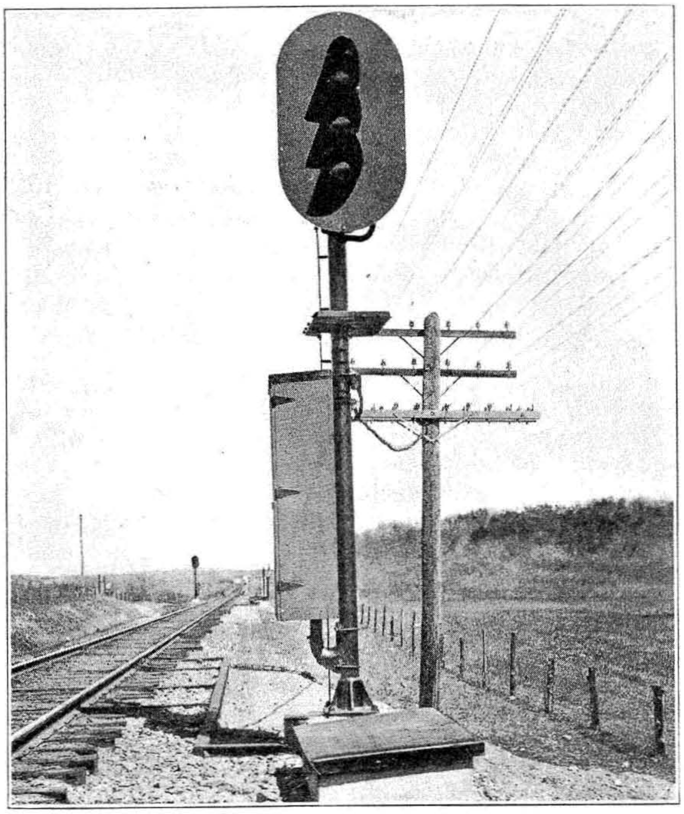
Circuit Diagrams of Finnigan Device

the engine battery has a potential of 1½ volts, the e. m. f. generated in the train circuit by the passage of the train will cause the battery to react and the air valve will function. At any speed below 5 miles an hour, the e. m. f. generated will be insufficient to affect the engine-carried battery and no brake application takes place.

It will be noted that all these operations take place without requiring the movement of any part, or the opening or closing of any electric contact.

American Train Control System

THE apparatus of the American Train Control Company was first developed on the Maryland & Pennsylvania railroad and was brought before the Interstate Commerce Commission in 1907. It was not fully developed, however, until the apparatus was installed on the Chesapeake & Ohio. The first complete



A Light Signal Location

tests made on that road were carried out in March, 1916. The track circuits and control wires, as developed by Charles Stephens, signal engineer of the road (and patented by him), are arranged on the "absolute permissive block" plan. Following the tests in March, 1919, an installation was completed between Gordonsville, Va., and Charlottesville, a distance of 21 miles single track, in conjunction with the installation of color light automatic block signals.

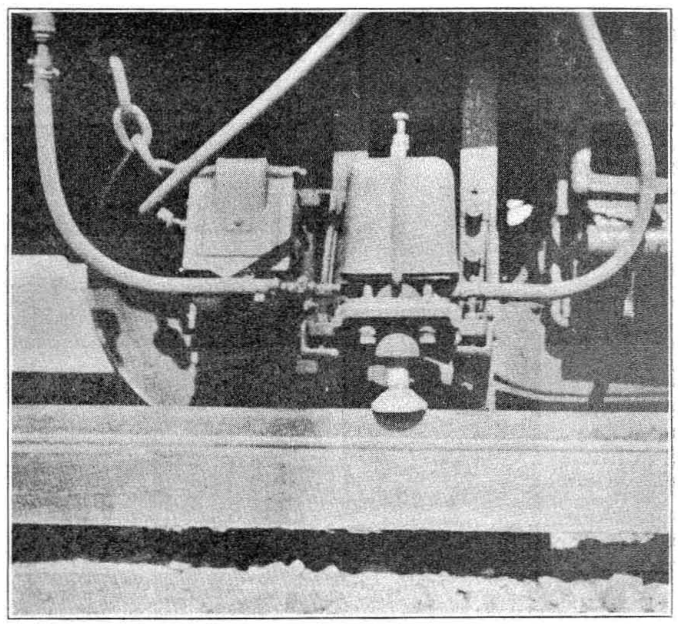
The installation between Charlottesville, Va., and Gordonville on the C. & O. was inspected by the Automatic Train Control Committee under the Railroad Administration on April 15 and 16, 1919, at which time 21 miles were in service and 32 engines were equipped. This installation has now been in service for three years.

The system is of the "intermittent contact" or ramp type. The ramp is fixed to the ties 27½ in. outside the gage line of the running rail. On the right hand side of the track all of the ramps are arranged to apply the brakes (when the block ahead is not clear); while on the left hand side all of the ramps are arranged to give only the cautionary indication in the cab. In connection with each three-indication signal there are two ramps, one on the left hand side corresponding to the cautionary indication of the signal, and one on the right corresponding to the stop indication of the signal.

The installation of automatic block signals of the color type light is now being extended 20 miles to Staunton, Va., and train control apparatus is being extended to cover this territory. Some 38 locomotives are now equipped with the automatic control apparatus and as soon as the extended control facilities are in service all locomotives operating over both divisions are to be equipped. With the latest improvements of the device the cab signal and application of the air control are operated by one shoe from one ramp.

The Contact Shoe

The contact shoes are of the single moving element vertical rise type. The diagram shows the interior of the contact shoe and the method of operation of the circuit breaker, contacts *X* and *Y*, and the shoe pressure mechanism. The contact piece is free to turn at will and the contact *D* is circular in form for making proper contact irrespective of the position of contact *C* and plunger *B*. The contacts *X* and *Y* are arranged one above the other, so that when the shoe passes over a ramp rail the plunger rod *B* is forced up, the contact *Y* will pass off the contact cylinder *D* on the insulating rubbing ring *W*, when the plunger rod has raised from ½ to ¾ in. Contact *X* is so arranged that it never goes off the cylinder *D* when the shoe is raised to full height,



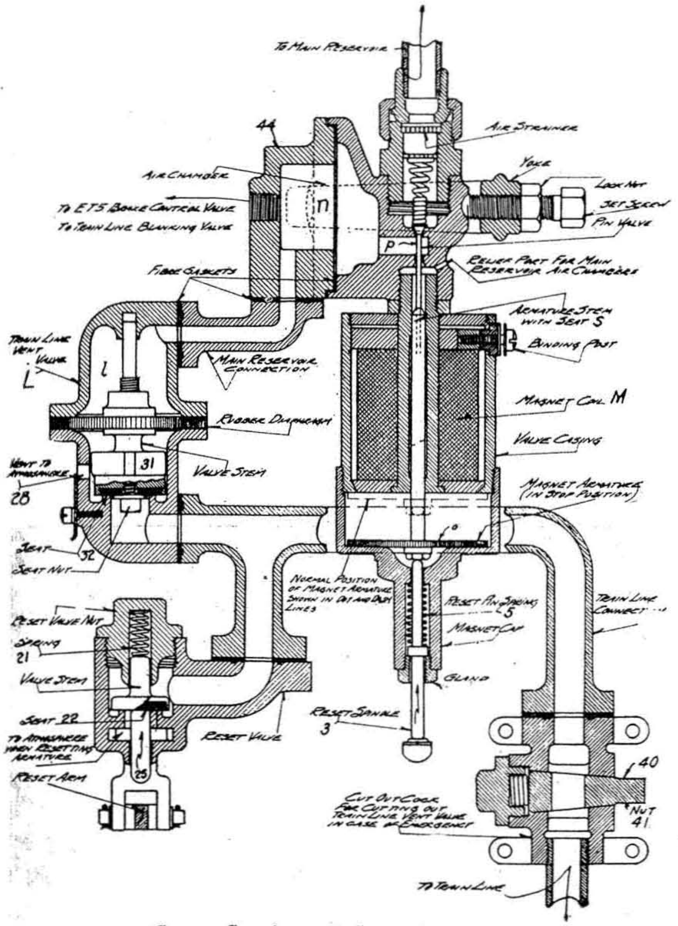
The Contact Shoe

and this cylinder is in constant electrical contact with the plunger rod *B* and contact *C*. Plunger rod *B* is insulated from all other parts of the contact shoe and the frame of the engine.

The contacts *X* and *Y* are supported on an insulating block *S* securely fastened to the top housing. The bell contact shown on top of the cylindrical contact *D* is insulated from the plunger *B* and the contact *D*, and the two bell contacts are arranged to close when the shoe raises about ¼ in., thereby ringing a vibrating bell in the cab each time the contact shoe goes over a ramp rail. Certain designs provide an electric light and an air whistle in the cab eliminating the electric bell. The contact shoe is fastened at a distance of 27½ in. from the gage of rail and the contact piece rides 4½ in. above the top of running rail. These clearances were necessary because of various types of engines in use on the Chesapeake & Ohio. One added feature not shown in the diagram is the extension of the air connection into the shoe, in such a manner that providing the shoe is broken off the exhaust of air will operate the brake mechanism.

The Valves Used

The train line blanking valve is installed as a by-pass valve for the train line pressure between the engineman's brake valve and the double-heading cock. A cut-out



Cross Section of Stop Apparatus

cock is provided in this same line and its position is sealed closed, so that the train line air will have to go through the blanking valve in order to get to the train line on the train. This valve is of the differential piston type. Its function is to cut off or blank the train line pressure from the train upon receipt of an automatic stop. This prevents the engineman from releasing the brakes on the train until it has been brought to a full stop.

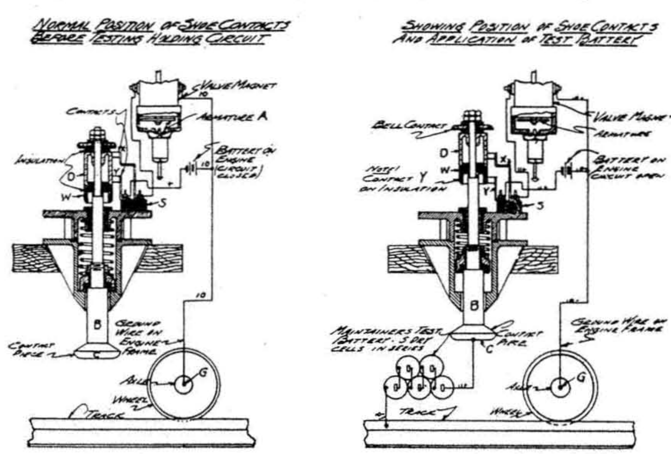
By referring to the diagram the operation of the magnet valve may be followed. It is seen that the armature (shown down) has a stem *S*, the upper end of which forms a seat and a cavity to guide the pin valve *p*. When the armature is energized the stem *S* is raised, which in turn pushes the pin valve *p* off its seat, thereby allowing main reservoir air pressure to pass into chamber *n* of the magnet valve body, and chamber *l* of the train line vent valve as well as to chambers *e* and *d* of the train line blanking valve and brake control valve, respectively.

Referring to the train line vent valve, the main reservoir pressure in chamber *l* causes the diaphragm to press down valve stem *31* seating soft seat *32*, thus preventing train line air pressure, which is in the lower chamber of the vent valve, from escaping to atmosphere through the vent port *28*. The main reservoir air pressure in chamber *l* of the vent valve, chamber *n* of the magnet valve, chamber *e* of the train line blanking valve and chamber *d* of the brake control valve is held in check by means of the armature stem seating and closing the relief port for main reservoir air pressure. When the magnet drops for any reason this relief port is opened to atmosphere, thereby relieving this pressure in all the chambers mentioned above, which in turn allows the opposing pressure to work its respective valve and perform its functions.

If the stop shoe passes over a de-energized ramp rail, the circuit to the magnet *M* is interrupted and armature *e* drops, causing pin valve *p* to seat and cut off main reservoir pressure from the top of the diaphragm in the vent valve, and, as stated above, allows the air that was in the chamber *l* to escape to atmosphere through the relief port. Train line pressure on the bottom side of seat *32* forces that seat open, allowing train line air pressure to escape to the atmosphere through port *28*. This train line air is piped from over the top of the engineman's cut-out cock directly in the train line, so that when it becomes necessary for him to double-head he automatically cuts out the automatic stop valve. This same magnet is made to control the operation of holding the train line blanking valve and the brake control valve open by main reservoir pressure in the same manner as the vent valve.

A cut-out cock is put in the valve box to provide means for the engineman to prevent the operation of the automatic stop valve venting the train line air to atmosphere, whenever there is necessity to do so, as in case of broken pipes, failed parts or broken battery wires, etc. This escaping air must be stopped or the train cannot move.

The reset valve is placed in the other path of the train line air as shown in the diagram. This valve is a normally closed air valve and the only time it is opened is



Shoe Circuit and Method of Testing

when the engineman resets the stop valve after an automatic application of the air brakes occasioned by the magnet valve dropping. It serves a triple purpose in that it resets the armature of magnet *M*, which drops away too far for it to pick up after it has once dropped; it vents train line pressure through a double port on either side of the valve when it is held up and this prevents the engineman or others from tying this valve up to prevent the magnet valve armature acting; it also serves to give the engineman and the maintainer an indication that the blanking valve on the engine is working properly, because upon receipt of a stop the blanking valve shuts off train line pressure from the train and allows this pressure to drain off of the vent valve. With a train this takes longer to do than it does on a light engine, but the engineman or maintainer can immediately tell when the blanking valve opens as a surge of air will come from the reset valve.

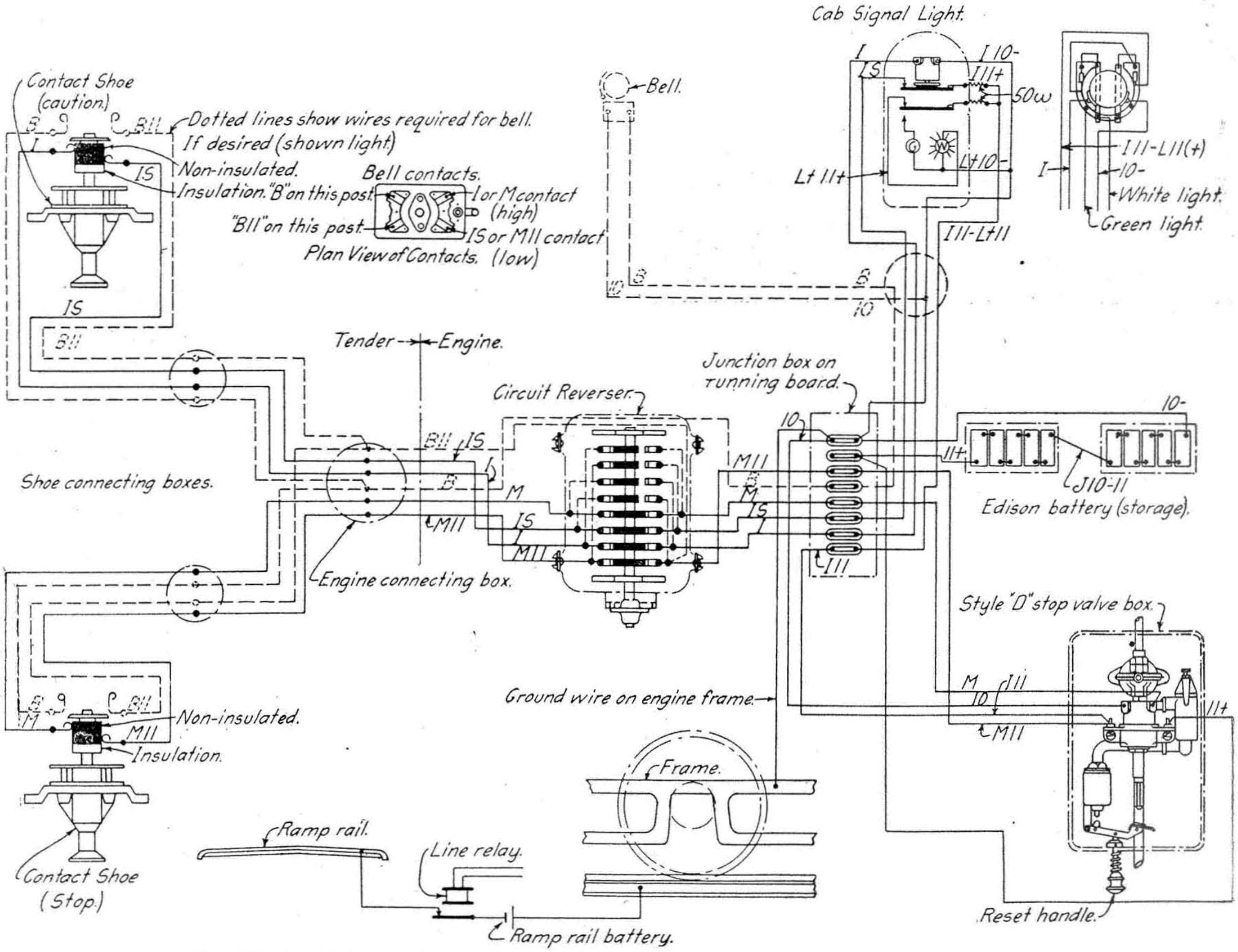
The action in resetting the valve magnet is as follows: Attached to the bottom of the reset valve is an arm called the reset arm, which is pivoted at one end. Directly under the reset valve stem *25* there is a pin which is fixed to engage it when the reset handle is pushed upward. The end of this reset arm has a flat circular piece on it in line with the reset spindle *3* of the valve magnet. This reset spindle is arranged to slide easily upwards, and is held down constantly by a compression spring *5* in the stem of the magnet cap. When the reset handle is pushed upward valve stem *25* is raised off its seat, and at the same time reset spindle *3* is pushed upwards, which places the armature *0* of the magnet valve closer to the coil. When the armature is close enough for the current to pick it up, the reset handle is released, and pin reset spindle is forced down to its normal position by the reset pin spring *5*. Valve stem *25* is forced down on its seat by valve stem spring *21*, which stops the leak caused by the raising of the reset handle.

The Engine Circuits

Three circuits are used on the engine. These are the caution, stop and bell circuits (bell circuits optional). The caution circuit takes positive battery from the storage battery on the engine, through wire *11* +, through terminal *11*, to contact on the stop valve apparatus, through wire *I11*, through terminal board over wires *I11-Lt11*, where it splits through two 50-ohm resistances and passes through the contacts of the cab signal relay. The second contact forms a local circuit for the cab light, the white light being energized through the front contact, while the green light is energized through the back contact as shown. The wire *IS* is then carried through the front point of the first contact, through the terminal board through the circuit reverser and the engine connections to the contact *IS* on the engine shoe. The current is then carried to the contact drum on the engine shoe through wire *I* back to one side of the magnet on the cab signal relay and through the coils to common. Should the caution ramp be de-energized when the shoe passes over it this circuit is broken at the point *IS* on the shoe and the green light of the cab signal is lighted up through the back point on the second contact. If the caution ramp is energized the cab signal circuit is maintained by the passing of positive battery through the ramp to the caution shoe, through wire *I* to the magnet coils of the cab signal and to common.

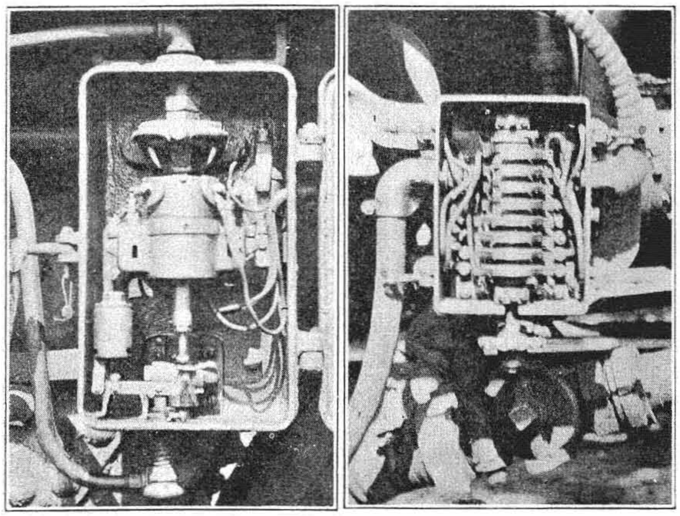
The stop circuit takes battery through wire *11* +, through terminal *11*, thence over wire *11* +, through contacts on the stop valve apparatus, through wire *M11*, through the terminal board and circuit reverser, through contact *M11* to the drum on the contact stop of the shoe, thence through drum to contact *M*, over wire *M*, circuit reversers, and terminal board to one side of the electro-pneumatic magnet valve on the stop valve apparatus, thence through wire *1o* to common.

Should the stop ramp be de-energized the stop circuit is broken on the shoe at the contact point *M11*. On passing over a non-electrified stop ramp rail the contact



The Engine Wiring, Showing the Caution, Stop, Bell and Cab Signal Circuits

shoe will, in raising, operate the circuit controller attached to the plunger, thus interrupting the normal electrical locomotive circuit, causing the armature of valve magnet *M* of the stop valve to assume the position shown in the cross section of the stop valve apparatus. When the valve magnet armature *o* drops to the position shown pin valve *p* will seat and close off main reservoir pressure from chamber *n* of valve magnet body, thereby causing valves in blanking valve *E* or brake control valve *D* to seat and relieving the pressure from the diaphragm of vent valve *L*, causing train line pressure to exhaust to atmosphere through ports *m-m* in vent valve *L*, producing the desired train line reduction. When the stop ramp rail is energized the valve magnet *M* of the stop valve apparatus is held energized by positive battery through a point on the line relay, through the ramp rail, through the contact shoe and contact drum on the shoe through wire *M*, through the circuit reverser and terminal board to one side of the electromagnet *M* and from there over wire *10* to frame of the locomotive, thus completing the circuit and maintaining this valve in the energized position, which prevents a stop being made. The bell circuit is a simple local circuit as shown by dotted lines on the diagram.



The Stop Valve and the Circuit Reverser

The engine apparatus or "shoe" is fixed to the frame of the front truck of the tender, each ramp causing an upward movement of the "shoe." A battery on the roadside conveys current to the ramp, and with the ramp energized, this current is carried by the shoe to the apparatus on the locomotive; and by controlling electric magnets it prevents the application of the brakes at the stop ramps and the giving of the cautionary signal in the cab at cautionary ramps. With the ramp de-energized, the lifting of the shoe opens a circuit, de-energizing a magnet; and thus air is exhausted from the train line so as to apply the brakes. The bottom of the contact shoe is in the form of a circular disk, and is arranged so as to make contact even when a little out of line. The ramp rail is of the inverted T shape. The T iron used is ⅜ in. by 3 in. by 3 in. and is mounted on a 6-in. sleeper bolted to the ties.

A vibrating bell in the cab is arranged to sound whenever the shoe rises as much as ¼ in., so that the engineman thus receives notice every time a shoe goes over a ramp, without regard to whether the indication is or is not against him. If the vertical movable member of the shoe is broken there is provision made for opening the train line and applying the brakes; if it is bent the first contact with a ramp will tend to cause it to stick in its upward position, thus causing a continual ringing of the bell in the cab. If the shoe should be broken off completely the electrical connections would be broken so as to cause application of the brakes.

To provide for running in either direction and also to provide for using the left hand apparatus in place of the right hand, or vice versa, all of the wires on the locomotive are run through a box containing circuit reversers. Thus in case either shoe is lost or disabled the engineman, by a single operation, can change all of the circuits and substitute either shoe for the other. The cab signal has a proceed light and a cautionary light, but none for stop; but always on the dropping of the stop valve both lights go out, thus indicating that an automatic stop contact has been made.

After the brakes have been applied the apparatus can be restored to normal position only by lifting the armature of the stop valve; and this must be done by pushing a knob which can be reached only by a person standing on the ground.

The circuits on the engine are fed normally from a storage battery, of 80 a. h. capacity. The normal voltage is from 10 to 12 volts, furnished by 10 cells of this battery mounted on the running board. A permissive movement may be made over a ramp providing the speed has been reduced to a predetermined limit and in addition the engineman presses the button while passing over the ramp. Provision has also been made for an automatic cutting off of the bleeding of the train line when a reduction to 25 lb. has been made, thereby lessening the time of stopping, as it is not necessary to pump up the entire train line.

British Report on Light Signals

The Ministry of Transport of the British Government has issued a report, dated October 28, in which a committee, appointed in July, reports on its investigation of light signals to be used for both day and night signaling on British railroads. The committee consists of Major C. H. W. Edmonds, of the Ministry of Transport, chairman; J. C. Allen, of the National Union of Railwaymen; Major G. L. Hall, government inspecting officer; H. J. Oxlade, Associated Society of Locomotive Engineers and Firemen; Captain B. H. Peter, Westinghouse Brake & Saxby Signal Company; W. J. Thorrowgood, telegraph and signal superintendent, London & Southwestern; M. R. Gardner, Ministry of Transport.

The committee inspected the color light signals in use on the Liverpool Overhead Railway, where such signals have been in use for some considerable time; and it was found that the signals were distinctly visible at a distance of 1,000 yards, when seen during brilliant sunshine. A position light signal on the London & Southwestern was also examined, and in both cases the lights were found sufficient and satisfactory. The conclusion of the committee is that the color light signal, with separate lenses for each color indication, is superior to all other signals. The committee holds that the use of color light signals will afford most, if not all, of the advantages obtained from power worked semaphores, and at considerably lower cost, particularly in congested districts, where power is available; and even for sparsely signaled areas there is little difference in cost as compared with mechanical semaphores.

The committee believes that not more than three types of color light signals would be necessary, namely, for long range, for short range and for switching. It is believed that artificial backgrounds are not necessary; also that lenses alone are preferable to reflectors or to combinations of reflector and lenses. Extensive hoods are believed undesirable.

The General Railway Signal Company System of Train Control

THE General Railway Signal Company's automatic train control is of the intermittent, non-contact, inert roadside element type and is designed primarily for enforcing obedience to or recognition of fixed signals or speed restrictions. It comprises equipment which can be combined as required to give automatic train control as follows:

An automatic train stop system in which the automatic stop equipment is operative at each stop signal where an overlap of full braking distance can be provided or in case signals are not overlapped the automatic stop equipment can be made operative at braking distance from the stop signal.

An auto-manual train control system in which the automatic stop equipment is operative at each caution or stop signal, acknowledging devices being provided in the locomotive which, if properly operated, permits a train to pass a caution or stop signal without automatic control being effective.

An automatic train speed control system in which the train control equipment can be made operative as required to cause an automatic application of the brakes in case a predetermined speed is exceeded through a caution block or approaching a stop signal or a danger zone or in passing over a section of track where it is desired to enforce a speed restriction.

In applying automatic train control as outlined, operation against traffic or into and out of unequipped territory is provided for automatically, both entering and leaving, and likewise motive power equipment can be arranged to operate head-on or backing with traffic, while switching moves and operation at interlocking plants are provided for. Single track operation is secured in a simple manner.

Means for Transmitting Control From the Right-of-Way to the Train

The means by which control is transmitted from the right-of-way to the moving train is induction, employing the inductor-alternator principle, as illustrated in Fig.

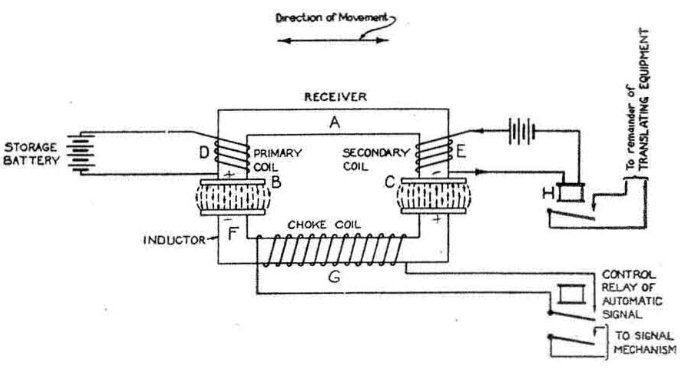


Fig. 1. Illustrating the Inductive Principle of Transmitting Control

1. The track element or the inductor G is located on the ends of the ties parallel with the rails and 19 in. from gage of nearest to center of the track element, the pole faces coming $2\frac{1}{2}$ in. above the top of the running rails. The track element is 6 in. wide. The receiver or locomotive element A is located on the tender truck so that its pole faces pass over and about 2 in. above the pole faces of the inductor. On one leg of the receiver is placed a primary coil D fed from a storage battery or other source of power. While it will be noted that the primary coil D as shown is on the open circuit principle, in actual practice and as will be described later, it is on the closed circuit principle.

A secondary coil E is wound on the other leg of the receiver and includes in its circuit a storage battery and a relay H. According to the well-known law of electromagnetic induction, if the magnetic flux passing within the secondary coil remains constant in amount, the flow of current through the relay will likewise remain constant. This would be the condition with the locomotive passing along between control points. When, however, the locomotive passes a control point, if the circuit of the choke coil G is open, the inductor partially completing the magnetic circuit of the receiver, will cause a large change of magnetic flux within the secondary coil E, which in turn will result in a sufficient variation of current flowing through the relay to cause it to open. The relay, when open, will, through the remainder of the translating equipment on the engine, cause a brake application to take place.

If, on the other hand, as the locomotive passes a control point the circuit, including coil G, is closed by the signal control relay or other means, this coil will then act as a choke, preventing the magnetic flux from varying materially in the secondary coil of the receiver, with the

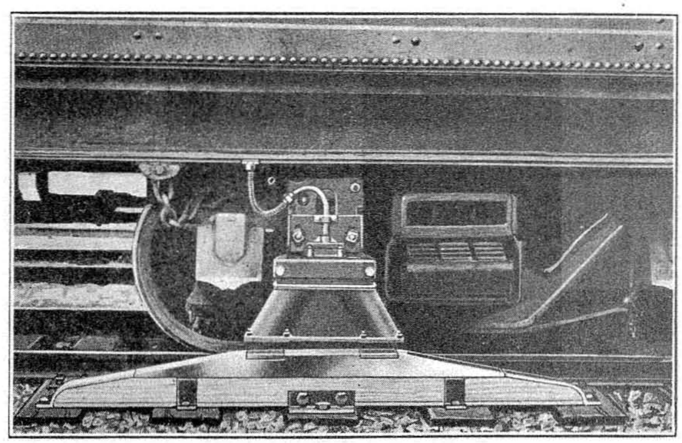


Fig. 2. Receiver on Locomotive Over the Inductor

result that the engine relay will not be opened and the train will therefore pass without automatic control being effected. It is to be noted that the coil on the inductor is never supplied with energy, the only thing necessary to make it effective to stop a train or permit it to proceed is the opening or closing, respectively, of the circuit through the coil wound on the inductor.

A view of the inductor and receiver is shown in Fig. 2. An oak foundation is provided for the inductor with a manganese steel cap on the top, which cap is used to suspend, protect and house the inductor. The manganese steel being fairly non-magnetic, does not interfere with the proper function of the inductor. Ordinary tie-plate stock is shown so applied as to protect the ends of the oak foundation so that dragging equipment will have little tendency to damage the structure. The whole outfit is fastened to the ties in a secure manner.

The receiver is designed to nest in between the projecting springs and journal box of the truck frame of the tender and is adjustable vertically to compensate for wheel wear. It is resiliently supported by a cast steel structure, which is fastened directly to the truck frame in such manner that no car springs intervene between it and the axles.

Engine Relays

Two relays are employed, a primary and a secondary. The primary relay is designed to be especially rapid in action and takes a very small amount of energy. This relay is especially designed to respond reliably to the impulse received from the engine receiver. The secondary relay need not be rapid in action and is provided with heavy carbon to metal contacts, giving a wide break and is capable of continuous and satisfactory handling of the current taken by the electro-pneumatic valve (marked E. P. V. on circuit plans).

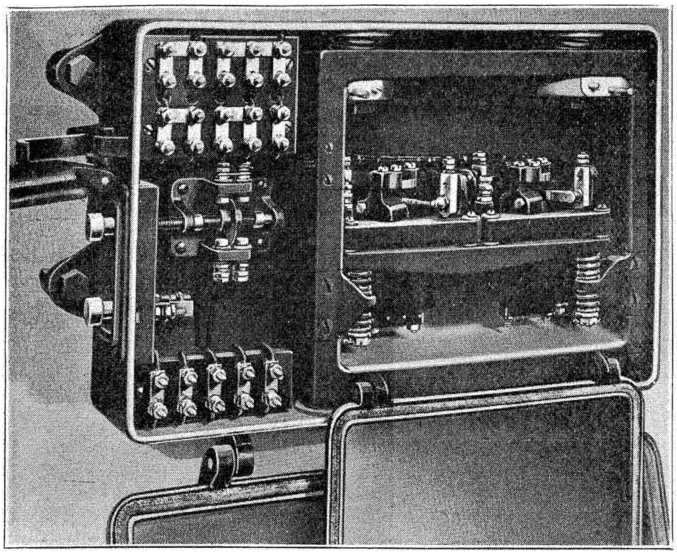


Fig. 3. Relay Case With Relays and Reset Key

These two relays are resiliently supported in an inner housing, which has purposely been made heavy, that is to say, it weighs in the neighborhood of 70 to 80 lb. This inner housing in turn is resiliently supported in the relay box proper in such a manner that the box will not bob up and down too much as a result of shock transmitted by the locomotive. This support is designed to prevent the engine vibration from affecting the relays. The inner enclosure in addition prevents frost troubles and the accumulation of dust on the relays. The relays with their spring suspension, inner and outer enclosure, etc., are shown in Fig. 3.

Brake Setting Apparatus

The brake setting apparatus consists of an electro-pneumatic valve, Fig. 4, controlling a cylinder, Fig. 6, which operates the engineman's brake valve handle direct.

The electro-pneumatic valve proper is of standard construction and provided with contacts as required by the circuits employed. The brake-operating cylinder is directly connected to the engineman's brake valve handle with a mechanism so designed that the brake lever will automatically move to the service position without danger of its jumping to the emergency position. However, the design is such as to permit the engineman at any time to put on the emergency if he so desires, or by exerting heavy pressure against the brake handle he can modify an automatic brake application as required, such, for example, as to prevent bleeding of the train line on a down grade, etc. The device works on the so-called closed circuit principle, that is to say, absence of air permits a heavy compression coil spring within the cylinder to move the brake handle to the service position. The spring is so designed and protected that even if it should break it would continue to operate reliably, in view of the fact that the space between the convolutions is less than the diameter of the wire.

Release Key

In order to encourage vigilance it is required that if an engineman permits automatic application of the brakes he must stop the train in order to release. In this connection there is provided a reset key with front and back contacts and so connected in the circuit that if operated following an automatic application of the brakes, it will restore the automatic control equipment to normal. The design is such that if an attempt should be made to lock the key in its release position it would cause an application of the brakes, it being necessary in the process of restoring the automatic control equipment to normal, first to push the plunger in and then allow it to come back to its normal position. The reset key is located in the same box with the relays as shown in Fig. 3, this box being located on the tender frame midway between the trucks and therefore cannot be reached from the cab.

In order to set up the proper combination so that the engine will be controlled when operating with traffic, either running forward or backward, and so that it will not be under control when operating against traffic either forward or backward, and so that single track operation may be conveniently worked out, a reversing switch is employed and arranged to be operated by one of the axles of the locomotive or tender and so fixed that the direction of rotation of the axle automatically puts into commission the equipment on the right side of the locomotive, with reference to the direction in which it is moving. For this purpose a receiver is placed on each side of the locomotive.

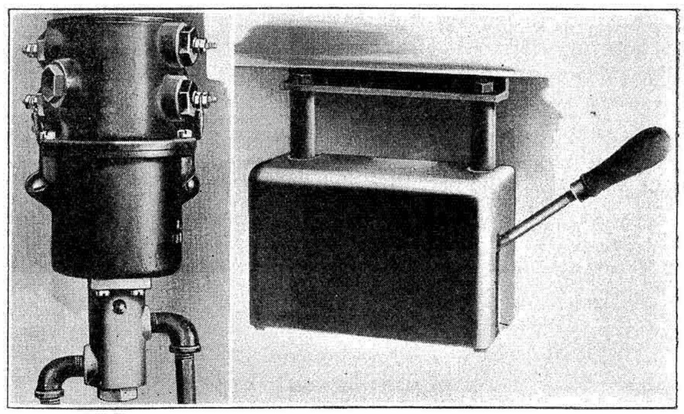


Fig. 4. Electro-Pneumatic Valve and
Fig. 5. Acknowledging Contactor

Acknowledging Contactors

In connection with the auto-manual system, there is provided an acknowledging contactor for the engineman and also one for the fireman. These devices are so designed and connected with the system that if they are operated at the time a restrictive signal is passed it will forestall an automatic application of the brakes. The device in question is shown in Fig. 5. It is provided with a normally closed and a normally open contact. The normally open contact is closed when the lever is depressed and when closed prevents a brake application. The normally closed contact is controlled by a time element arrangement so that it will open after an elapse of 10 sec., the object of this contact being to prevent giving a continuous release if an attempt should be made to tie or hook the lever down and also to give sufficient time in which comfortably to effect the acknowledgment. Ten seconds has been determined as sufficient time, this representing about 900 ft. of train travel at 60 mi. an hr.

It is understood that on certain railroads it is required that the fireman call off the signals. Furthermore, it is felt by some that the responsibility for forestalling an automatic application of the brakes in passing a caution signal should be in the hands of at least two men and therefore it is arranged to supply two of these acknowledging contactors with their contacts connected in series, so that it is necessary for both the engineman and the fireman to operate these devices simultaneously, in order to forestall an automatic application of the brakes. It is further believed that bringing in the fireman minimizes the chance of the engineman habitually or thoughtlessly operating this device. It has been urged by some that the fireman's duties would prevent him from operating the acknowledging device. However, attention is called to the fact that he need only acknowledge restrictive signals and that there should be no objection to requiring a fireman to do this, especially when the railroads require that he call off signals.

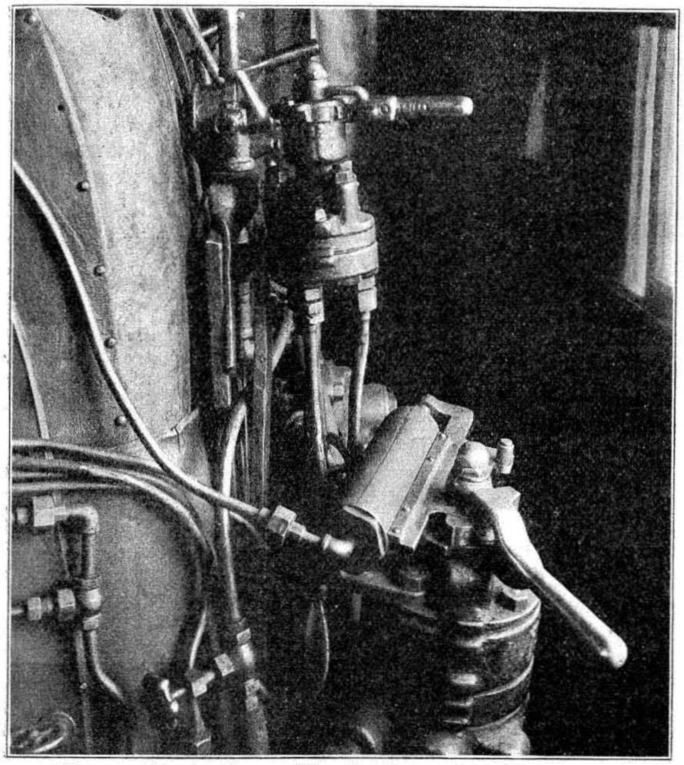


Fig. 6. Brake Lever Handle Operating Mechanism

Current Supply for Locomotives

The current supply for the automatic train control equipment on the locomotive may be taken from the turbo-generator direct or from a storage battery independently charged or from a storage battery of smaller capacity floated across the turbo-generator and provided with the usual reverse current relay to prevent its discharge in case the turbo-generator voltage should fall unduly or fail. About 25 watts are required continuously while the automatic control is in effect. A cut-out switch is placed in the relay box as shown in Fig. 3, so that the battery current may be cut off when the locomotive is out of commission. This for the purpose of economy only.

The above description refers to the principles underlying the system and touches upon the fundamental principles and various devices employed in this type of automatic train control. The various combinations referred to in the commencement of this article are discussed more in detail in the following.

Automatic Stop

The least expensive and simplest combination of parts to give any form of train control whatsoever would be the automatic stop arrangement effective with motive power equipment operating head on only. On the engine would be a single receiver, primary and secondary relays, a reset key, a source of power and the proper brake setting apparatus, as shown in the circuit diagram, Fig. 7. On the track would be an inductor at each signal where a signal overlap is provided or one would be placed braking distance in advance of the signal where there is no overlap. Of course, under the conditions last named a train approaching a stop signal would always have the brakes applied at a distance from the signal, it being then necessary for the engineman or the fireman to get out and operate the release key, after which the train may proceed up to the signal, but without automatic control. If it is desired to have motive power equipment operate either forward or backward with current direction of traffic, it would be necessary to add an additional receiver on the engine, together with a reversing switch. This combination is shown in the circuit plan, Fig. 8.

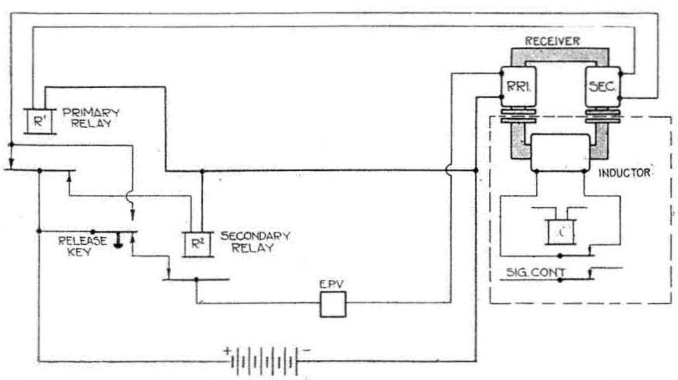


Fig. 7. Typical Circuit of Automatic Train Stop Using Inert Elements With or Without Tapered Control, Effective "Head On" (Only) With Traffic Relay "C" Is Signal Control Relay

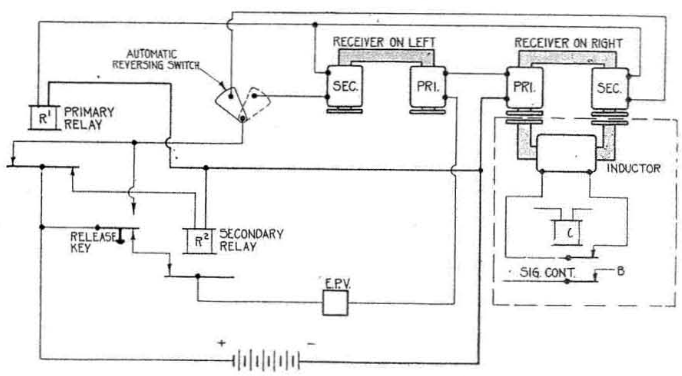


Fig. 8. Typical Circuit of Automatic Train Stop Using Inert Elements With or Without Tapered Control, Effective "Head On" and "Backing" With Traffic Relay "C" Is Signal Control Relay

Auto-Manual System

Where overlaps are not available, in order to permit a train to move up to the stop signal without an automatic application of the brakes, there is employed an automatic stop equipment on the engine supplemented by acknowledging contactors so arranged that if operated at the time an inductor at a caution or stop signal is passed, an automatic brake application will be forestalled. Such an arrangement is designated the auto-manual train control system, signifying thereby that no attempt is made to take the control of the train away from the engineman. This auto-manual system is based on the theory that locomotive enginemen are as a rule high grade, carefully trained, intelligent and experienced men. It is believed that they value their own lives, at least, and that if awake, mentally alert, physically capable and fully aware that they are passing a restrictive signal that they may be depended upon promptly and safely to control their trains without automatic interference. Furthermore, the majority of the serious accidents which have occurred in the last years are alleged to have come about due to man-failure resulting from drowsiness, pre-occupation, sudden illness, inability to see or correctly interpret the signals due to smoke, fog, snow, etc., and in which case the auto-manual system would be all that would have been necessary to prevent such accidents.

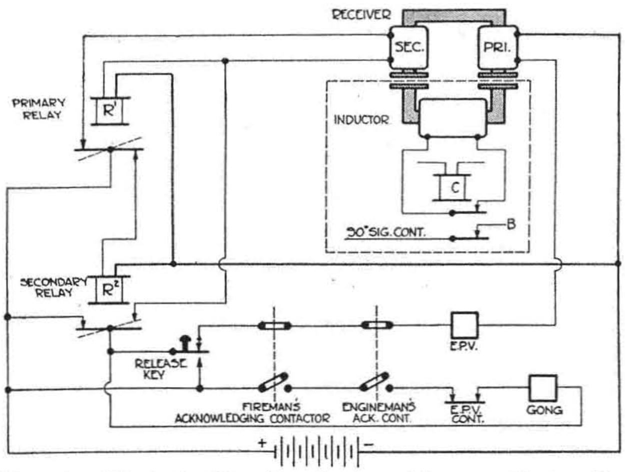


Fig. 9. Typical Circuit of Auto-Manual Train Control Effective "Head On" (Only) With Traffic

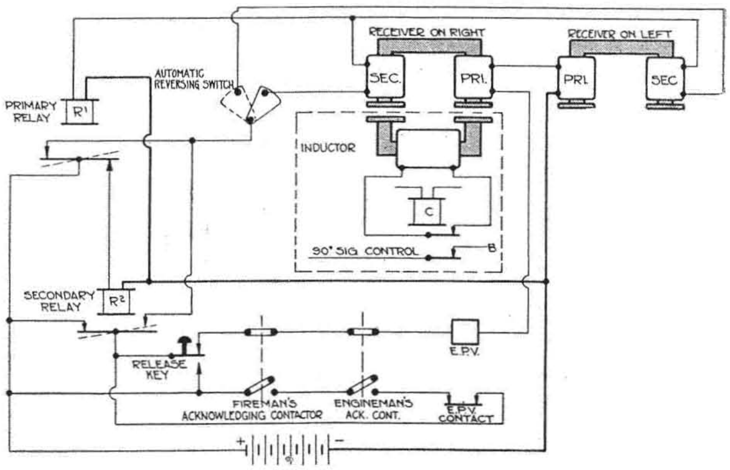


Fig. 10. Typical Circuit of Auto-Manual Train Control Effective "Head On" and "Backing" With Traffic

This system is designed to direct the engineman's attention forcibly to the fact that he is passing a caution or stop signal and automatically to apply the brakes only in case the engineman or the engineman and fireman fail to take appropriate action, that is to say, fail to operate their acknowledging contactors. The system does not take the control of the engine out of the hands of the engineman. The circuit plans, Fig. 9 and Fig. 10, show the arrangement of parts in connection with the auto-manual system.

Train Speed Control

In order to permit a train to move up to a stop signal without an automatic application of the brakes and without the use of acknowledging contactors and also to provide for the enforcement of speed restrictions approaching cross-overs, curves, etc., the automatic train speed control system is available. This system is based on the use of inductors placed along the right-of-way in combination with a time element device on the locomotive, the whole so organized that if a train passes from one inductor to the next within a pre-determined speed, no automatic brake application will take place.

It is arranged that if a train in passing from one inductor to the next consumes the proper amount of time, upon reaching the second inductor the time element device will again have closed its circuit, so that it would not cause a brake application. With this arrangement it then becomes merely necessary to space the inductors on the right-of-way to suit the particular speed restrictions required, as provision can be made for down grade, up grade, the approach to curves, cross-overs, etc.

The speed restrictions are instantly removed when and if the signal ahead shows a more favorable indication. As a result of the failure to conform to speed restrictions the train would be stopped and must be released by operating the reset key, which again is a provision to encourage the retention of full vigilance.

Operation Against Traffic and in Unequipped Territory

Operation against the current direction of traffic into and out of unsignaled territory is permitted automatically, does not require any manual operation on the part of the engineman, the set-up being entirely automatic. All of the controlling inductors are on the right side of the track with reference to the current direction of traffic. It will, therefore, be apparent that whenever equipment operates against the direction of traffic, due to the reversing switch, the controlling receivers will be on the side of the engine opposite to that of the inductor and that therefore no control will be transmitted to the train when making such a movement. Furthermore, in view of the fact that the intermittent system is employed, no manual operation is required in entering or leaving unequipped territory, the train being permitted to operate without interference in such territories.

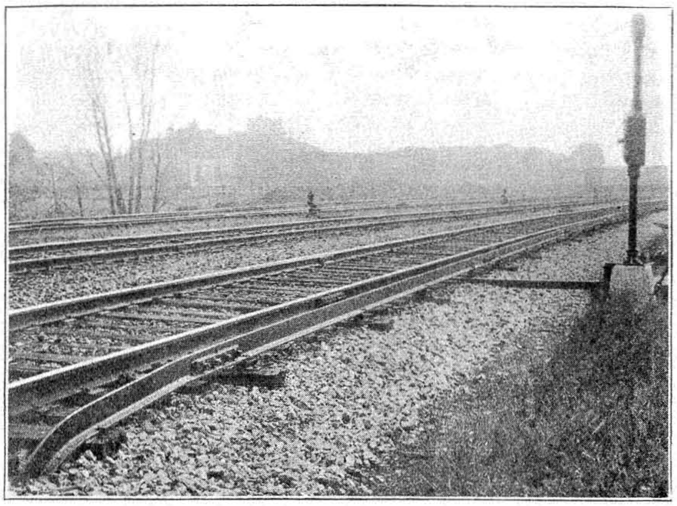
Single Track Operation

In single track work all that is necessary is to place inductors on both sides of the track, inductors on the right side being controlled in accordance with the signals on the right side of the track and those on the left side being similarly controlled. This arrangement in combination with the reversing switch, which always throws the inductors on the right side of the engine into commission, brings about single track operation without complication.

Belgium Prize for Electrical Thesis.—A prize amounting to the accumulated interest of 150,000 francs at 3 per cent will be awarded in 1923 by the George Montefiore Electro-Technical Institute of Liege, Belgium, for the best original work on the scientific advancement and progress in technical applications of electricity in any field. This competition normally takes place every three years, but the competition of 1920 has been carried over to 1923. The amount of the prize is, therefore, 21,000 francs. The address of the secretary is Rue St. Gilles, 31, Liege, Belgium.

The Miller Automatic Train Control

THE Miller train control is of the intermittent electrical contact type, using the roadside ramp. The electrical equipment on the locomotive consists of a normally de-energized electro-magnet that receives energy from the ramp. This equipment was first tested out

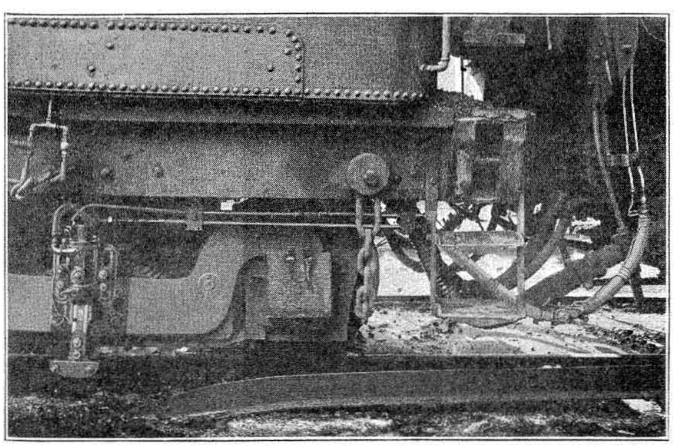


Ramp Location With Relay Box

on the Chicago & Eastern Illinois, October 5, 1911, followed by an installation of 106 miles of double track between Dolton Yards, Chicago, and Danville, Ill., completed in November, 1914. This installation was inspected by the Automatic Train Control Committee of the United States Railroad Administration, March 17, 20, 21 and 22, 1919, at which time there were 73 locomotives equipped. At present there are 85 locomotives equipped. The Joint Committee on Automatic Train Control and the Bureau of Safety, Interstate Commerce Commission, have maintained inspectors and received complete reports of the maintenance and operation of the entire installation during the past year.

Wayside Apparatus

The wayside ramp is made of 4 in. by 5 in. T iron inverted, supported on malleable iron stands, which are fastened by lag-screws to every sixth tie. The ramp is



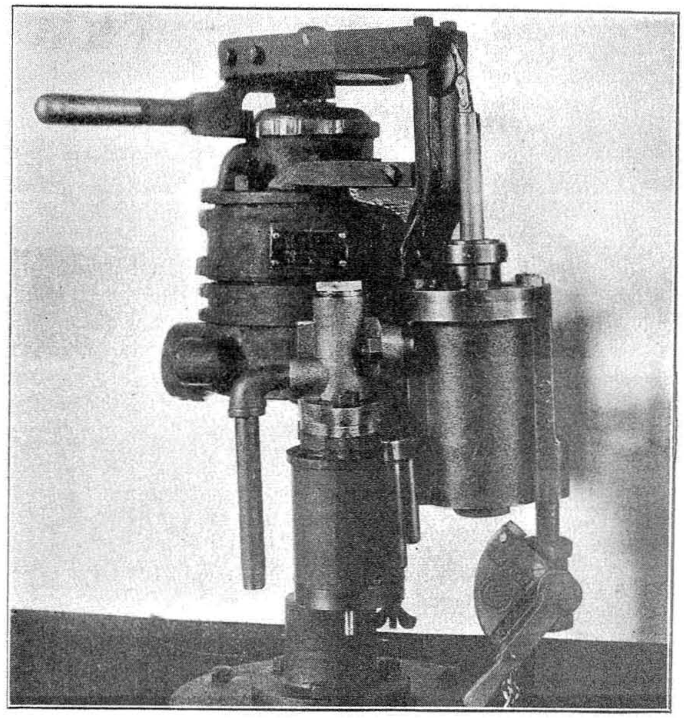
Contact Shoe, Showing Air Pipe and the Wire to the Cab

set to a clearance of 22 in. from the gage side of the running rail, with a maximum height of 6 in. above the rail at the center and a gradual decline toward the ends. The main part of the ramp is insulated from the end sections, which are bent down and buried in the ballast. Ramps are located at braking distances from the automatic signals. This distance varies according to grade, curves, etc.

The ramp is energized by 16 cells of 500 a. h. primary battery, which is placed in a battery box near the ramp. The negative of this local battery is connected to the running rail and the positive is fed through the front contact of a line relay to the ramp. This line relay, housed in a cast-iron box at the ramp location, is controlled by a line circuit that is broken through the track relay in advance of the automatic signal and also through a circuit controller on the automatic signal mechanism. Typical circuits of the wayside apparatus are shown in the diagram.

Equipment on the Locomotive

The automatic stop equipment on the locomotive consists of the shoe, an electro-pneumatic valve and a pneu-



Magnetic Air Valve and Air Mechanism for Operating Engineman's Brake Valve

matic mechanism for operating the engineman's brake valve handle.

The shoe housing which carries the contact shoe is attached to a cast steel bracket securely fastened to, and insulated from, the arch bar of the forward truck of the tender. Hard iron insert blocks, that are renewable, fit in the bottom of the shoe where it rubs on the ramp. There is a ½-in. air pipe leading from the control mechanism in the cab to the shoe and a conduit that carries the one electrical wire. Connection between the engine and tender is made with a standard air hose coupler. The air pressure tends to force the shoe down, and as the air connection is extended into the hollow part of the shoe, in case the shoe is broken off the air is exhausted, causing an application of the brakes.

Attached to the side of the engineman's brake valve is the automatic stop instrument, consisting of an electro-pneumatic valve and the pneumatic mechanism to operate the engineman's brake valve handle. The magnet coil has a resistance of approximately 4 ohms and draws about 2 amperes when passing over a clear ramp.

Description of the Operation

As the shoe engages a ramp the plunger is raised and the air line *L* to the shoe is opened to atmosphere. Pro-

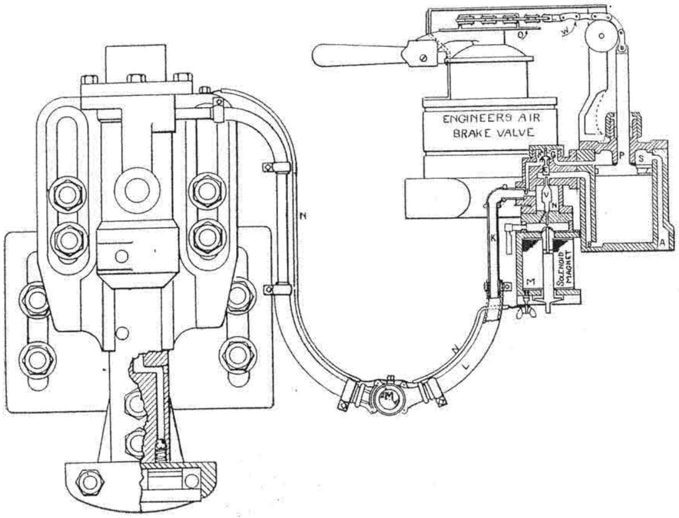
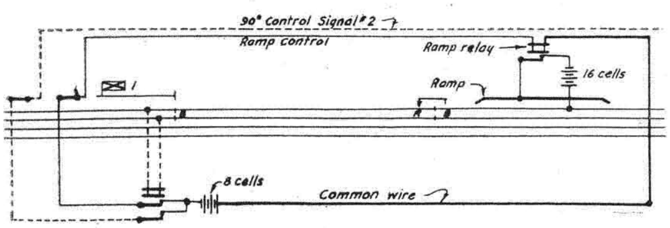
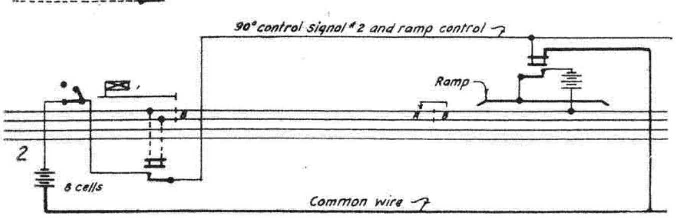


Diagram of the Shoe, the Air Valve and Operating Mechanism

viding the signal is clear and the ramp is energized the current from the ramp follows wire *N* to the magnet coil, which is at once energized, lifting the plunger and closing the valve *V*, which prevents further exhausting of air pressure through the pipe *K* to the shoe. This operation, of course, leaves the remaining apparatus in a *status quo* condition. When the shoe passes off the ramp the solenoid magnet is released and valve is opened; however, at the same time the shoe closes the port in the shoe housing and air is not allowed to exhaust through *K*. As an indi-





Circuit Diagram of Signal Connection and Ramp Circuit

cation to the engineman, the small whistle to the left of the magnet is blown continuously while passing a clear ramp.

When the signal is at danger the ramp is not energized, therefore, when the shoe is raised the port in the shoe housing is opened and air is free to exhaust through the pipe-line *L* and *K*, and as there is no energy to pick up the solenoid magnet the valve *V* remains open. Air is thus free to exhaust out of the chamber below the piston *P*, which is forced down by air pressure from the reservoir. As piston *P* goes down the chain *W* (which is tested for 1,000 lb. breaking strain) pulls the wheel *O* around, bringing the brake handle to the service application position.

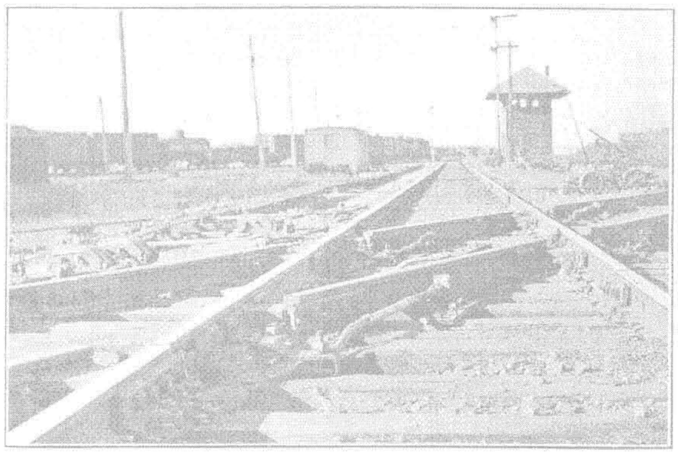
As installed on the C. & E. I., the engineman if alert may forestall the automatic application of the brakes by lifting the stem of the magnet armature, which extends below the magnet for this purpose. However, such action on the part of the enginemen can be prevented and the train automatically brought to a stop for each stop application by eliminating the extension of the stem below the magnet armature housing and having it self-contained therein. Speed control and other adjuncts to the stop system may be incorporated as a part of this device.

A Swing Rail Crossing

By W. H. R.

A SWING rail type of crossing was installed at Amarillo, Tex., at the main line crossing of the Atchison, Topeka & Santa Fe and the Chicago, Rock Island & Pacific, on November 19, 1921. This is the first crossing of this type manufactured by the Walls, Frogless Switch & Manufacturing Company, East St. Louis, Ill., and was connected into the interlocking by the signal forces of the Santa Fe, which road maintains the interlocking at Amarillo.

The crossing is operated and locked from the interlocking and has the same protection as an interlocked



View of the Swing Rail Crossing in Service on the Sante Fe

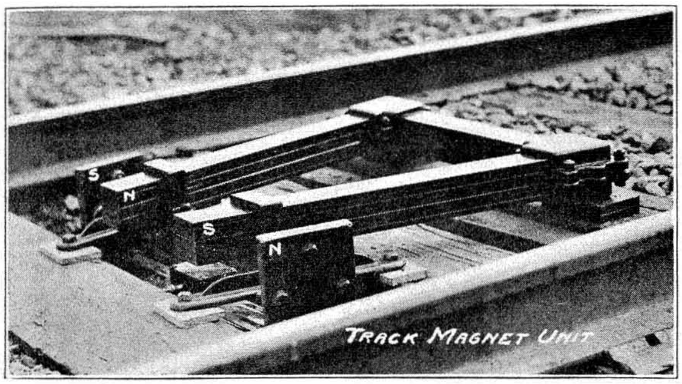
switch. The lever, normal or reversed, operates and locks the crossing and no extra lever is used for locking. There are four 4-ft. swing rails in this crossing, each having a 5-in. throw. The crossing is anchored to a 1-in. tie plate and there are toe-plates ahead of each of the adjoining rails. There has been no trouble on account of expansion. The crossing is set at an angle of 20 deg. and 21 min.

It is claimed that the swing rails will last as long as the running rails and that when new rail is laid all that is necessary is to cut 4 pieces of rail 4 ft. long and install same with the old equipment. The total cost of such renewal is estimated at $25.00 as compared with $1,000 or more for a solid crossing. In operating trains over this crossing it is not necessary to reduce the speed and there need not be any more noise or vibration than with an ordinary rail joint.

Employees in the offices of the Chicago & North Western at Chicago have been notified that they will have to work Saturday afternoons. It is reported that vacations will also be curtailed.

National Safety Appliance Company's Train Control System

THIS system is of the intermittent induction type, employs permanent magnets on both track and train, and has been developed in a decade of practical experimenting under actual operating conditions. In 1916 an installation was made on the Western Pacific at Oroville, Cal., and tested by the Bureau of Safety of the Interstate Commerce Commission. In 1919 a revised and improved installation at the same point was



Track Magnet Unit in Place

tested by the Bureau of Safety and its report issued to Congress on the complete tests, including supplementary high-speed tests on the Southern Pacific.

In 1921 several complete equipments of the apparatus were shipped to Japan on the order of officers of the Imperial Government Railways. These were subjected to intensive testing under severe climatic conditions, viz.: In South Manchuria in January, with the temperature at all times far below freezing; in Japan in midsummer, under extremes of heat and humidity. An installation was operated on the Hanshin Electric Railway between Osaka and Kobe, the cars being equipped with straight air and the wayside signals being of the track circuit operated, three-position light-signal type.

An installation is now in service operation on the line of the Southern Pacific immediately east of Hayward, Cal. This installation covers about five miles of single track and provides automatic stops and intermittent speed control or permissive features. Track magnets, 8 in all, are placed at each semaphore within the limits of the installation. The track is signaled with normal clear, two-position, home and distant, lower quadrant signals, after the practice of the Southern Pacific. Three of the magnets are at distant signals, two at home and distant and three at home signals. Three magnets control trains in each direction; medium-speed restriction is provided at five magnet locations, at all of which are distant signals; and maximum-speed restriction is provided at all magnet locations. Two passenger and two freight engines are equipped with the automatic safety apparatus. The scheduled train movement over this territory consists of 15 passenger and 4 freight trains daily.

The system is designed as an adjunct to fixed block or interlocking signal systems, is constructed for interconnection with such signal systems, and its operation is controlled in the same way. Automatic stop operation is caused whenever a condition is produced which would cause a standard automatic semaphore signal to assume the stop position and should the engineman fail to obey the fixed signal indication. It is also operable when the signals are actuated manually, in this instance suitable circuits along the track being provided to control the operation of the electro-control magnet.

Actuation from the track to the train is by means of magnetic induction. The track apparatus lies wholly below the upper surface of the track rails. Clearance between track apparatus and that on the train is from five to six inches and there is no mechanical contact.

The appliances are four only:

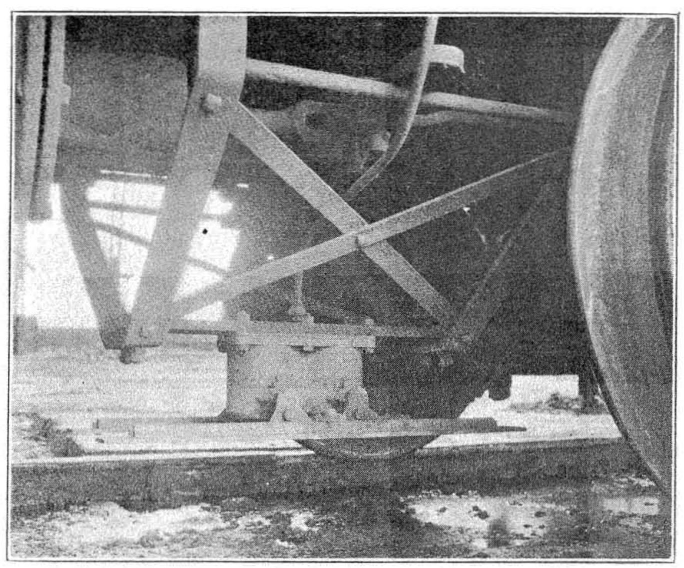
On the engine: Magnet control valve unit.
Pneumatic stop valve.
Release and double-heading cock.

On the track: A permanent magnet, controlled electrically.

The track permanent magnet normally operates to stop trains. Automatic-stop operation is positive when track conditions would cause a semaphore stop signal and should the engineman fail to obey the indication. Operation on the train is pneumatic solely and is entirely automatic for train movements in either direction. Release after an automatic application is the only manual operation. Intermittent speed control is provided from the track and as may be desired for control to any predetermined speed at distant signals, at curves and at any restricted speed territory; also for control of speed to the maximum speed restriction of the railroad upon which the system is installed.

Engineering Description of the System

The track apparatus consists of a permanent magnet,



Receiving Unit on the Locomotive

13, Fig. 1, mounted on the ties in the center of the track, its length paralleling the rails, and its upper surface being preferably about one inch below the upper surface of the rails. An electro-magnet control unit, 14, with extended pole-pieces, 17-18, is positioned below and across the poles of the permanent magnet and is of superior power when energized. Its control is through the track and line circuits of any standard automatic signal system, current from standard signal battery being supplied to the electro-magnet control unit through a local circuit for clear movements only, and only while the train is passing through a short insulated track section, current being cut off when this section is bridged. The control is provided as desired, for either or both directions of traffic. Normally the magnet field of the permanent magnet is in place for automatic stop operation, and it is diverted only for clear movements by energizing the electro-magnet control unit.

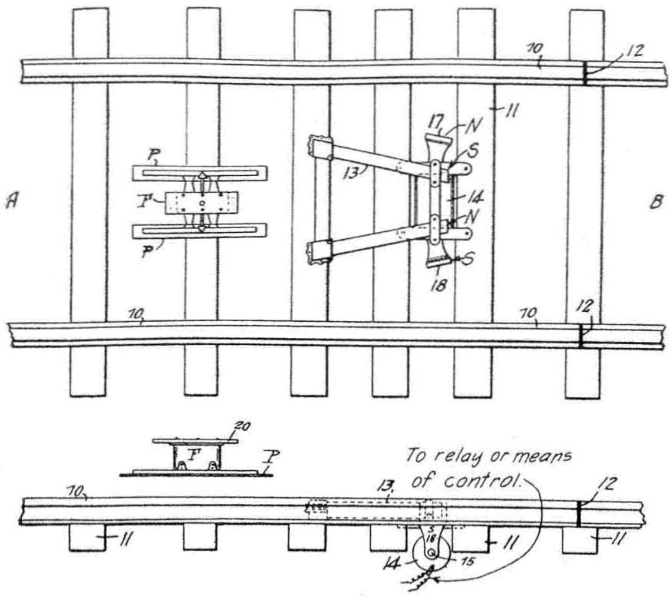


Fig. 1. Diagram of a Track Magnet Location

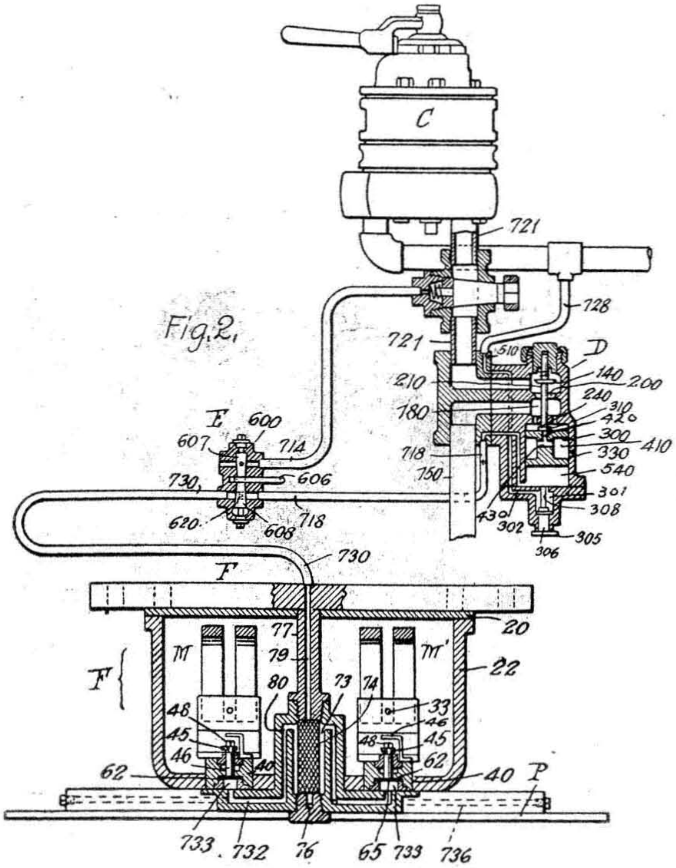
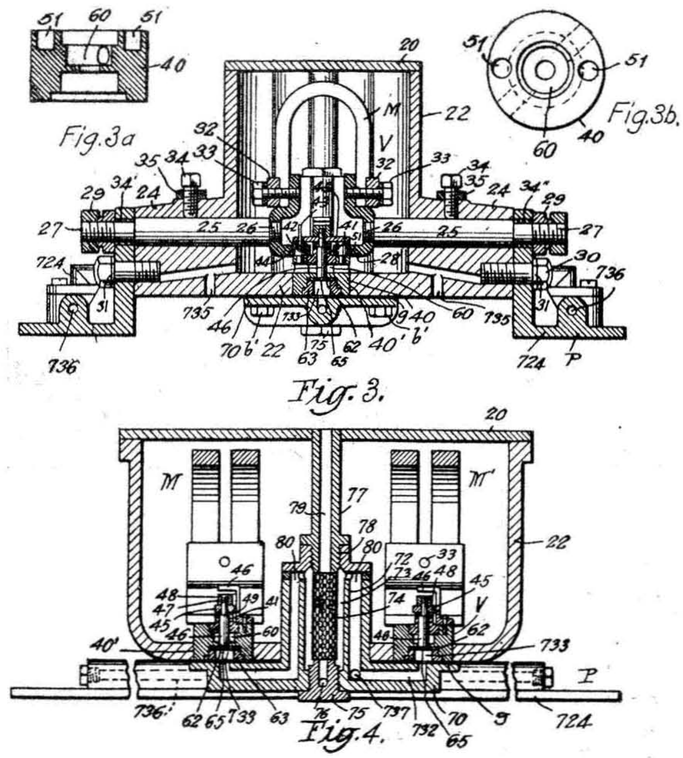


Fig. 2. Diagrammatic Illustration of Magnet Control Valve Unit, Pneumatic Stop Valve and Release and Double Heading Cock

The electro-control magnet, 14, Fig. 1, is positioned adjacent the poles of the permanent track magnet with the poles reversed with respect to the poles of the permanent magnet to provide a means for deflecting its field, and during such deflection distorting the magnetism of the permanent magnet, thus permitting free passage thereover of the locomotive and train.

Each magneto-control valve, Figs. 2 and 4, consists of two pairs of "U" shaped permanent magnets, M and M', with pole-pieces 28, Fig. 3, securely attached. Extensions 25 connect with inductor planes, P. extending parallel to the longitudinal axis of the engine tender, so that they pass directly over the pole pieces of the track magnets, at a clearance of 5 or 6 inches. The two pairs are oppositely placed with reference to their polarities.



Figs. 3 and 4. Cross-Section of Magnet Control Valve Unit

The valve proper is a brass casting, 40, with steel pole pieces fitting in the recesses 51, and extending through the horizontal lugs on the pole pieces 28. A valve stem, 46, carries on its upper end an armature, 45, which rests on the pole pieces above mentioned. A leather gasket, 62, with a small centrally located hole is held against a seat in the valve by a bushing, 63. The lower end of the valve stem rests against this leather gasket. Main reservoir air is admitted through passage 79, strainer 74 and port 80 to the chamber in the bushing 63 beneath the gasket 62, which forces it against the lower end of the valve stem 46, thus sealing the opening from passage 79 to the atmosphere and preventing the escape of the air as long as the armature is held against the pole pieces by the permanent magnets M and M'. When the field of these magnets is neutralized by passing over active track magnets, the armature is released and the air escapes from passage 79 to the atmosphere through a port in the valve. The entire valve is protected by a brass casing which provides the air passage 79 and holds the valve 40 tightly against the pole pieces. Passage 79, Fig. 2, is connected by pipe 730 through the double-heading valve E to the brake application or stop valve D.

The stop valve as shown in Fig. 2 is combined with the non-release valve and consists of a spool-shaped piston, 300, moving vertically in a chamber, 410, which has a vent, 330, to the atmosphere from the central space between the flanges of the piston. The piston has a chamber, 420, extending axially from its upper surfaces connected by radial ports, 430, to the chamber between its flanges. The piston moves freely but is so adjusted that when raised it engages the piston rod, 210, of the poppet valve, 140, working in a chamber above. Where it engages the spool-shaped piston it forms a valve, 240, which closes the central port of the piston when it is in its upper position. Above the chamber occupied by the spool-shaped valve are two chambers separated by a diaphragm, which forms a seat for the poppet valve above mentioned. This valve, forming the non-release feature of the train-control valve, when opened, provides a free passage from the train line to the engineman's brake valve through connections 721 and 150. Train line pressure, admitted to the chamber above the spool-shaped piston by ports from the chamber directly above, tends to force piston 300 down, but is resisted by main reservoir pressure on the lower surface admitted through connection 728 and port 302.

A connection, 718, leads from chamber 301, connecting with chamber 540 through the double-heading and release cock, and connects with the central core 79 of the casing referred to.

When the field of one pair of the engine magnets is neutralized by passing over an active track magnet—which affects the engine magnets of polarity opposite to itself—air is exhausted from chamber 420, through the connection 718. Train line pressure above piston 300 forces it down and allows the valve 240 to open, thus permitting the train line to be vented through chamber 420 and piston valve chamber 410 and ports 330 to atmosphere. On account of poppet valve, 140, being now closed, the engineman cannot increase the pressure in the train line. After the valve has operated as above described and the engine has passed outside of the field of the track magnets, the double-heading release cock is operated, which closes the connection in pipe 718 between chambers 540 and port 79, relieving the pressure on the end of the valve stem so that gravity, assisted by the magnets, may bring it back to the seat. The lever 606 is then restored to normal position, which allows the pressure from the main reservoir to build up in chamber 540, forcing piston 300 to normal position and opening valve 140. Lever 606 must be restored to normal position, for while reversed a connection is opened from a double-heading cock to pipe 79 to the atmosphere, which will cause the brakes to be applied as long as the lever 606 is in reversed position.

The track is divided, as usual, into a series of blocks insulated from each other. A single permanent track magnet associated with an electro-magnet or solenoid of opposite polarity is suitably installed within or at the entrance of each block in an insulated track section of two or more rail lengths. The track magnet acting alone is capable of controlling the operation of the train stopping means carried by the train every time a train passes over the magnet, since it has a polarity opposite to that of one of the valve magnets.

When a train passes over the track magnet its field acts upon the inductor planes of the duplex control valve, F, Fig. 2, which causes a reversal of polarity in one of the armatures thereof and thus permits the release of the armature from the poles installed as heretofore described in the duplex control valve and thereby permits the opening of the valve therein because of the air pressure normally exerted thereon, which action results in the stopping of the train. The electro-magnet control unit, however, is energized whenever its circuit is closed by a train closing the track and line circuits of a system to provide clear signals and thus acts to divert the free field of the track magnet and thereby prevents the track magnet from causing the train stopping mechanism of the train to operate. The installation of the electro-magnet control unit is such that it will be energized on the approach of a train when the block ahead is clear or unoccupied, and its circuit will not be closed by the approach of a train when the block ahead is occupied; thereby permitting the permanent track magnet to act upon the train stopping mechanism. The reason the electro-magnet control unit acts upon the track magnet

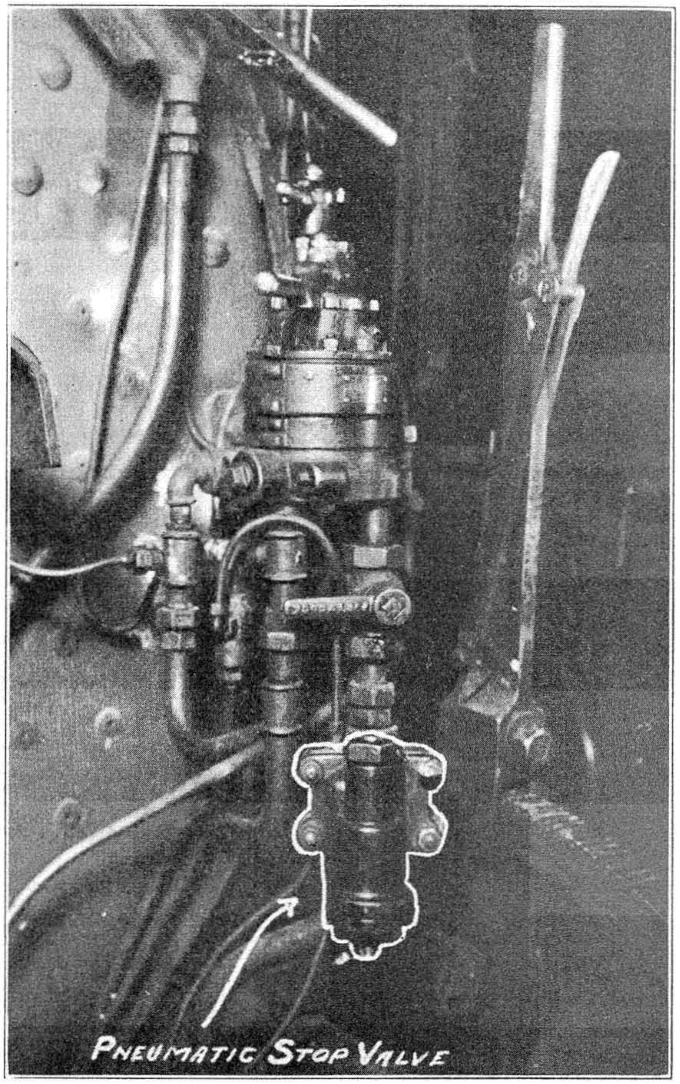


Fig. 5. Pneumatic Stop Valve Attachment to Engine Equipment

to divert its field is due to the fact that the former is stronger than the permanent track magnet and its polarity is opposite thereto.

Only one of the magneto-pneumatic control valves is operated at any one time. The magnets of the two valves, as heretofore stated, are so arranged as to be of opposite polarity, that is, the S pole of one and the N pole of the other are in a line parallel to the center line of the track. One of the locomotive magnets is therefore always of a polarity opposite to that of the track magnet, regardless of the direction the locomotive is headed, and also regardless of the position of the track magnet; and the magnet of the duplex valve which is of opposite polarity to the track magnet is the one that is operative.

After the device is operated and the operative field of the track magnet passed by and the train brought to a stop the double-heading lever 606 of the double-heading release cock, E, Fig. 2, is manually moved (for absolute stop from a position outside the cab requiring the engineer to dismount therefrom) to released position. This closes the lower plug cock, cutting off communication from the pipe 718 to the pipe 730 and venting any remaining pressure in the chamber 733 to the atmosphere through the port 620 (in the double-heading cock), this relieving the pressure on the end of the valve stem, restoring the armature 45 to normal and closing valve 46.

While the lever 606 is in released position the upper plug cock 607 of the double-heading release valve is open, allowing the brake pipe pressure to flow through the double-heading cock, through the pipe 714 and thence to atmosphere. The lever 606 must be returned to running position for the purpose of closing the exhaust port to this cock, thereby ensuring that the lower cock will be opened and in proper operative position. Failure to do so will leave the brakes still unreleased as the air is exhausting through the pipe 714 and the plug cock 607.

The returning of the lever 606 to running position allows main reservoir pressure to build up in the chamber 540, forcing the piston 300 up into the chamber 230, closing the valve 240 into its seat 310 and raising the valve 140 off of its seat 200, as above described.

In double-heading, all following engines close the air conduit leading from the engineman's automatic control valve, thus preventing him from operating the train brakes. It is also necessary that the train stops on all following engines be made inoperative and the double-heading release cock, E, provides this means.

When the handle 606 is placed in released or double-heading position the vent pipe air from the stop to the control valves is cut off and the pipe leading from the engineman's control valve is closed first. Should the engineman fail to place the handle 606 of the cock 600 in double-heading release position, the stop will still be operative; should he fail to place the handle 606 in running position after double-heading, his brakes will be applied as soon as he turns the double-heading cock to running position because the brake pipe will be vented through the plug cock 607 of the double-heading release cock E.

Protection is provided against broken indicator planes in the duplex control valve. These indicator planes, P, are constructed of cast iron with a port or air passage 736 running lengtrwise thereof. If these planes should get broken, air pressure will be exhausted to the atmosphere and bring about the application of the brakes in exactly the same way as if the valve 46 attached to the armature was open in the regular way.

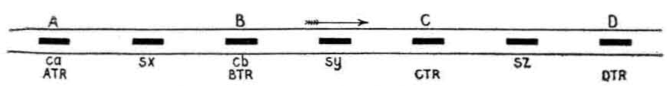
M-V All Weather Train Control

THIS device is of the induction type with no contact between the locomotive apparatus and the roadway, and no moving parts in the roadway member. The valves controlling the setting of the brakes of the train are automatically opened at the approach to each block section, and the brakes are set, unless the valves are held closed, at that point, by what is equivalent to a proceed indication conveyed by induction from the roadway element. This periodical operation of the brake apparatus is accomplished by means of a cam, which is revolved slowly by gearing actuated through a suitable connection to one of the front truck wheels of the locomotive. The scheme involves the division of the line of road into block sections of equal length, the gearing connecting the truck wheels and the cam or cams being so proportioned that the cam, in its revolution, will have reached its brake-setting position when the locomotive has reached the point on the road where it is desired that the brakes should be applied. If there is no reason for stopping, or for slackening speed, the cam, by the influence of a magnet controlled from the roadway, is released, and before causing a brake application is reset at its starting point, to begin a new revolution, preparatory to causing a stop (if a stop shall be required) at the next point.

The air valves, controlling magnets and centrifugal governor (by which latter the speed of the train is made to control the setting of the brakes) are contained in a box fixed on the front of the locomotive and the photographic illustration is a front view of these parts, the front cover of the box being off.

The scheme contemplates the use of blocks of a length which (including a suitable margin of safety) will correspond to the braking distance for the fastest trains; and the brakes of such trains, for stopping at the entrance of block B C, will be applied at A (see diagram). Assuming the presence of a train in section B C, the track relay at B, being open, holds open the wire circuit which energizes the track magnets at sx and at ca. A following train, if moving at more than 30 miles an hour, has its brakes applied at A; and at sx, if block B C is still occupied, another application of the brakes is made, to bring the train to a stop before it reaches B. The second brake-applying point (sx) is fixed at a sufficient braking distance short of B to stop trains traveling at restricted speed (30 miles an hour). Further details are not made public at this time; but Dr. Charles W. Burrows, consulting engineer of the controller company, has favored us with the description, given below, of the valve-actuating apparatus.

The track equipment, taking, for example, block B C, consists of the caution magnet ca, the stop magnet sx,



Location of Track Elements

the track circuit relay at B, the track circuit relay at A, and the power line. The roadway circuit which energizes ca and sx (in series) includes these two track magnets, the back contact of the track circuit relay at A, and the front contact of the track circuit relay at B. Each track magnet is virtually the primary of a transformer. This circuit is normally open, due to the fact that the track circuit relay at A is normally closed. When this is opened by the approaching train and that at B is closed (no train in block B C) the track magnets are both energized, preventing the application of brakes.

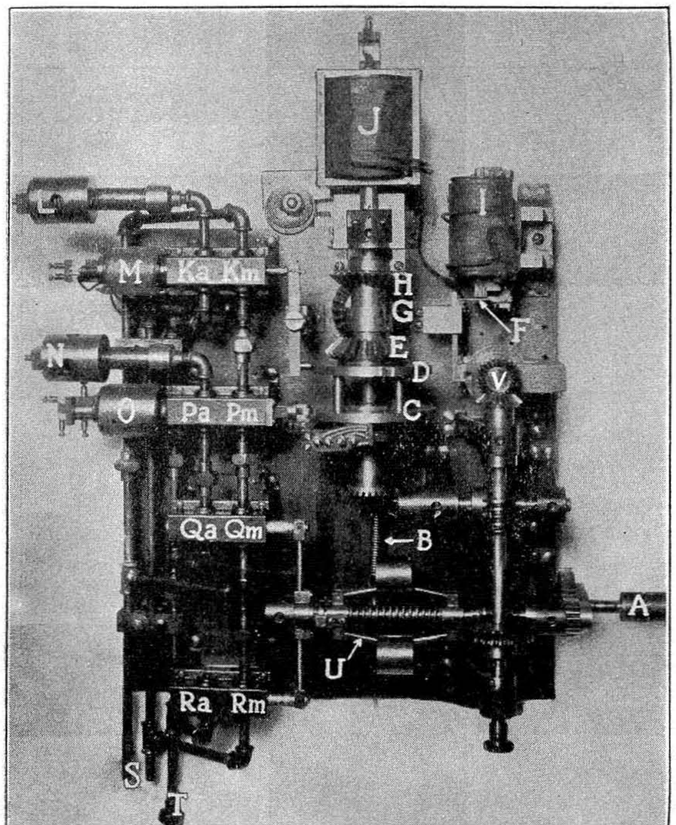
If a train passing A finds the track magnet at that point (ca) dead, the fact indicates that there is a train in block B C; no magnetic impulse being received from the roadway, the cam causes the application of the brakes until the speed is reduced to the restricted rate (30 miles an hour). If the second magnet (sx) is dead (block B C being still occupied) the valve to cause a full stop is opened. To stop a train the track magnets must be dead; and to allow it to proceed—to prevent the setting of the brakes—must be energized.

The electromagnets on the roadway are of the horseshoe type, consisting of two cores arranged vertically, and a yoke of laminated silicon steel. This yoke is about 30 in. long and of 2 in. x 2 in. section. The vertical members are about 8 in. x 8 in. The magnetizing coils, surrounding the cores, are energized by a 60-cycle alternating current. A magnet consumes, when operating, 30 watts.

The locomotive collecting coil is fixed on a bar of laminated steel fastened under the tender, and it constitutes the secondary of a transformer, the winding of the roadway element being the primary.

In the photographic illustration of the cab mechanism, A is the connection to the wheels of the locomotive and U is the centrifugal governor operating the two sets of valves, Qa-Qm and Ra-Rm. The continuously rotating element is indicated by V at the top of the vertical shaft at the right. The armature of the relay is indicated by F, shown resting against the detent of the lever; and the magnetizing solenoid is indicated by I; this is in series with the coil beneath the tender. The clutch member and the rotating switch are directly behind the miter gear V. The two cams, C and D, are driven, as shown, through a train of gears.

At the top of the picture is shown the cam-resetting magnet J; this is energized from a storage battery, the



Brake Setting Apparatus on the Locomotive

current of which is controlled by relay I; and when energized pulls up its armature, and with it the miter gear H. This gear rotates continuously whenever the locomotive is in motion, and is free to slide upon its shaft. Normally, H engages the gear G, which in turn drives the gear E. This latter is rigidly attached to both cams so that whenever the gears are in the position shown and the locomotive is in motion, the cams are rotated.

When the magnet disengages H from G, the cams cease to revolve and the spring B restores them to normal position. In this position the cam system remains at rest until the resetting magnet is de-energized and the gear H again engages G.

On the left of the photograph are four pairs of air valves, Ra-Rm, Qa-Qm, Pa-Pm and Ka-Km. Each controls two passages; one, designated by *a,* is between the atmosphere and the engineer's valve reservoir (through the pipe T); the other, *m,* connects the two sides of a differential air valve (through the two pipes S). The action of this differential air valve is such that the equalization of the pressure in the pipes shuts off communication between the main reservoir and the engineer's brake valve.

The valves Ra-Rm, Qa-Qm are for speed control only and are actuated by the governor U. The valve Ra-Rm is to prevent the maximum allowable speed being exceeded. The centrifugal governor pulls the valve stem to the right, opening pipe T to the atmosphere, making a reduction of pressure in the engineer's brake valve reservoir. Valve Rm connects pipes S, cutting off connection between the main reservoir and the train line. This valve is controlled entirely by the speed of the locomotive.

The valve Ka-Km is controlled by the cam D, as shown. The air passage at the left (Ka) opens to the atmosphere through the reducing valve L, thus connecting the engineer's brake-valve reservoir and the atmosphere, through the pipe T. The opening at the right (Km) connects the two pipes S and disconnects the main reservoir.

A similarity between the action of the valves Ra-Rm and Ka-Km is obvious. The former is controlled by the rate of speed and the latter by the distance of travel of the locomotive, and each one is independent of the other. While the other two valves have functions similar to those just described, they differ in this important respect —the application of the air brakes requires the co-operative functioning of both valves. Valve Qa-Qm is operated by the centrifugal governor, moving at lower speed when it operates Ra-Rm. Valve Pa-Pm is operated by the distance of travel of the train but by a shorter distance than is required for Ka-Km. When the centrifugal governor has caused the ports of Qa-Qm to open, connection is made with the corresponding parts of Pa-Pm. If the ports of the valve are closed there is no resultant action on the brake. Valve Pa-Pm through the motion of cam C is open after the train has traversed the prescribed distance. The opening of the passage Pa of this valve connects the atmosphere, through the reducing valve N, to Qa. Consequently, it requires the co-operative action of these two valves to open up a continuous passage between pipe T and the atmosphere. Pm opens a passageway between the pipes S only when Qm is open.

The lower valve is entirely independent of all the other valves and has for its sole function the prevention of excessive speed. The upper valve is entirely independent of all other valves and when operated produces an absolute stop. The co-operating action of the other two valves permits a train to proceed, but at restricted speed.

Valves Pa-Pm and Ka-Km having been opened, there are no mechanical means for restoring them to their normal position. This is accomplished through the energization of the electromagnets M and O. Magnet M restores to its normal position the valve which has brought the train to a stop, but such a full stop will not occur if the engineer has been alert; and the key for closing this circuit is placed where he must descend to the ground to operate it. In the solenoid controlling the other valve, conditions are different; O may be energized from the inside of the cab. In addition, this latter magnet is always operated automatically whenever relay I is energized from the roadway.

Regan Automatic Train Control System

THE Regan intermittent electrical contact type of automatic train control consists of two elements: one comprising the locomotive and tender equipment and the other apparatus located on the roadside. The locomotive equipment for automatic stop only includes an electro-pneumatic valve, shoe mechanism, battery and release key. When a combination of automatic stop and speed control is used, then the locomotive equipment includes, in addition to the above, a speed controller and a relay. Visual or audible cab signals may be included when desired. The illustration, Fig. 1, is typical of the arrangement as installed on locomotives of the Chicago, Rock Island & Pacific Ry. The roadside equipment consists of a specially designed ramp, a battery, a relay and the necessary connections into the signal system. The illustration, Fig. 2, shows the ramp as installed on the Rock Island.

Various Arrangements That May Be Provided

The Regan System provides for the following arrangements and combinations of automatic train control:

(1) *Automatic Stop Only* with provision for releasing after stop is made that the train may proceed at unrestricted speed.

(2) *Automatic Stop With Low Speed Control,* so arranged that:

(a) After the train is brought to a stop it may be released and permitted to proceed under some prescribed low speed until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the stop application.

(b) When the speed of the train is retarded to a prescribed low rate the engineman may, if he desires, in lieu of being stopped, operate a release for the train to continue at or under the prescribed low rate until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the stop or restricted speed operation.

(3) *Automatic Train Control with Medium Speed Control* so arranged that the speed of the train is checked to a prescribed medium rate on passing through a caution block and must so continue as long as caution blocks prevail. When a stop block is encountered the train is automatically stopped, after which it may be released to proceed, but only under the prescribed rate fixed for operating through a caution block, this to continue until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the stop application and restricted speed.

(4) *Automatic Train Control with Medium and Low Speed Control* so arranged that the speed of the train is checked to a prescribed medium rate on passing into a caution block and must so continue as long as caution blocks prevail; but when a stop block is encountered the arrangement is such that:

(a) The train is automatically stopped, after which it may be released to proceed, but only under a prescribed low rate of speed.

(b) The train is automatically retarded to a prescribed low rate of speed and then the engineman may, if he desires, in lieu of being stopped, operate a release for the train to continue at or under the prescribed low rate of speed. Medium speed running may be resumed when a caution block is encountered and the apparatus is automatically restored for the normal running of the train when a clear block is entered.

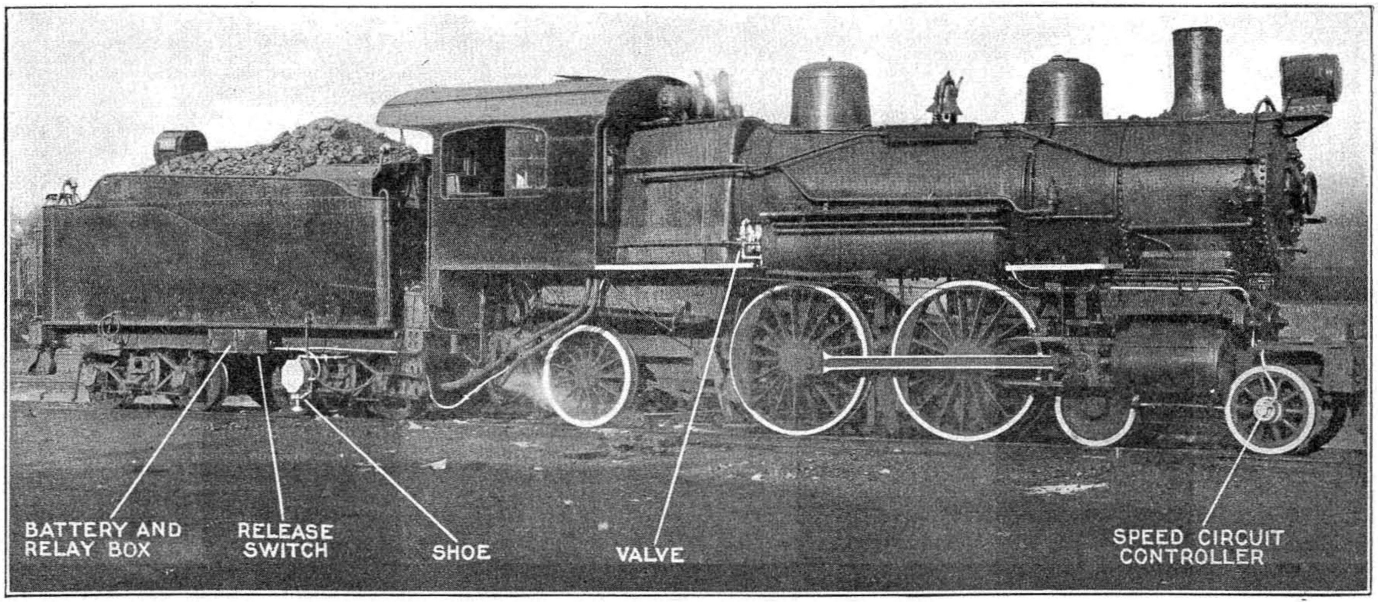


Fig. 1. Location of Apparatus on a Locomotive

Shoe Mechanism

The shoe mechanism is contained in a steel housing secured to a bracket, which is rigidly fastened to the tender truck frame or to some other suitable place on the locomotive. In this shoe mechanism there is a cast iron stem which is operated from brake pipe air pressure contained in a cylinder at the top of the stem. The arrangement is such that in case the shoe stem is broken off by contact with an obstruction, the brake pipe air pressure is reduced to apply the brakes through an opening to atmosphere, created in the shoe stem when the breakage occurs. A bracket, fastened to the shoe stem, supports a circuit controller for changing the engine relay circuits from the engine battery to the roadside battery whenever the shoe rides over an indicating ramp; that is, when the shoe rides over the ramp the only source of energy for maintaining or changing the indication on the engine is that obtained from the roadside circuits, and as the shoe rides down the leaving end of the ramp, the shoe mechanism circuit controller again changes the circuits so that the source of energy for maintaining the indication received is then transferred to the locomotive battery.

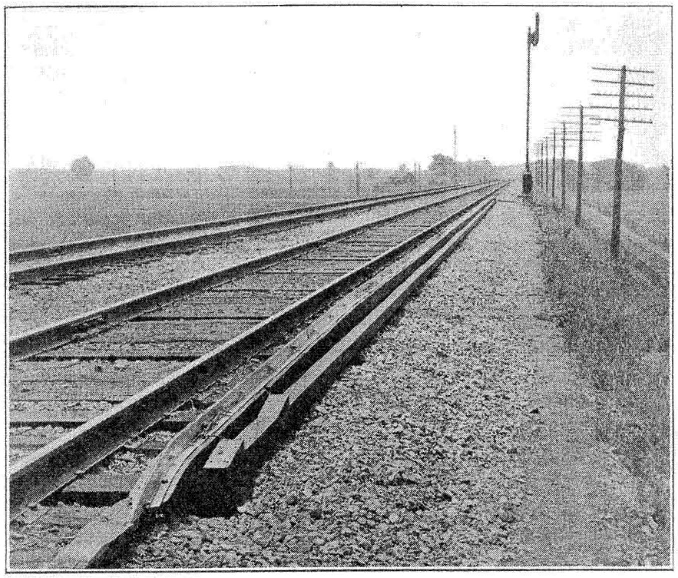


Fig. 2. Ramp Located on Roadside

The shoe stem is held in position for contact with the ramp by means of brake pipe air pressure; this forces the shoe stem down and gives sufficient contact pressure when riding over the ramp. When the shoe stem is secured in the "up" position, the locomotive circuit is de-energized, thus conserving energy from the storage battery.

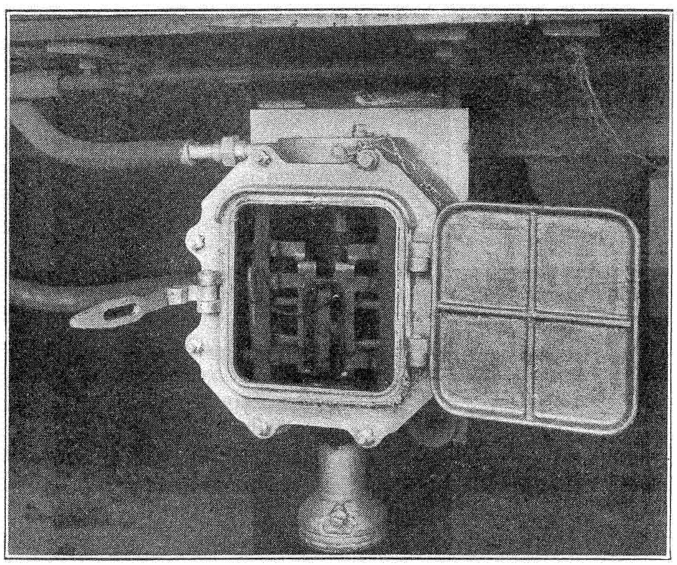


Fig. 3. Contact Shoe With Door Open

Speed Controller

The speed controller mechanism is housed in a weather-proof case directly attached to the front wheel and axle of the pony truck. It consists of two parts: one which revolves with the axle to which it is connected, and the other which remains stationary, being arranged for connection with the locomotive circuit by means of a substantial flexible conduit. Ball bearings are used to reduce the friction to a practical degree and to guard against undue strain on the flexible conduit. The housing is rigidly bolted to the end of the axle of the pony truck wheels and accurately centered by a projection from the housing, fitting in the counterbore in the axle. This speed controller is of the centrifugal type and is provided with a spindle which forms the axis of the centrifuge arrangement. It operates in the horizontal position on the spindle. A crosshead, which is connected by links to the arms of the centrifuge, is free to move along the spindle. Fastened to the end of the crosshead and insulated therefrom, is a contact button. Attached to the stationary part of the speed controller are electrical contact springs designed so as to contact with the contact button. As the locomotive accelerates or retards in speed, the crosshead moves back and forth on the spindle, causing the contact button to break or make the electrical circuits connected through the contact springs. A compression spring is used to keep the crosshead in the extended position, thus opposing the force of the centrifuge when the locomotive is moving. The tension in the compression spring is adjustable to the speed at which it is desired the electrical contacts should make and break.

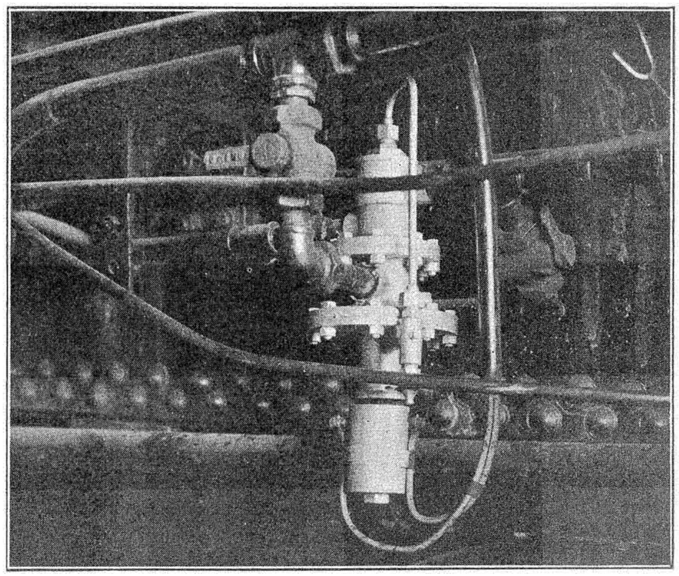


Fig. 4. Reservoir and Brake Applied to Engine

The Electro-Pneumatic Valve

The electro-pneumatic reservoir and brake pipe valve shown diagrammatically in Fig. 5 and illustrated in Fig. 4 is of the diaphragm type. This valve is connected in the main reservoir pipe at the openings *6* and *7*, the flow of air being normally that shown by the arrow. A branch from the brake pipe connects to opening *5*.

Part *D* is a stem rigidly connected to the armature of the magnet, being in an "up" position when the magnet is energized and "down" when the magnet is de-energized. Pipe *15*, chamber *16* and channel *17* connect chamber *1* with chamber *18*, so that the air pressure in chamber *18* is the same as in chamber *1*. When magnet is energized stem *K* is lifted, admitting air to primary valve from chamber *18* to chamber *3*, via channels *19*, *20* and *21*. With air at pressure in chamber *3*, the lower diaphragm *I* is extended upward, causing valve opening *28* to be closed by valve *G* and valve *F* to be unseated from opening *29*.

These valves being connected by stem *22* (the position shown is that existing normally and the one just described).

When magnet is de-energized, primary valve stem *K* is closed on seat *L* at the top, so that air cannot pass into channels *19*, *20* and *21*, leading to chamber *3* from chamber *18*. Simultaneously, primary valve stem *K* is open at the bottom seat L_1, permitting the air at pressure in chamber *3* to flow to atmosphere via channels *21*, *20*, *19*, chamber *23* and channels *24*. With chamber *3* freely opened to atmosphere the air at pressure in chamber *1* on top of valve *F*, in chamber *2* on top of upper diaphragm *H* and in chamber *4* through port *28* on top of valve *G*, together with the force of gravity forced downward, stem *22*, to which valve *F* and *G* and diaphragms *H* and *I* are connected, so that valve *F* is seated, cutting off flow of air from opening *6* to opening *7*, and valve *G* is opened, permitting a free passage of air to atmosphere via opening *5*, chamber *4*, port *28*, chamber *25*, channels *26* and ports *27* in vent plug *C*. The air is restricted in its outlet to atmosphere by the ports in exhaust vents *Z*. These ports are of a size to give the proper brake application. There is no free passage for air between chambers *2* and *4*. A strainer *M* is placed in chamber *16* in such a manner as to catch any dirt or moisture from the air line if any should be present, causing it to fall into the chamber of air cock *U*, where it can be expelled from the system.

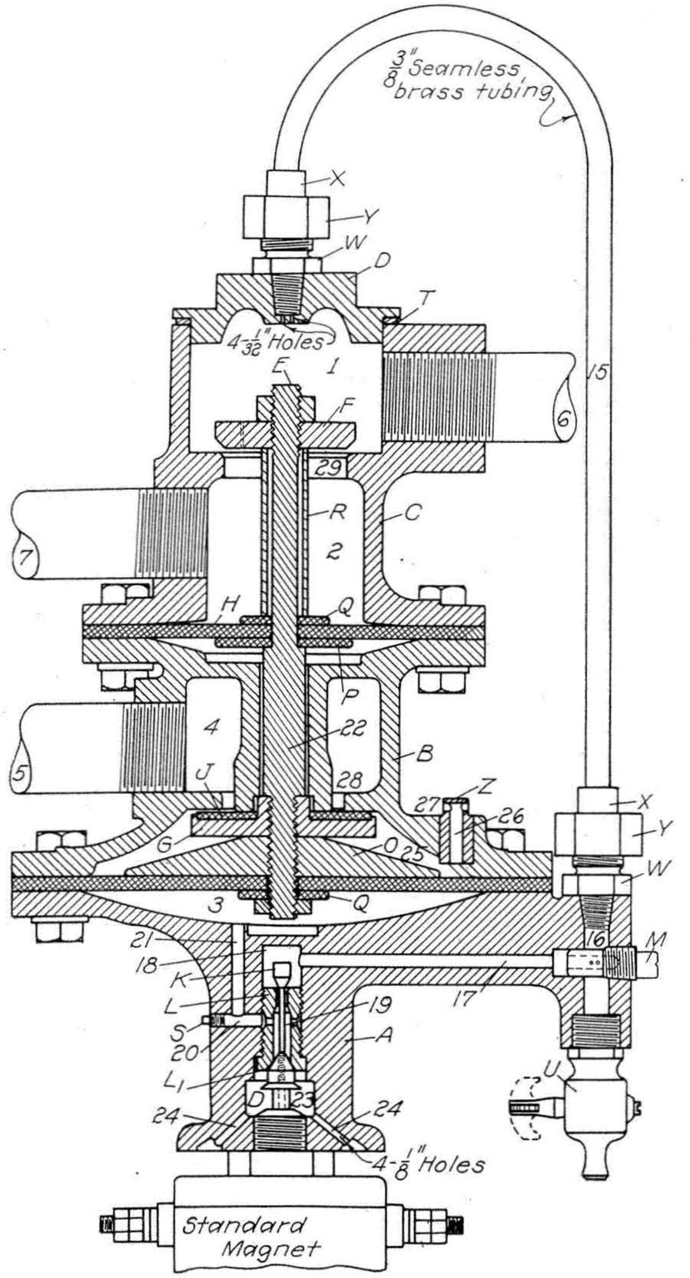


Fig. 5. Diaphragm Type Reservoir and Brake Valve

Typical Locomotive and Ramp Circuits

This circuit, Fig. 8, for automatic train control is based on its use with a three-position signal system, having a polarized control line circuit. The train control system is controlled by relay *B* insofar as wayside indications are concerned.

Ramp Circuit

Normally the ramp is energized through the following circuit: 16 cell battery, positive pole, wire *D3* and *D2*, polar and neutral contacts of relay *D*, wire *100*, ramp, wire *105*, present railway company signal line relay, wire *106*, neutral and polar contacts of relay *B* to negative pole of *16* cell battery. This circuit as described is primarily for checking the integrity of the ramp. Anything happening in it to de-energize relay *A* will cause the signal at this location to indicate stop and the signal in the rear to indicate caution.

That part of the ramp circuit co-operating with the locomotive when it passes over the ramp is as follows: Wire *107*, connecting to track rail *P'*, circuit controller on signal, wire *108*, resistance, wire *109*, polar contact of relay *B*, *16* cell battery, polar and neutral contacts of relay *B* and wire *100* to ramp.

Whenever the polarity to the control relay *B* is reversed, which is the condition when the signal indicates caution, then the polar contacts of relay *B* are reversed as to position and the electrical energy of the ramp is reversed in polarity. When the signal is in the stop position, relay *B* is de-energized so that the opening of its neutral contacts cuts energy off the ramp. In order that the ramp may not transmit energy to the locomotive apparatus, if the signal for any reason is at stop while the control circuit is intact, the ramp circuit is carried through a circuit controller attached to the signal and designed to be open when the signal is at stop.

Locomotive Circuits

Normally the locomotive circuit is furnished with electrical energy from a 10-volt storage battery on the locomotive. The circuit is as follows: Positive battery, contact *2* of the three-position relay, wire *3*, contact *16* of shoe mechanism, wire *5*, electro-magnets of neutral lock and three-position relay, wire *7*, contact *10* of shoe mechanism, wire *11*, contact *21* and wire *13* to negative side of 10-volt battery.

As shoe *S'* rides the ramp, its stem operates a circuit controller connected to it, so that at first the upper contacts *18* and *14* are made, then contacts *10* and *16* are broken. When contacts *10* and *16* break the circuit of the three-position relay through the 10-volt battery on the locomotive is broken, which, unless the ramp is energized, causes the three-position relay to become de-energized and assume a neutral or de-energized position. However, when contacts *10* and *16* break, and while shoe rides ramp, providing ramp is energized as shown, the three-position relay will receive current through the following circuit: 16 cell battery, positive pole, wire *D3*, wire *D2*, polar and neutral contacts of relay *B*, wire *100*, ramp, shoe, wire *19*, contact *18*, wire *5*, three-position relay and neutral lock coils, wire *7*, contact *14*, wire *43*, frame of locomotive *G*, axle and wheels *T*, track rail *P'*, wire *107*, circuit controller on signal, wire *108*, 4-ohm resistance unit, wire *109*, polar contacts of relay *B*, to negative pole of 16 cell battery. This retains the three-position relay in the normal energized position. As the shoe leaves the ramp, contacts *10* and *16* are first made, then contacts *14* and *18* break. As contacts *10* and *16* make, the three-position relay receives current from the engine battery and so continue after the shoe leaves the ramp. This is the case when conditions are right for the train to proceed at speed; that is, when the signal is clear. Assume a condition where the polarity on the ramp is reversed from that shown. When the shoe is on the ramp, with contacts *18* and *14* made and *10* and *16* broken, then the three-position relay receives current as follows: 16 cell battery, positive pole, wire *D3*, wire *D4*, polar contacts of relay *B* reversed, wire *109*, wire *108*, circuit controller of signal, wire *107*, track rail *P'*, wheels and axles *T*, frame of locomotive G, wire *43*, contact *14* of shoe mechanism, wire *7*, neutral lock and three-position relay coils, wire *5*, contact *18*, wire *19*, shoe, ramp, wire *100*, neutral and polar contacts of relay *B* reversed. to 16 cell battery negative pole.

This condition causes the three-position relay to assume the negative or reverse position so that contacts *20, 21, 27*, etc., are closed, instead of *2, 12, 26*, etc. As the shoe leaves the ramp, contacts *10* and *16* of the shoe mechanism are made and then contacts *18* and *14* are open, in which position they remain after the shoe leaves the ramp. The three-position relay also remains in the negative or reverse position. The following circuit under this condition is established: Locomotive battery, positive pole, resistance, wire *1* and *23*, contacts *21*, wire *11*, contact *10*, wire *7*, neutral lock and three-position relay coils, wire *5*, contact *16*, wire *3*, contact *20*, wire *22* and *13* to locomotive battery, negative pole.

With no energy on the ramp another condition exists. As heretofore explained, contacts *18* and *14* are made and then contacts *10* and *16* are broken as the shoe rises on the ramp. The breaking of contacts *10* and *16* disconnects the locomotive battery from the three-position relay. As the three-position relay is de-energized, it assumes the third or de-energized position with no contacts (except special) closed and remains in this condition until some independent action as the operation of the release switch is taken.

The electro-pneumatic reservoir and brake valve is normally controlled with the following circuit: Locomotive battery, positive pole, resistance, wire *1*, wire *23*, contact *26*, wire *31*, magnet, wires *33* and *13* to locomotive battery, negative pole. This retains the magnet of the reservoir and brake valve energized, providing the contact *29* in the speed controller is closed. As the closing of contact *29* is dependent upon the adjustment to a predetermined speed, it will be closed when the train speed is under the predetermined speed. The result would be in a case where the ramp is not enegrized that all contacts of the three-position relay (except special) would be open. Hence, the circuit for the magnet of the valve must be open, de-energizing the magnet, in which case the electro-pneumatic valve will cause an exhaust of brake pipe pressure, thus applying the brakes automatically.

When the three-position relay is de-energized it may be energized to assume the negative or reverse position by pushing the release switch *C*. When this switch is operated the following circuit is established: Locomotive battery, positive pole, wire *13* and *38*, contacts *37*, wire *41*, resistance, wire *4*, coils of the three-position relay and neutral lock, resistance, wire *40*, contacts *36*, wire *39*, special contact closed *A* to *B* on three-position relay, wire *1* and resistance to battery, positive pole. With the three-position relay in the negative or reverse position as heretofore explained, the magnet of the electro-pneumatic reservoir and brake valve can only be energized through the speed controller contact *29*.

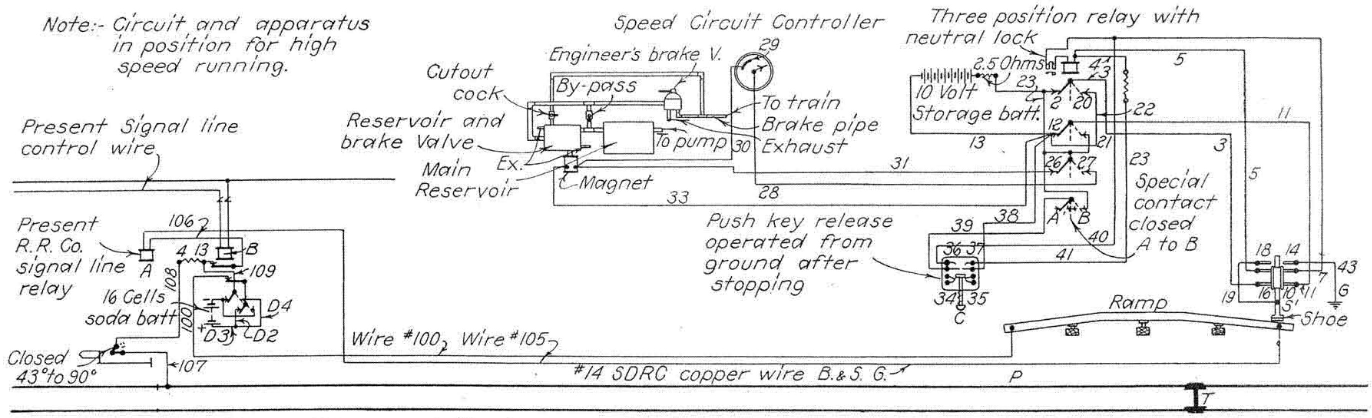


Fig. 6. Diagram of Circuits on the Locomotive and Way Side Signal Connections

The Regan Intermittent Induction Type

In this system of train control the speed controller and electro-pneumatic valve are the same as used in the intermittent electrical contact ramp type, while the inductor elements shown in Fig. 7 take the place of and perform the same function as the shoe mechanism of the ramp system. In addition to the speed controller and electro-pneumatic valve on the locomotive, there are three inductors, a tripping element and two reset elements, two holding relays, a release key, an alternating current generator of the headlight type and appropriate circuits. On the roadside are three inductors and one inert element, as shown in Fig. 8.

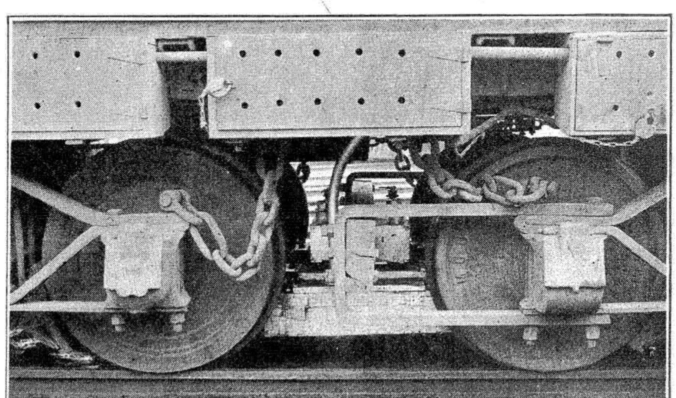


Fig. 7. Induction Receiving Apparatus on the Locomotive

When the locomotive is operated over the inert roadside elements, they influence the inductors on the locomotive to create a stop condition, but at the same time the inductors of the locomotive come within the influenec of the inductors on the track such that a cycle of influence is established from the locomotive through the inductors on the track to the locomotive again. The control relays of the signal system are connected to circuits so arranged as to control this cycle of influence such that if the block is occupied a stop condition is produced; if the block is in caution condition, then a caution condition is produced in the apparatus on the locomotive; while if the block is clear then a condition of clear is produced on the locomotive.

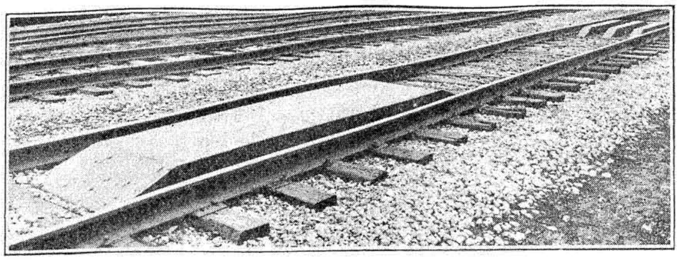


Fig. 8. Induction Type Track Elements

The inductive installation on the Chicago, Rock Island & Pacific in its operation follows out the same general scheme as is involved in the ramp system, namely, that a train entering a clear block proceeds at unrestricted speed; a train entering a caution block has its speed retarded to some predetermined rate as 30 mi. an hr., while a train about to enter a stop block is brought to a stop.

The Induction system, the same as the ramp system, is susceptible to a variety of combinations for automatic stop and speed control. No roadside energy is necessary in the operation of the train control and it may be used equally well as either a two-position or three-position scheme and with any possible type of wayside signaling. The clearance of the locomotive element above the track element is four inches. Nothing in the track is above the top of the track rails.

Schweyer Automatic Train Control

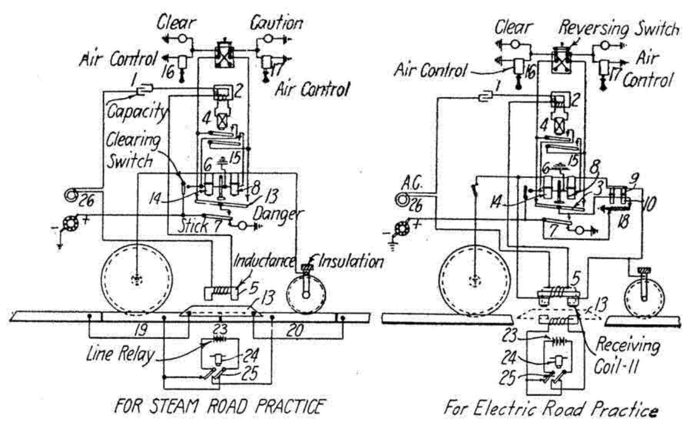
THE Schweyer automatic train control system is of the intermittent, non-contact, inert roadside element type of control with no physical contact made between the roadside apparatus and that installed on the engine. The device is used in connection with roadside signals and makes use of both alternating and direct current. The apparatus was briefly described on page 224 of the July, 1918, issue and its test was covered on page 353 of the November, 1918, issue of the *Railway Signal Engineer*. The operation of this system is based on the principle of introducing a mass of iron in the path of the magnetic circuit of a coil which is energized with alternating current and which is suspended from the engine.

Since the track armature does not move, the train would stop every time it passed the testing point if there was not some means of keeping it running when the signal indicated proceed or caution. This is true, but part of the engine or train is insulated and one side of a polarized relay is connected to the ground of the engine or train and the other side to the insulated wheel or truck so that it picks up current furnished by a local track battery every time it runs through the insulated section under clear or caution conditions.

The Types of Control Employed

Two types of apparatus are shown in Figs. 1 and 2, either of which may be used on steam roads, although electric lines may use only one type. For both types there is a fixed bar "13" having inclined ends alongside the rail. This projects $2\frac{1}{4}$ in. above the top of the rail, the level section being 2 ft. 6 in. long, and containing enough metal to properly perform its function as a track armature, as described later. This bar is insulated from the ties on which it is supported and is included electrically in the main track circuit as shown, but has no mechanical connections. In order to handle traffic in both directions these armatures are arranged in pairs on both sides of the track. In one type of roadside apparatus (Fig. 2) a coil 22 is placed in a certain definite relation to the track armature 13 and in such a position that any magnetic field formed by a circuit through it will influence a receiving coil carried by the locomotive. The track coil 22 may be energized from a roadside battery 23, controlled by the usual track relay 24. By means of circuit closers 25 controlled by the roadside signal, the direction of current flow through the track coil 22 may be changed.

In the other type of control, shown in Fig. 1, two short track circuit sections 19 and 20 are introduced at each location of the track armature 13. A resistance is introduced around the insulated joint separating the two short sections on one rail, while around the joint in the other rail there is a loop containing the battery for both track sections, which is controlled by pole changers operated by a polarized relay 24; the loop circuit may also pass through the front contact of a relay, or through a



Wiring Diagram for the Apparatus

resistance if this relay is de-energized. Both of the relays in the loop are controlled from adjacent blocks and depending on the direction of current flow through the loop, as governed by the pole changers, a caution or clear indication is given to a passing train.

The choke coil 5 is installed in such a position as to come within range of the track armatures 13, but it is high enough so as not to be influenced by the rails of a turnout or other pieces of steel that may be part of the roadway structures. When the short track sections are used instead of the track magnet 22, a portion of the engine is insulated, and a polarized relay and the engine receiving coils are eliminated. The impulse is then received through the wheels and axles when the engine passes over the looped insulated joints.

A Description of the Circuits

Referring to Figs. 1 and 2, turbine 26 furnishes alternating current to the main engine circuit through condenser 1, primary of transformer 2, and around the choke coil 5 back of the collector ring of the turbine and is a closed circuit energized at all times when the generator is running. Another part of the circuit is from the secondary of the transformer 2 through the coils of the main engine a.c. relay 4, which is also constantly energized. The remaining circuits are direct current from the generator grounded on one side. The "clear" circuit goes from ground through one set of electro-pneumatic coils 16; through the left side of the polarized armature 3 in its closed position; and through the stick neutral armature 7 in its raised position back to the generator. The "caution" circuit is from ground through the coils 14 of caution electro-pneumatic valve 17; through right side of polarized armature 3 in its closed position, and through the stick neutral armature 7 in its raised position back to the generator. The upper and lower armatures of the main engine a.c. relay 4 control the stick circuits respectively of "clear" coil 14 and "caution" coil 8. A primary closed pick-up circuit is through the engine receiving coils 11, through the upper coils of a polarized relay 6 and through the time limit relay 9; this circuit, though closed, is normally de-energized and only receives current momentarily when the engine coils 11 pass over track coils 22. If the track circuit loop is used instead of the track coils, this circuit is connected to the separate insulated parts of the engine.

Depending upon the polarity of the pickup current the effect of the opening of the main engine relay 4 is bridged over when it engages a track armature; if a "danger" condition exists, however, the "clear" and "caution" circuits are not completed since the track coil 22 or the insulated sections 19-20 will not be energized, and the falling of the armatures of the main engine a.c. relay 4 will open the controlling stick circuits thus producing a stop, and energizing a red lamp through a back contact on the stick armature 7. The other two signals are in parallel with the "clear" and "caution" valves 16-17.

The polarized relay 6 has its coils 14 and 8 wound in opposite directions to each other and each are grounded through ground 15. The current flowing through either 8 or 14 to ground maintains the definite polarity of the polarized armature 3.

The Time Limit Relay

The time limit relay 9, Fig. 2, has its stick armature 18 raised through its upper coils every time the pickup circuit is energized. The wire wound around the armature 18 causes a thermos expansion breaking the circuit at 10 after a certain period of time has elapsed. Any other suitable time limit devices may be used.

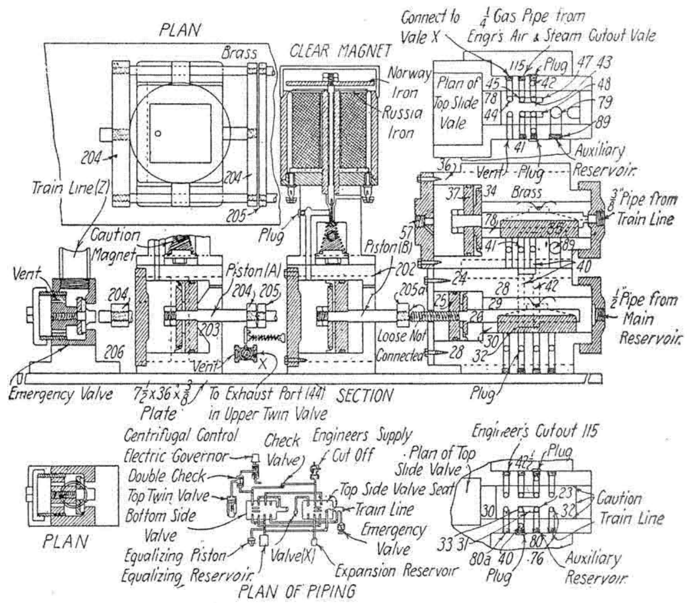
The operation of this device is as follows: When the engine choke coil 5 comes within the range of a track armature 13, the current flow through the coil and through the primary of the transformer is greatly retarded. This results in a corresponding decrease in the secondary of the transformer 2, so that the main engine a.c. relay 4 does not receive enough current to hold up its armature, which, therefore, drops. If, now, the block ahead is occupied, all the engine circuits are opened by the de-energization of the main engine relay 4 and the electro-pneumatic valve magnets 16-17 will be de-energized, shutting off the air supply from the two pistons of the air control apparatus, which will permit them to be moved to the left by the pressure constantly exerted on the third smaller piston, thus venting the train line.

If the track conditions are such that a "caution" indication should be received, the main engine relay is opened in the same way, but through the track magnet or short track section a current is picked up, which, by means of the polarized engine relay 6, reverses its polarity, opening the front contact of the armature to the left and closing it at the right. The clear electro-pneumatic valve 16 being thus de-energized, air is drawn off from the longer of the two cylinders, causing the slide valve to move to the caution position, venting the train pipe if the train is running in excess of a speed determined by the centrifugal governor.

If the block is clear, the polarized current picked up from the track holds the polarized armature 3 in the "clear" or left-closed position, while the main relay a.c. circuit is opened, and there will be no application of the brakes.

The Air Control Apparatus

The operation of the air control apparatus, shown in the illustration, is controlled through the electric circuits that operate electro-pneumatic pin valves 200 and (201 not shown), which, when energized, admit air from the main reservoir to separate cylinders 202 and 203. These cylinders are of the same diameter, but 202 is approximately twice the length of 203. These pistons are connected to yokes 204 and 205 in a manner that allows for the difference in stroke of the pistons. The yoke 205a connects to the piston rod B of the longer cylinder 202 and loosely butts against the rear end of piston rod 26 operating piston 25 in the lower twin cylinder 24 of the same stroke, but of smaller diameter. The main reservoir pressure behind piston 25 tends to pull slide valve 32 to the left when air is exhausted from behind the pistons in cylinders 202 and 203, opening the emergency valve 206 and venting the train pipe.



Details of the Air Control Apparatus

If, however, the clear poition magnet is de-energized and the caution position magnet is energized, the slide valve 32 will only move one-half the stroke to the left, allowing pressure from the supplementary reservoir to reach the bottom of slide valve 35 in the upper twin cylinder 36 by way of pipe 80, port 23, cavity 31 in slide valve 32, port 33 and by-pass 40. If the train is now exceeding a caution or predetermined speed, main reservoir pressure is fed in through port 57 behind piston 37, forcing it to the right against the train line pressure in cavity 78, taking with it slide valve 35 connecting by-pass 40 and port 41 to the expansion reservoir 90. This allows pressure in the supplementary reservoir 86 to reduce, depending on the capacity of the expansion reservoir 90, which causes equalizing piston 84 to raise from its seat and gradually vent the train pipe to the atmosphere through port 96, thus making a gradual application of the brakes. Simultaneously with this action the main reservoir, by way of port 42½, cavity 31a in slide valve 32, by-pass 42, cavity 47 in slide valve 35 and ports 45 and 115, has forced its pressure to the air and steam cutoff valves, cutting off communication between the main reservoir supply pipe and engineman's brake valve and cutting off the motive power. Thus the engineman cannot release the brakes while they are being automatically applied. When the train comes within safety speed the governor causes the main reservoir pressure to be exhausted from behind piston 37, whereby the train line pressure forces slide valve 35 to the left, venting expansion reservoir to the atmosphere via cavity 48, recharging the supplementary reservoir 86 with train line pressure by way of port 79, seating equalizing piston 84 and opening engineman's cutout valves by connecting ports 44 and 45 with cavity 47. Since valve X is connected to port 44 these last two cutout valves cannot be opened except in the clear position as shown.

Assume a train passing a clear signal to be running in excess of caution speed. Slide valve 32 would move to the right, connecting train line pressure to supplementary reservoir 86 by way of port 76, cavity 31, port 31 and port 80. The engineman's cutout valve and motive power cutoff valve would be opened by pressure venting to the atmosphere by way of port 115, port 45, cavity 47, port 43, by-pass 42, cavity 31a to atmosphere, allowing the engineman to have full control of the train.

If a service application of the brakes is desired in the emergency position, emergency valve 206 is cut out by closing a stop-cock between it and the train line so that when slide valve 32 moves to the extreme left main reservoir pressure flows through port 42½, cavity 31a, port 115, through one end of the double check valve, through port 57, moving slide valve 35 to the right, making a service application, because port 80a is now connected to by-pass 40 by way of cavity 31 in slide valve 32 connecting port 33. It will be noted that when valve Z is open to the train line a service and emergency application is simultaneously made unless communication from 80a is disconnected from 80 by a suitable valve.

Shadle Automatic Train Signal-Stop

The Shadle automatic train signal and stop is of the intermittent ramp contact type incorporating cab signals and speed control. This system has been developed during the past five years on the Cincinnati, Indianapolis & Western by C. F. Shadle, signal and efficiency engineer of that road. This apparatus was inspected by the Automatic Train Control Committee of the Railroad Administration on July 11, 1919. On this test three ramps were installed and one engine was equipped. Speed control features were included and were controlled by a specially wound generator driven from an axle, so designed to close the circuit to the brake valve at a certain speed, permitting a de-energized ramp to be passed, if the circuit controllers were operated by the engineman and fireman at the same time.

The circuits are so developed that the system will work in conjunction with existing automatic signal systems, or, if introduced on roads not so equipped, it will operate without the necessity of such an installation as the engineman gets the indication from signal lights located in the cab. These lights will indicate to him the action necessary for him to take. If such action is not taken the brakes are set and the train is automatically brought to a standstill.

Type of Apparatus

All of the electrical devices employed in this system are standard parts, as manufactured by the Union Switch & Signal Company for electro-pneumatic signal and interlocking purpose, the system being so designed that it is not necessary to manufacture or introduce any new devices unknown in the signal field.

Five miles of the main line on the Cincinnati, Indianapolis & Western has been equipped with the necessary local contacts, consisting of 40 ft. ramp rails and a passenger engine has been in regular daily service between Indianapolis, Ind., and Cincinnati, Ohio, running over this portion of the line, which is also equipped with automatic signals.

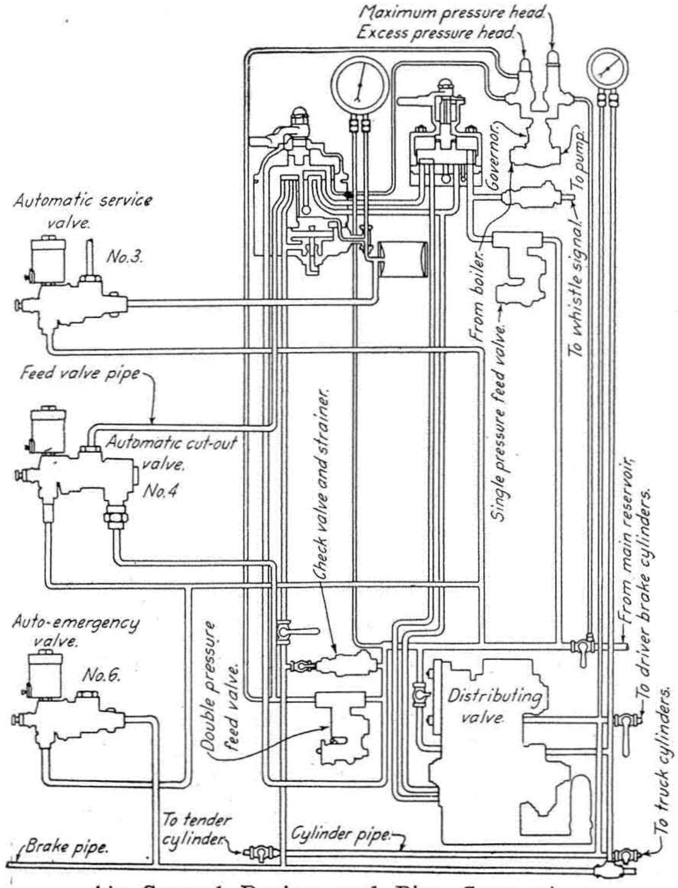
In order that the engine equipment may not fail to pick up the electrical impulse required to operate it when running at high speed in passing over a 40-ft. ramp rail, a retarding device, or "stick" circuit, is so arranged that the time of contact between the traveling vehicle and the ramp rail is not the important item.

The Circuit Arrangement

Referring to the general arrangement of the circuit and the mechanism as applied to an engine it will be noted that the electric solenoid movements *A*, *B* and *C*, also the engineman's control switch *b*, consists of standard Union Switch & Signal Company's magnets as used in electro-pneumatic interlocking. The electro-pneumatic relays *1* and *2* are shown on the circuit plan, are interlocking dwarf signal movements, with no changes in the mechanism except the addition of one or more circuit breaker contacts to the movement.

The positive wire from a 12-volt local battery at a signal or a track location is carried through the points of a track relay to the 40-ft. ramp rail, the negative side of the battery being connected to the track rail. A 12-volt Edison storage battery of 60 ampere hours' capacity is carried on the engine, the negative side of the battery being tapped to the frame. The contact shoe is mounted at the front end of the engine just back of the pilot and the wire from the positive side of the storage battery on the engine is looped through the wearing plate on the shoe so that if it should be torn off or otherwise damaged this wire would be broken. When the engine leaves the roundhouse the air brake equipment on the locomotive is tested. At the same time the signal device must be put into service in order to open the feed valve pipe before the brakes can be used. The cab signal would, therefore, show a yellow light. In order for the engineman to have control it is then necessary for him to push the engineman's control switch. After these contacts are closed both the green and yellow lights will appear, indicating to the engineman that he has control, thereby preventing an automatic application of the air. This condition will continue until the train enters the first clear block; then the apparatus will automatically release the engineman's valve, and the yellow light will disappear, while the green light will remain, thus indicating that the block ahead is clear.

With reference to the engineman's control switch it

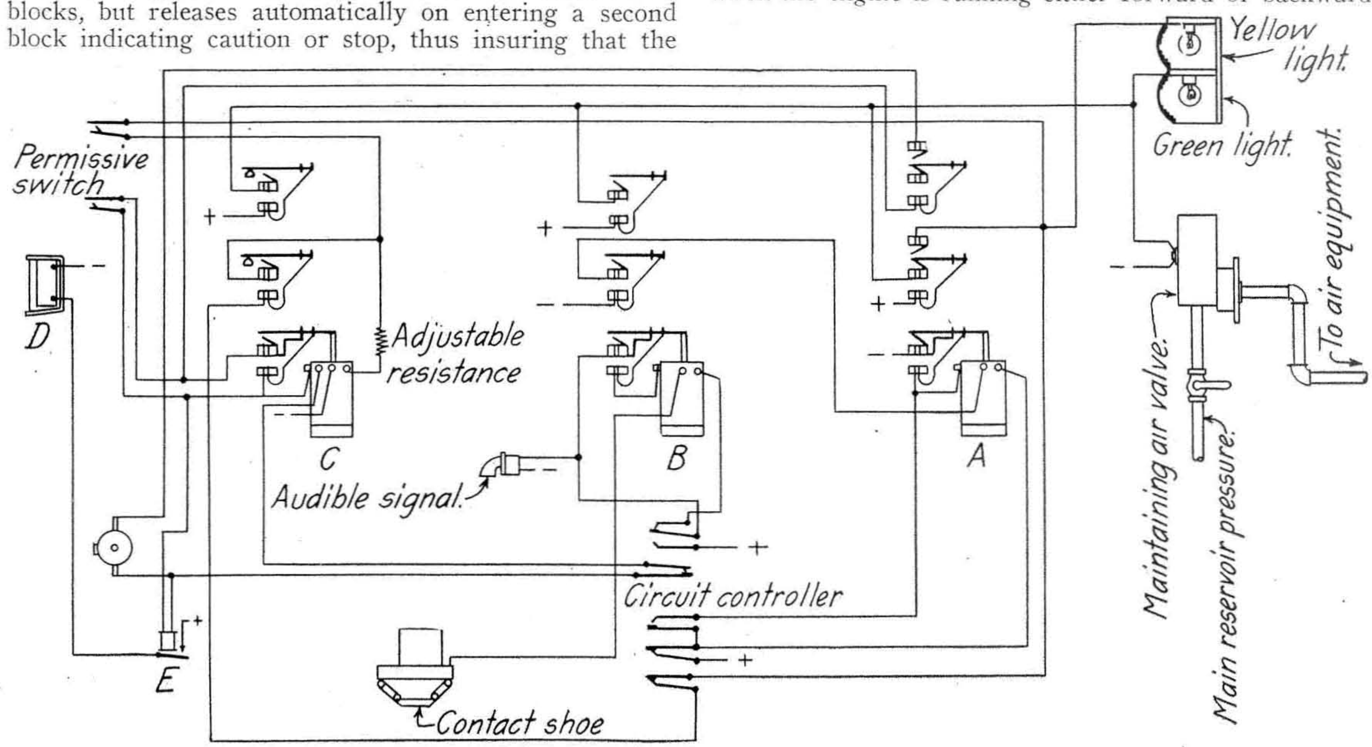


Air Control Devices and Pipe Connections

is to be noted that this switch is to be operated by the engineman on the appearance of a yellow signal light, which indicates that he has entered a caution block or an occupied block. This switch, however, does not remain in the holding position through consecutive caution or red blocks, but releases automatically on entering a second block indicating caution or stop, thus insuring that the engineman does not forget that he has assumed control and also compelling him to operate the switch manually in order to prevent an automatic application of the brakes. The service brake valve *3*, as shown on the plan, operates a hand-set release. This hand release requires that the engineman get on the ground to reset it after the train has been brought to a full stop, thereby closing valve *3* before the brakes can be released. However, it is not necessary to use a hand release if this feature is found undesirable, as the engineman can release the brakes immediately by operating the engineman's control switch and proceed without stopping, if the brakes go to a service application.

The diagram illustrates the method of connecting the air controlling device with the air brake system on the locomotive. The service application is relied upon entirely to stop the train with the intermittent set-up timer on both brake reduction and time between reductions. With this device it is possible to secure automatically a given amount of service brake reduction in pounds and a given period of time between successive reductions in minutes or seconds as may be desired according to the tonnage of the train and the stopping distance required. To make the locomotive signal effective the local contacts should be placed from 800 ft. to 1,000 ft. in advance of the block in order to give the engineman advance information, so that he may have sufficient time to assume control and prevent an automatic application of the brakes and at the same time acknowledge the signal indication.

The automatic control apparatus must be put in service at the same time the brake on the engine is tested at the terminal by closing the control switch on the engine or the brakes will remain in the holding position. At the first clear block the engine signal will change to clear, but if the fixed signal is at caution or stop, the signal in the cab will change to yellow and release the device ready to apply the brakes automatically in a service application, unless the engineman on the appearance of the yellow signal assumes control by again replacing the holding switch. This condition repeats at each red or caution block, when the system is set up for the service application. The apparatus is so constructed as to be operative when the engine is running either forward or backward.



Circuits of the Shadle Automatic Train Signal and Stop

The Simmen System of Speed Control and Train Dispatching

THE Simmen Automatic Railway Signal Company has been developing train control devices since 1907 and has had one or more installations in operation since that time. The method of pick-up is of the intermittent signal rail (ramp) and contact shoe type. The energization of the signal rail is controlled by means of a remote control dispatching and recording system or by the track circuit, or by both. The development of train control has been entirely of the speed control type. Some work has been done with an inductive pick-up method.

The first installation was made in 1908 on the San Jacinto branch of the Atchison, Topeka & Santa Fe in Southern California, 30 miles and 7 locomotives being equipped. This installation was in continuous operation for 18 months. Owing to the mild climatic conditions of Southern California, certainty of the shoe contact with the signal rail could not be proved under ice and snow conditions, and therefore a second test installation was made on the Toronto & York Radial Railway, an interurban electric line out of Toronto, Canada. Ten miles of track and 16 cars were equipped and from 1909 this installation was in daily use until 1916, when the road was double-tracked, the roadway paved for street purposes and the cars operated as in ordinary city streets.

The third installation was made in 1912 on the Indianapolis & Cincinnati Traction Company's line between Indianapolis, Ind., and Greensburg, a distance of 45 miles, single track, with 22 sidings and 24 cars equipped. This is a high speed interurban line with scheduled trains of 60 mi. an hr. and will be more fully described later. In 1913, two more installations were made, one near Nashville, Tenn., for a distance of 25 miles and with 10 cars equipped, and one at Virginia, Minn., for a distance of 38 miles with 18 cars equipped.

Cab Circuits

Two-position, three-position and six-position cab circuits have been developed. All these are of the intermittent signal rail and shoe contact type, and any signal obtained from a signal rail is continued by means of a stick circuit until the next signal rail is reached. Distant and home signal rails, 60 ft. long, are erected at proper locations and energized or de-energized by a track circuit, through an interlocking machine, or through the "Simmen Remote Control Dispatching and Recording System."

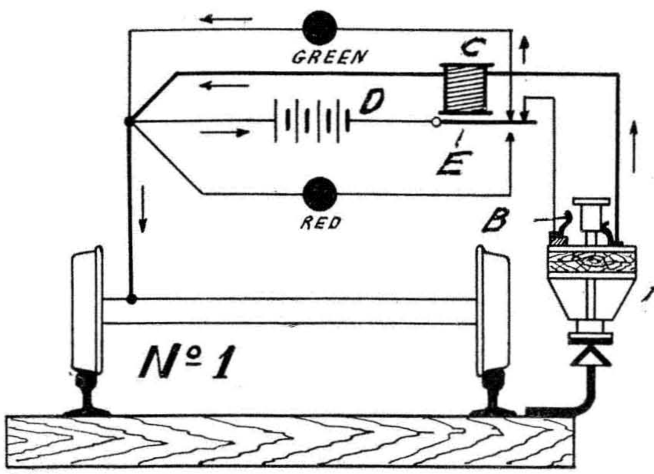


Fig. 1. Circuit Diagram With Red and Green Lights

In the two-position circuit when the signal rail is energized, a clear signal is displayed; when the signal rail is de-energized, a danger signal is given. Figure 1 shows the two-position circuit. *A* is a contact shoe, *B* a switch which is opened when a shoe slides upon a signal rail, *C* a neutral standard relay, *D* a 10-volt storage battery and *E* the armature of the relay.

The operation is as follows: When the shoe slides up on a signal rail, switch *B* is opened. If the signal rail is energized, current from a battery along the track will flow from the shoe through the relay to ground; when the shoe leaves the signal rail, switch *B* is closed and a closed stick circuit on the engine is established as follows: From shoe *A*, through relay *B*, through battery *D*, front contact of armature *E* to switch *B* and contact shoe, thus continuing the clear signal. Assuming that the next signal rail is de-energized, the operation will be as follows: When the shoe slides upon the de-energized signal rail, switch *B* is opened, and there now being no energy from the track battery, relay *C* becomes de-energized on account of the cab stick circuit now being open at switch *B*, and the armature *E* drops to close a back contact for a danger signal circuit. As the shoe leaves the signal rail, switch *B* is again closed but the danger signal is continued, since the cab stick circuit is now open at the front contact of armature *E*. This circuit is used to control the speed of the train, as will be explained later.

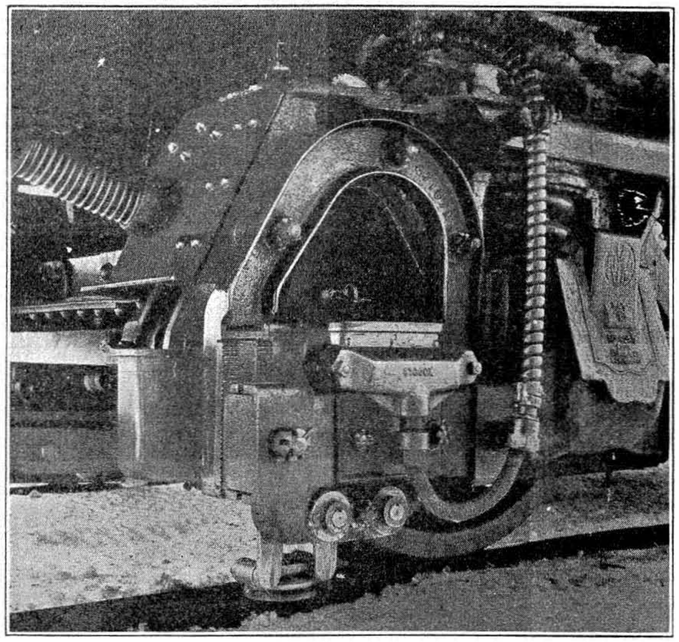


Fig. 2. Contact Shoe Equipment in Place

Figure 3 shows the three-position circuit. When the signal rail is energized with positive energy, a clear signal is given; when energized with negative energy, a caution signal, and when de-energized, a danger signal. The operation is practically the same as the two-position circuit. For speed control this circuit is used to control maximum, caution and minimum speed.

In Fig. 5 is shown the six-position circuit, on the same principle as the two and three-position.

No. 1 signal is set up when the signal rail is energized

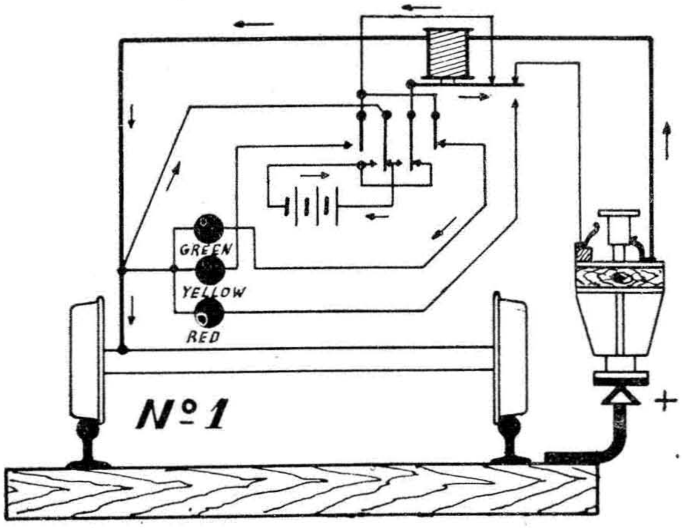


Fig. 3. Circuit Diagram With Red, Green and Yellow Lights

with a.c. and positive d.c. current. No. 2 signal is set up when the signal rail is energized with a.c. and negative d.c. current. No. 3 signal is set up when the signal rail is energized with positive d.c. current only. No. 4 signal is set up when the signal rail is energized with negative d.c. current only. No. 5 signal is set up when the signal rail is energized with a.c. current only.

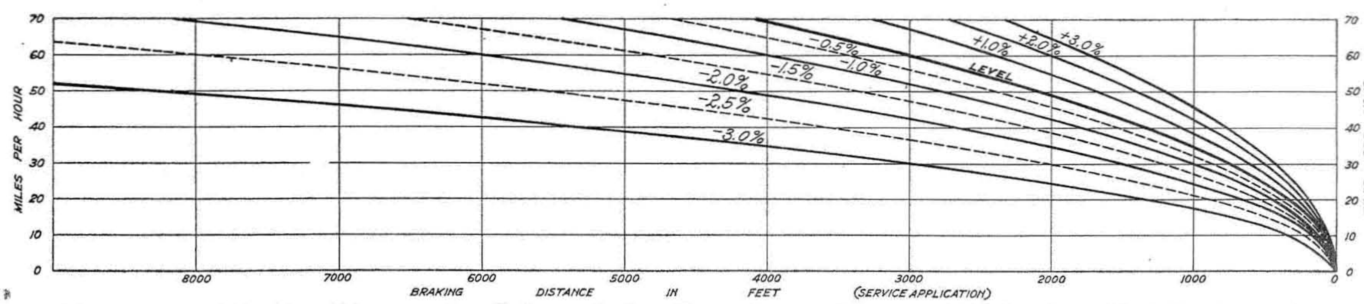


Fig. 4. Actual Braking Distances for Railway Trains, Depending on Speed and Grades, from Tests Made by the Pennsylvania Railroad

Speed Control

The only true principle on which to solve speed control is to bring into co-operation the element of the distance traveled by the train, with the element of the speed of the train. To illustrate: Assume a braking distance of 4,000 ft. at 70 mi. an hr. on a level track. The distant signal rail is placed 4,000 ft. in advance of the home signal rail. When a train arrives at a de-energized distant signal rail, indicating that the home signal is at stop, its permissive speed is 70 mi. an hr. After the train has advanced 500 ft. its permissive maximum speed should be less, or 65 mi. an hr. After advancing another 500 ft., its permissive maximum should be still less, or 60 mi. an hr. After the train advances another 1,000 ft. its permissive speed should be down to 48 mi. an hr.—in other words, the closer the train gets to the home signal, the less its speed should be, so that, should the engineman exceed the permissive speed anywhere between the distant and the home signal rails, there is always sufficient distance left to bring the train to a stop (or minimum speed) at the home signal by an automatic application of the brakes. The speed control apparatus should prescribe the permissive speed in accordance with a predetermined speed reduction curve—see speed diagram for level track.

The Simmen control system in its simplest form provides: *First,* the enforcement of a maximum speed under all track conditions. This maximum can be varied for different classes of trains. *Second.* Upon approaching a home signal at danger a speed reduction is enforced in accordance with a predetermined speed reduction curve as shown in Fig. 3. *Third.* Upon reaching the home signal (still at danger), the train may pass this signal and continue throughout the next block, but only at an established minimum speed of say 5 or 10 mi. an hr. *Fourth.* At points where an absolute stop is necessary, such as a railroad grade crossing or drawbridge, an absolute stop is enforced. *Fifth.* Speed reduction around curves, cross-overs, highway grade crossings or other limited speed points are enforced, the amount of the reduction of speed being variable and suitable for the place in question.

Figure 6 is a sketch showing the simplest form of the speed control apparatus. The cab circuits shown are the same as the two-position circuit shown in Fig. 1. Shaft *1* is directly driven from the axle of the locomotive. This shaft operates an ordinary speed governor *2*. Flange *3* of the speed governor rises and falls with the speed of the train. Number *4* is a motion transmitting mechanism driven by shaft *1*, which provides that shaft *5* is always driven in the same direction, whether the locomotive is going forward or backward. Gear train *6* constantly drives the gear wheel *7* in the same direction as long as the locomotive is in motion. Under clear signal conditions this gear is held electrically out of mesh with gear *8* by an electro-magnet *9*, which is controlled by the cab circuit. Gear *8* is fixed to shaft *10* and is a mutilated gear, having some of the gear teeth removed for a portion of its periphery. On shaft *10* a cam *11* is fixed. This cam is so shaped that it embodies the speed reduction curve shown in Fig. 3. Cam *11* rides on a roller *12*

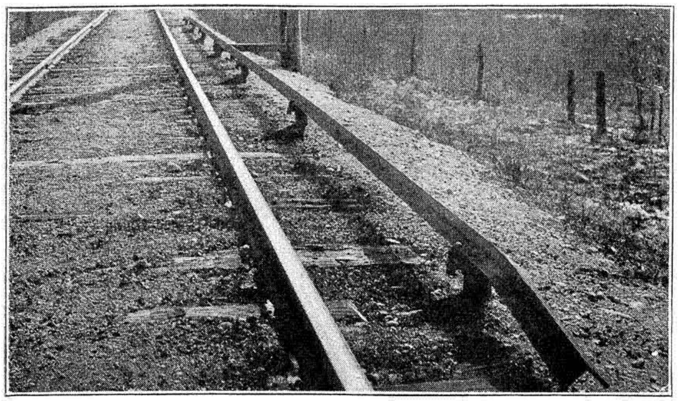
BRAKING DISTANCE IN FEET (Service Application)
DOWN GRADE

Factor	% Grade	Miles Per Hour				
		30	40	50	60	70
1.00	0.0	750	1335	2080	3000	4080
1.1429	—0.5	857	1526	2377	3429	4663
1.3333	—1.0	1000	1779	2772	4000	5439
1.60	—1.5	1200	2136	3328	4800	6528
2.00	—2.0	1500	2670	4160	6000	8160
2.6667	—2.5	2000	3560	5547	8000	10880
4.00	—3.0	3000	5340	8320	12000	16320

UP GRADE

Factor	% Grade	Miles Per Hour				
		30	40	50	60	70
1.00	0.0	750	1335	2080	3000	4080
0.8889	+0.5	667	1187	1849	2667	3627
0.80	+1.0	600	1068	1664	2400	3264
0.7273	+1.5	545	971	1513	2182	2967
0.6667	+2.0	500	890	1387	2000	2720
0.6154	+2.5	462	822	1280	1846	2511
0.5714	+3.0	428	763	1188	1714	2331

and when the cam is in motion it gives movement to an arm *13*. This arm *13* is hinged at *14*. A movable fork *15* hinged to main arm *13* at the point *16* is so positioned that flange *3* of the governor can raise the same. The movable fork *15* carries a contact *17*, which makes con-



Location of Signal Rail

tact with another contact supported by frame *18*. Support *18* is fixed to the main arm *13* and insulated therefrom. As long as the electrical contacts are closed, a circuit is established through battery *B* and magnet *19*. Magnet *19*, when energized, holds closed an automatic valve in the train line pipe. Arm *13* also controls an additional contact *20*. This contact when open will actuate an air whistle in the cab. Contact *20* will open when the actual speed of the train is within a mile or two of the

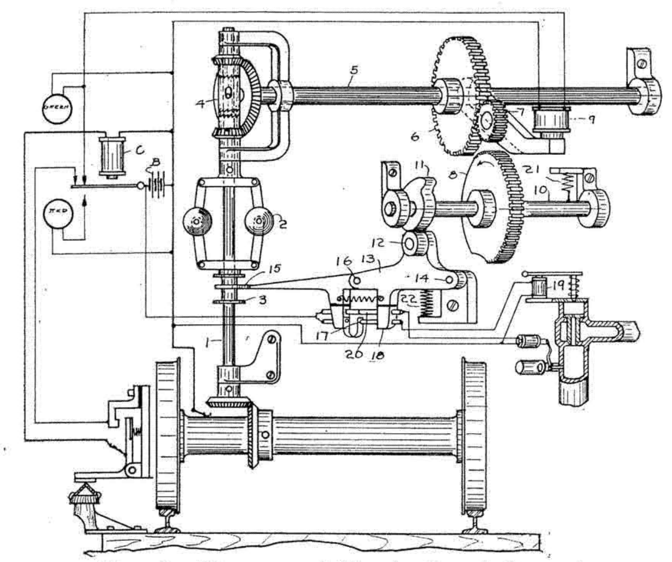


Fig. 6. Diagram of Simple Speed Control

permissive speed; in other words, contact *20* will open slightly ahead of contact *17*, which controls the automatic application of the brakes. An engineman will therefore always get a warning before the air brakes are applied automatically.

The apparatus operates as follows: When the train is proceeding under a clear indication, gear *7* is out of mesh with gear *8* and cam *11* assumes its maximum speed position by the tension of the spring *21*. Arm *13* also assumes its maximum speed position by the upward pressure of spring *22*. Therefore flange *3* can be raised by the speed of the train until it touches the forked arm *15*. If the speed of the train is further increased, contact *20* will be opened, giving the warning signal; and if the speed is still further increased contact *17* will be opened, thereby applying the air brakes automatically. As soon as the speed is thus automatically reduced, contacts *17* and *20* will close again.

When a train passes a de-energized distant signal rail, indicating that the home signal is at danger, electromagnet *9* is de-energized and gear *7* will drop into mesh with gear *8*, thus giving movement to shaft *10* and cam *11*. The movement to cam *11* forces down arms *13* and *15*, thus establishing a gradually reducing permissive speed; and if the engineman does not heed the warning signal, that is, not keep flange *3* of the governor below the forked arm *15*, an automatic application of the brakes may occur anywhere between the distant and the home signal rail. By the time the train arrives at the home signal cam *11* will have been turned to its minimum speed position, of say *10* mi. an hr., at which point gear *7* has entered the mutilated portion of gear *8*, and therefore no further movement is given to shaft *10* and cam *11*. If the home signal has cleared by this time cab relay *C* will have been

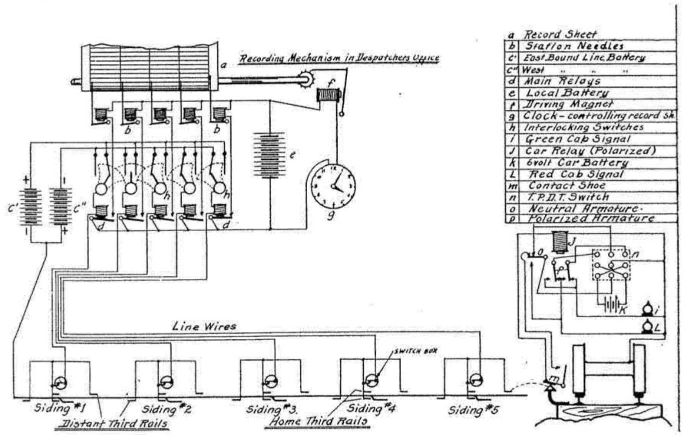


Fig. 5. Five-Position Circuit With an A. C. Relay

energized on the home signal rail, gear *7* lifted out of mesh with gear *8* by magnet *9*, cam *11* has assumed its maximum speed position and the train may proceed again at maximum speed. If, however, the home signal is still at danger, the train may pass it at 10 mi. an hr. and proceed at this speed throughout the danger block, but if the engineman attempts to exceed this minimum speed he will receive first a warning signal and then an automatic application of the brakes.

Speed reductions at curves, grade crossings and so forth are accomplished with the simplest form of apparatus by erecting a permanently de-energized rail some definite distance ahead of the point where the speed should be reduced, this distance depending upon the amount of reduction desired at the point. If the reduction is to be to 40 mi. an hr., the distance would be about 2,700 ft., and is the reduction is to be to 20 mi. an hr., this distance would be 3,650 ft. (see diagram Fig. 3). After the train has arrived at the point where reduced speed is required the contact shoe on the locomotive passes over a normally energized rail, thus restoring cam *11* again to its maximum speed position.

Where traffic conditions are so dense as to require more than one intermediate speed, the six-position cab circuit has been provided as shown in Fig. 5. The speed control apparatus is identically the same in operation, but five-gear trains and five-mutilated gears are provided instead of one, as in the simplest form. The periphery of each of the five mutilated gears is multilated to a greater degree, thus bringing cam *11* to rest at five different speed positions, including the minimum. It will be noted that the change from a higher speed position to a lower speed position is in each case accomplished in accordance with the predetermined speed reduction curve, while the change from a lower speed position to a higher speed position is always accomplished instantaneously and independent of the movement of the train. A practical application of a multi-speed apparatus of this kind is given in the following illustration: Assume a maximum braking distance of 4,000 ft. at 70 mi. an hr. Traffic conditions are so dense that 1,000 ft. block lengths are desirable. Assume that a train has come to a stop in a block and that a second train is following five blocks in the rear. The speed of the second train in the fifth block can be 70 mi. an hour. Upon entering the fourth block in the rear of the standing train the first gear train of the speed control apparatus is meshed with its mutilated gear, and turns the cam to a position of 60 mi. an hr. in traveling the distance of 1,000 ft. through the fourth block. Upon entering the third block the first multilated gear is released, but the second one is now enmeshed and the cam will continue to lower speed position so that the next 1,000 ft. traveled will bring it to a position of 48 mi. an hr., at which point the multilation of the second gear has been reached and the cam will receive no further movement from this gear. On entering the second block in the rear of the standing train the second mutilated gear is released, but the third one is now engaged and this one will turn the cam in the next 1,000 ft. traveled to a position of 35 mi. an hr., and when the train enters the first block in the rear the third mutilated gear is released and the fourth one is engaged, continuing the movement of the cam until its minimum speed position of 10 mi. an hr. is reached near the beginning of the danger block. It will be noted that the above illustrations will only require four gear trains and four mutilated gears instead of the five. It will be evident that if the first train had started and

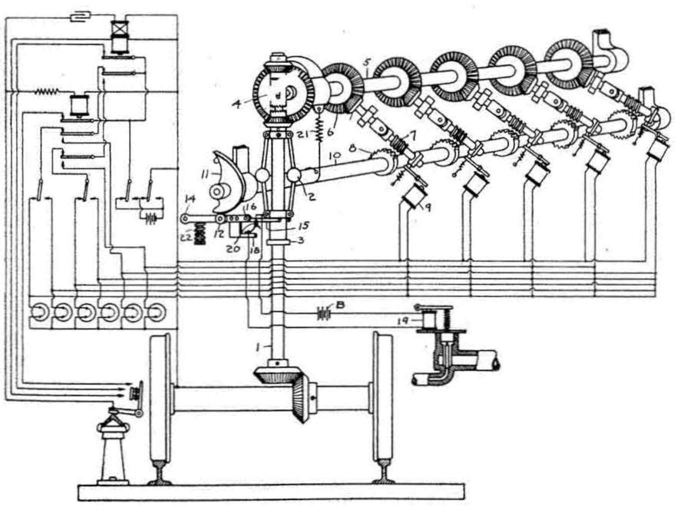


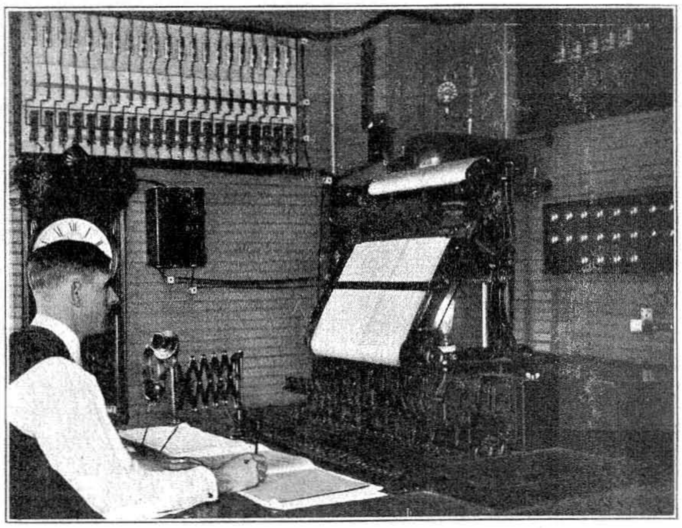
Fig. 7. Speed Control Apparatus for Six-Position Cab Circuit

had left the danger block before the second train had reached the beginning of the second block in the rear, the second train could have proceeded at 48 mi. an hr. throughout the second block in the rear; or, in other words, if a second train is following another in the same block its permissive speed is limited to 10 mi. an hr. If there is one full block between the trains, the second train can follow at 35 mi. an hr. If there are two blocks between the trains the second train can follow at 48 mi. an hr. If there are three blocks between the trains the second train can follow at 60 mi. an hr., and if there are four full blocks between the trains, the second train can run at maximum speed or 70 mi. an hr., thus maintaining a proper space interval.

Many other phases of speed control have been developed to meet special conditions, such as compensation on account of grades of the predetermined speed reduction curve. Simmen speed control apparatus was extensively tested out in the years 1912, 1913 and 1914 on the Indianapolis & Cincinnati Traction Company's line and in the years 1915, 1916, 1917 the General Railway Signal Company reduced to practice the Simmen speed control under the most complicated traffic conditions in the Brooklyn Subway. This work was done by the General Railway Signal Company under a license from the Simmen Automatic Railway Signal Company.

Indianapolis and Cincinnati Company Installation

This installation has been in operation since 1912. It consists of 22 single track blocks. The system is a "Re-



Dispatching and Recording Apparatus in the Indianapolis Office

mote Control Dispatching and Recording System" and in steam road language is essentially a controlled manual block system. Cab signals are used which are controlled by an interlocked switchboard from the dispatcher's office at Indianapolis.

Trains as they pass over the road record automatically their movement at the dispatcher's office in graphical form, so that the dispatcher instantly knows in which block each train on the road is located, the exact time in passing any point and the exact time consumed by the trains in each block. From this information he can determine quickly the proper meeting point for all trains and set up his interlocked switchboard accordingly. On the Indianapolis & Cincinnati installation no track circuits are used, but the signal rails are energized or de-energized solely through the dispatcher's interlocked switchboard. Track circuits can readily be used with the system, in which case the system may be called an "Automatic and Remote Manually Controlled Block System."

The general wiring diagram is shown in Fig. 5. A modified cab circuit is used from that shown in Fig. 2, as will be noted at right end of Fig. 6. When the signal rails are positively energized with direct current a clear signal is given for an eastbound train, but a danger signal for a westbound train. When the signal rails are energized with negative energy, a clear signal is given to a westbound train, but a danger signal to an eastbound train.

When the signal rails are entirely de-energized a danger signal is given to trains of both directions. These energizations of the signal rails are controlled through the dispatcher's interlocked switchboard and the dispatcher is interlocked against error; at the same time he has every facility to get the trains over the road with the least delay.

Union Switch & Signal Company's Automatic Train Control

THE Union Switch & Signal Company's automatic train control system is of the continuous induction type, designed to be applicable to direct or alternating current track circuits and to roads using electric propulsion as well as for use where both steam and electricity are used as motive power. It has been developed with the idea that automatic train control should be an adjunct to, and not a substitute for, wayside signals.

The system is designed for use with the speed control feature, but by the omission of such parts as pertain specifically to speed control, an automatic stop device is obtained which incorporates in it the features of the continuous track circuit control. Provision has been made so that when a train equipped with train control apparatus runs into unsignaled territory the engineman must take suitable action at the point of exit. When the train re-enters signaled territory the apparatus is automatically cut into service.

This system provides a means for applying the brakes if the train passes a caution signal, and in addition provides a valve in the engine cab which can be operated easily by the engineman to prevent the train speed being unduly restricted by a brake application, provided the engineman operates it just before passing a caution signal; thus, at each caution signal he is given the opportunity to show that he is awake and alert, and, by so doing, retains control and responsibility for control of the train. If the engineman fails to acknowledge the caution signal by the operation of the valve, the train is stopped, requiring him to be alert at each caution signal.

In the design of this system the Union Switch & Signal Company took into account certain fundamental requirements and principles which it felt to be vital: (1) The automatic train control device should be so installed that it does not interfere with proper control of the train by the engineman and does not detract from his responsibility for such control. (2) The use of the "closed circuit" principle, the application of which requires that the train control system be so designed that a signal is transmitted to the train to permit it to proceed, and in such a manner that a failure to transmit the signal will result in stopping the train. (3) The use of continuous track circuit protection, by which is meant that the section of track which governs the train should include the track rails directly in advance of the train. The rails of the track circuit are used to conduct the signaling current which operates the apparatus located on the engine, and to convey to the train control apparatus the traffic condition in advance, which may be caused by any change in track conditions, such as an opened switch or a train backing into the block. This change is immediately reflected in the braking system.

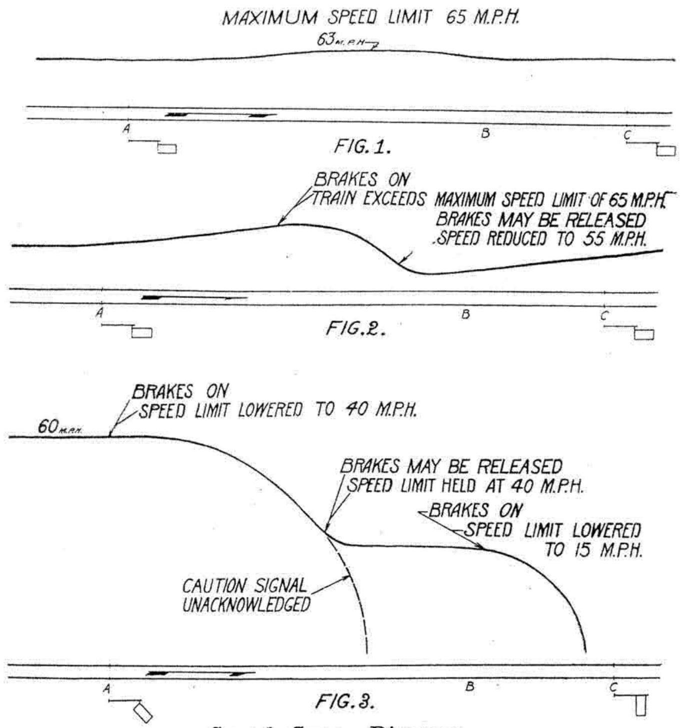
The system also may be extended beyond its purpose of protecting against the unavoidable human failure, to protect against errors in judgment in running at speeds which are incompatible with traffic conditions.

Principles of Speed Control

The accompanying diagrams, Figs. 1 to 6, inclusive, are given to illustrate the principles of "speed control" on which this system is designed. The figures indicating speed are merely illustrative. Fig. 1 shows at the bottom a typical section of track comprising one block equipped with automatic block signals, which are standing at "proceed." The upper portion is a "speed-distance" diagram, the distance between the track and the upper line representing the speed of a passenger train as it runs through the block. In Fig. 1 the train is running a full speed under "proceed" signals.

Figure 2 shows the same block condition as Fig. 1. In order that the signals may be effective, it is evident that the maximum speed of the train should be limited so as to enable it to stop in a distance less than the length of the block, with a reasonable safety factor. Therefore, a "maximum speed limit" is provided, whereby a full service application of the brakes is made automatically if the train, when running under clear signals, exceeds a maximum speed.

When the brakes are automatically applied, they remain applied until the train speed is reduced a definite amount, when they may be released manually. By thus



Speed Curve Diagrams

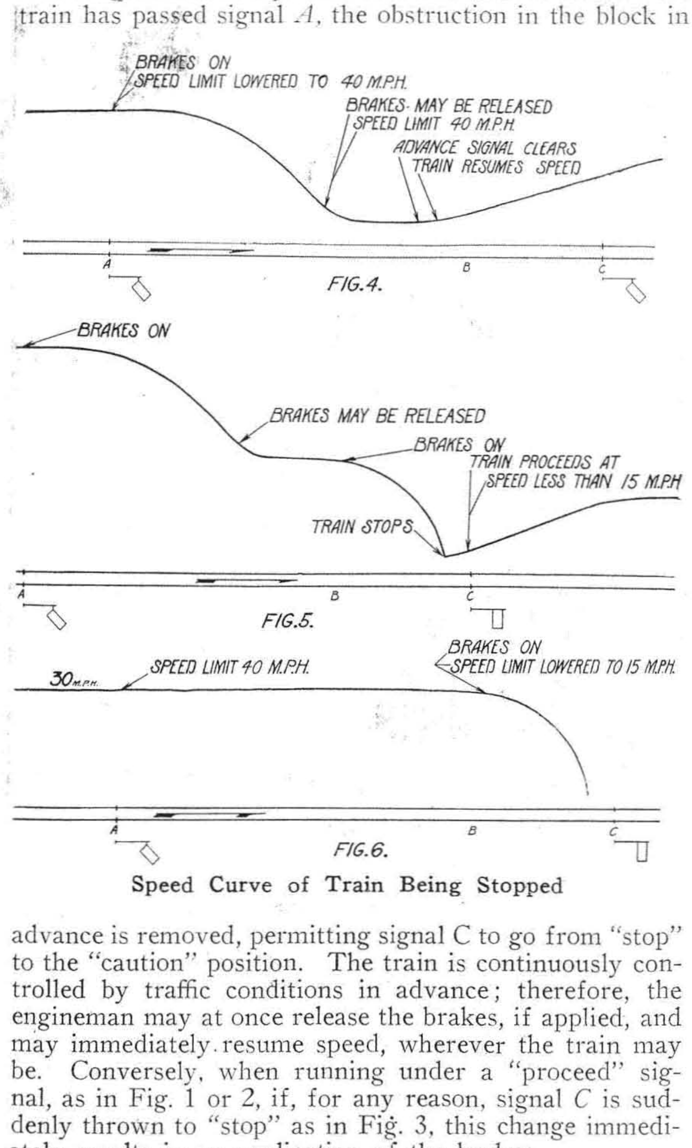
making the release of the brakes non-automatic, an additional check on the engineman is provided, for the automatic speed control will act to bring the train to a full stop when the maximum speed limit is exceeded under clear signals unless the brakes are released by the engineman.

In Fig. 3 it is assumed that there is an obstruction in the next block to the right, so that signal *C* indicates "stop," and signal *A* indicates "caution," or "proceed, prepared to stop." If the engineman fails to see signal *A* and to operate his acknowledging valve just before passing *A*, the brakes will be applied at *A* and the train brought to a stop with a single full service application.

If the engineman acknowledges the "caution" signal, a service application of the brakes will be made if the train speed is above a predetermined medium speed of, say, 40 mi. an hr., and the brakes may be released manually when the speed is reduced to this value. The train may then continue through the block at this speed until a point *B*, somewhat more than braking distance from the end of the block for this speed, is reached. At point *B* a service application of the brakes will be made to bring the train to a stop before passing signal *C*.

The approach of a high speed train to a stop signal is thus governed by the "two-application stop" method, wherein the "factor of safety," representing the difference between stopping distance and block length, appears as a free running period between two consecutive brake applications.

Figure 4 represents the same block as Fig. 3, and the same conditions, except that it is assumed that after the train has passed signal *A*, the obstruction in the block in



Speed Curve of Train Being Stopped

advance is removed, permitting signal C to go from "stop" to the "caution" position. The train is continuously controlled by traffic conditions in advance; therefore, the engineman may at once release the brakes, if applied, and may immediately resume speed, wherever the train may be. Conversely, when running under a "proceed" signal, as in Fig. 1 or 2, if, for any reason, signal *C* is suddenly thrown to "stop" as in Fig. 3, this change immediately results in an application of the brakes.

Figure 5 illustrates the same traffic conditions as Fig. 3. After the train has been brought to a stop before passing signal *C*, the brakes may be released, and the train may proceed at a low speed, limited to, say, 15 mi. an hr., and may enter and pass through the block to the right of *C*, prepared to stop short of any obstruction. Since the train is continuously controlled by traffic conditions in advance, the low speed restriction is removed as soon as the obstruction is removed and traffic conditions permit, and the train may therefore resume speed.

The speed control system may be arranged to provide any one of three methods by which movement past the stop signal *C* may be governed. One, the train may approach and pass the stop signal without a brake application, provided the speed is less than 15 mi. an hr.; two, the train may approach the stop signal at 15 mi. an hr., and if the engineman acknowledges the signal by operating a valve before passing it, may continue past the signal at 15 mi. an hr.; and, three, the train must come to a stop, after which it can release and proceed past the signal at 15 mi. an hr.

Figure 6 also illustrates the same traffic conditions as Fig. 3. In this case the train passes the caution signal *A* at a speed less than the medium speed limit in the caution block, and the brakes are not applied until point *B* is reached, whereupon the stop is made with a single application. However, if the engineman fails to acknowledge the caution signal by operating a valve before passing the signal, the brakes will be applied at *A*, as in the case of the high speed train. If the train is stopped due to the engineman's failure to acknowledge a caution signal, the brakes may be released.

The speed control system, therefore, provides three fixed speed limits—"high," "medium" and "low," corresponding closely to the three indications, "proceed," "caution" and "stop," of the automatic block signaling system. The control of the speed is by means of a centrifugal speed governor, connected by a propeller shaft type of drive to an axle of the locomotive. The control of the brakes by the governor is purely pneumatic, by means of the same type of valves as are used in existing air brake equipment. The governor is controlled by two magnets, which are, in turn, controlled by a three-position a.c. relay on the locomotive, designated the "train control" relay, which is of the same type and function as the track relay of the block signaling system.

Annual Meeting of Institute of Railway Signal Engineers

THE annual general meeting of the Institution of Railway Signal Engineers, England, was held on February 15, in the theatre of the Institution of Electrical Engineers, London, the retiring president, C. H. Ellison, Telegraph Superintendent, North Eastern Railway, occupying the chair at the opening of the meeting. The annual report and statement of accounts were adopted, as were also the Council's nominations for officers for 1922, as follows: President, W. C. Acfield, O. B. E., signal superintendent, Midland railway; vice-president, R. J. S. Insell, chief assistant signal engineer, Great Western railway; treasurer, A. E. Tattersall, signal superintendent, Great North railway (succeeding to R. J. S. Insell); secretary, M. G. Tweedie, signal department, Great Western railway. The result of the ballot for the council was also announced.

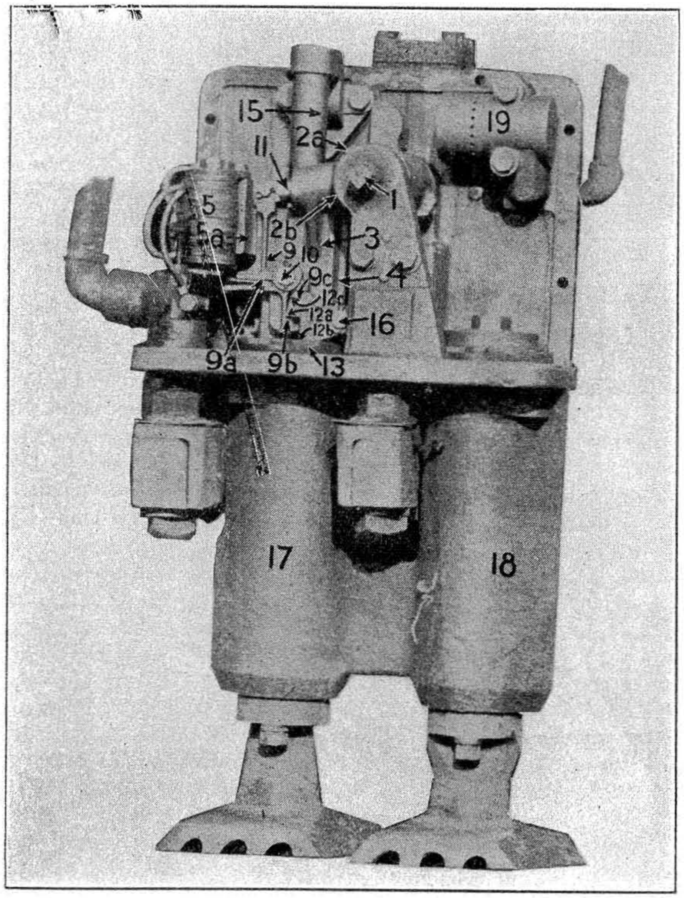
The new president, having been invited by C. H. Ellison to take the chair, delivered an address on the question of progress in signaling in its widest sense, dwelling upon the remarkable developments which have taken place in signaling since the first attempts in the earliest days of railways. He referred in high terms to the work done by the pioneers in the subject, and the numerous firms and inventors who have done so much for the advancement of the art. He emphasized the necessity for the institution being broadminded, progressive and far-seeing, so as to be in a position to tender sound advice and recommendations on practice to the railway companies.

The Institution has now recovered from the effects of the war and is about to enter on an era of increasing usefulness and prosperity.

Webb Automatic Train Control

THE Webb automatic train control was developed on the New York, New Haven and Hartford in 1915 and 1916 and was given a service test during 1917, as described in the May, 1917, issue of the *Railway Signal Engineer*. Further tests on the Erie were described in the February, 1922, issue.

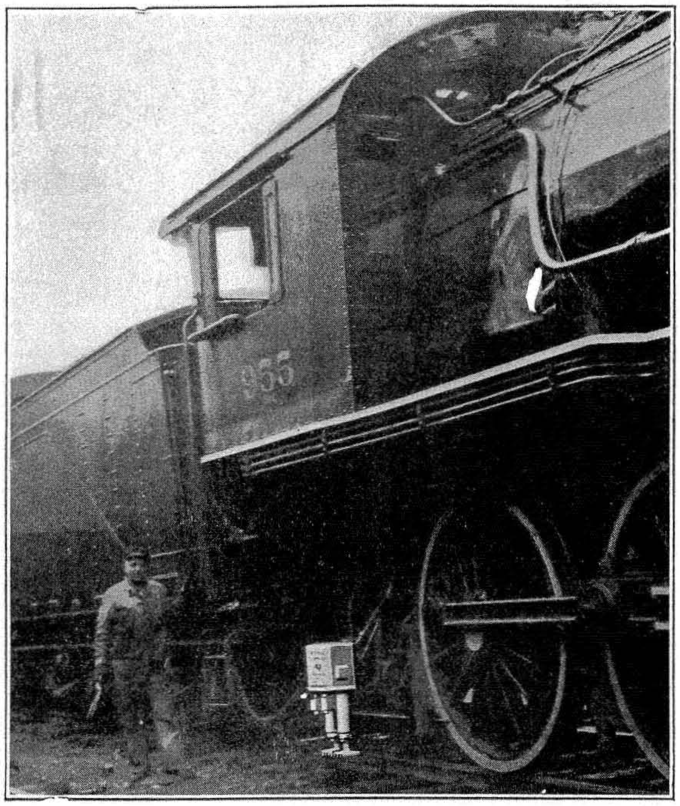
This device is of the intermittent contact type, the ramp, 34 ft. long, being fixed 17 in. outside the running rail. The shoe on the locomotive, supported on the frame behind the driving wheels (or on the trailing truck if there be one) is lifted, and causes the opening of the air brake train line, at every ramp; but if the block section to be entered is clear and its track relay closed, an electric circuit, controlled by this relay, and extending through the ramp and the shoe, actuates an electro-magnet on the locomotive which immediately closes the air valve, before the triple valves have been affected; and the only effect of the lifting of the shoe is to exhaust enough air to sound a blast of about one second on a whistle in the cab. In other words, there is a proceed indication at each ramp



Webb Automatic Brake-Setting Machine

approaching a clear signal. If no electric current is received from the roadway (indicating that the road is not clear to proceed), the exhaust of air sounds a blast on the cab whistle, which continues until the brakes are set, or until the engineman closes the valve, as he may do when he sees that his speed is sufficiently reduced.

There have been but few changes made in the detail of this apparatus since the description given in the issue of May, 1917, p, 151. The cam shaft *1* and the main cam, *2*, have been made hollow and connected with the train line air. The plunger head, *3*, with its contacting projection, *4*, have also been made hollow and connected with the train line air, so that now each portion of the apparatus that is used in the valve-opening operation is so designed that its breakage or removal would exhaust the train line air to the atmosphere. The armored hose has been superseded by a stationary piston, *15*, for connecting the train line air with the plunger head, plunger and shoe. The magnet bracket, *5a*, is now made an integral part of plunger head *3*. The path-clearing plunger *18* has now been made an integral part of the box design.



Automatic Stop Apparatus on Locomotive

The manual reclosing operation is now accomplished through cylinder *19* and its piston, instead of the slide formerly used.

As the train-carried fixture passes over the ramp, the operating plunger is lifted vertically and projection *4* engages cam projection *2a* oscillating the main cam, *2*, with its shaft, *1*; opening the air valve by means of the valve cam, which is also fixed on shaft *1*, so that the train line is vented to the atmosphere. If the track relay is in the stop position no further action takes place; and as the plunger resumes its normal position, after passing the ramp, the air valve remains open and the train is brought to a stop in the usual manner. If, however, the indication is clear, the electric current controlled by the track relay energizes magnet *5* and causes the bolt lever, *9*, to project the bolt, *11*, so that in the downward movement of the plunger the bolt restores the main cam and air valve to their normal positions and no braking action takes place.

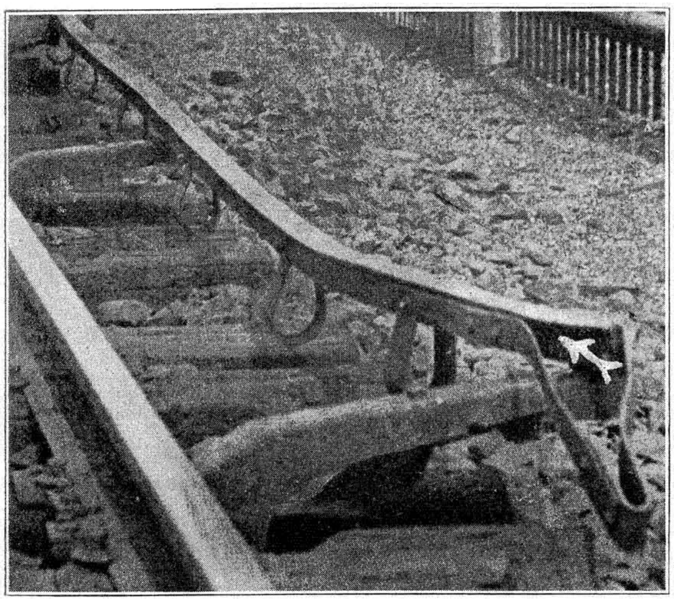
In this installation on the Erie Railroad there is no distant signal or line relay. The circuit to the ramp, which is located approximately 1,600 ft. in the rear of the signal, is controlled by the track relay and a circuit breaker operated by the signal itself.

Wooding Automatic Train Control

THE Wooding Automatic Train Control device, which includes a speed control apparatus, is of the intermittent electrical contact type, the most prominent feature of which is the ramp and train contact. This apparatus was tested by the Interstate Commerce Commission, Bureau of Safety, on the Delaware, Lackawanna & Western, in 1917.

The track equipment of the installation which was tested included five contact rails or ramps, a stop ramp being installed in connection with signal M-66, and both a caution and a home ramp being installed in connection with signals M-68 and M-56. The ramps were mounted on brackets attached to the right hand track rail. The circuits were so arranged that both the caution and the stop ramps in one block were energized from a battery at the signal location when the block ahead was clear and de-energized when the block ahead was occupied. Provision was also made in the circuits for the detection of the removal or displacement of a ramp. The difference between caution and home ramps resided in the angle at the entering end, the caution ramp being intended to provide a comparatively gradual deflection of the locomotive contact blade, while the deflection at a home ramp was designed to be quicker.

The locomotive equipment consists of a normally closed electric circuit, including a storage battery, a contact shoe and circuit breaker mounted on the right hand side of the forward tender truck, an electro-pneumatic valve



Ramp Location With Arrow Indicating Point Where the Blade Enters

installed in a branch of the brake pipe, provided with a cut-out cock and a knife switch for cutting out the battery when tests were not being made; the speed control feature of the system comprised a branch circuit, normally open at a push button installed in the cab as well as at speed control contacts of the contact blade circuit breaker.

In normal operation the local circuit on the locomotive is intended to be broken by lateral deflection of the contact shoe, caused by engaging a ramp; if the block section ahead is clear the ramp completes an electric circuit from a local battery at the signal location to the valve magnet on the locomotive, the valve thereby being maintained closed. If the block section ahead is occupied the current is cut out of the ramp, except in danger curve ramps, where the current is reversed to that of the engine circuit, and the valve magnet is de-energized, causing an application of the brakes.

The Speed Control Feature

The operation of the speed control feature of the system is dependent upon the action of an unbalanced wheel or cam operating to form part of the branch circuit at the

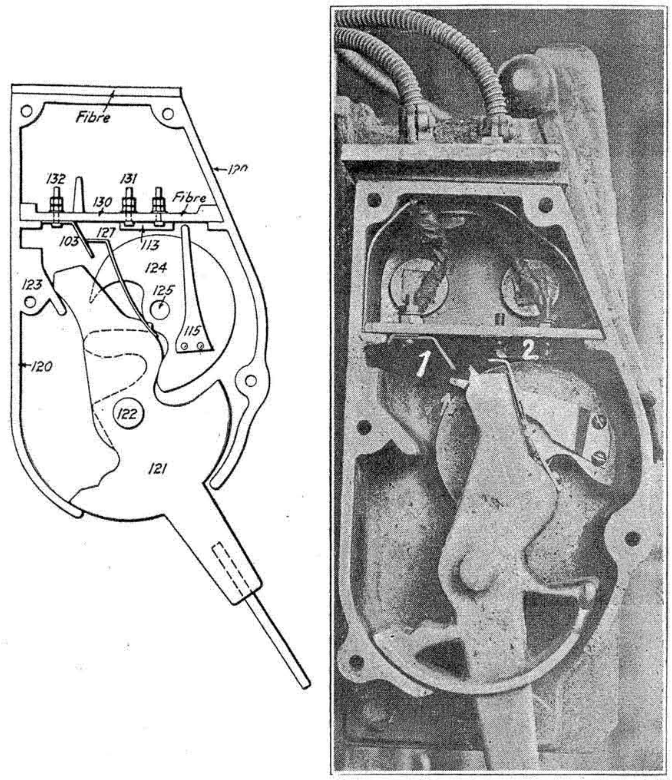


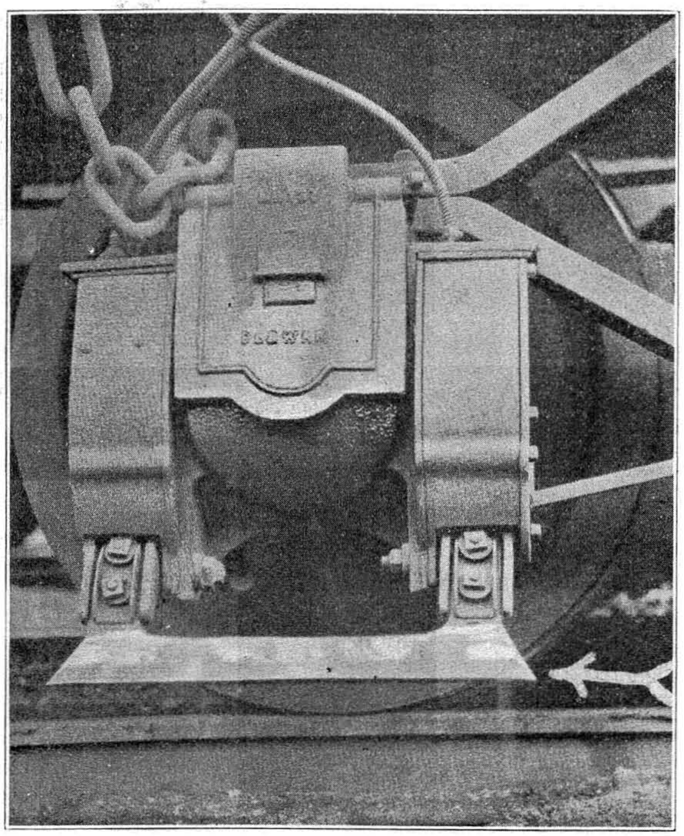
Diagram and Photograph of the Unit on the Locomotive With the Cover Removed

contact blade circuit breaker. The cam carries a contact spring (115), which, upon deflection of the contact shoe while passing through a ramp, engages another contact segment (113) mounted on an insulated block in the upper part of the housing, closing one of the two open points in the speed control branch of the locomotive circuits. If the rate of speed is below certain points (predetermined for both caution and home ramps), say, 30 or 40 miles for caution ramps and 8 or 10 miles for home ramps, the cam is not intended to complete its entire stroke, but to be moved only into position to close the contacts (113 and 115), and maintain that point closed as long as the shoe is in engagement with the ramp. Under these conditions the branch circuit may be completed by closing the engineman's push button in the cab, and the valve magnet is thereby maintained energized while passing a de-energized ramp. In case the speed is above the predetermined rate, however, the quicker and more abrupt becomes the deflection of the contact shoe, resulting from the higher rate of speed, which imparts sufficient momentum to the cam to throw it over its center, allowing it to complete its stroke. In this case the speed control contact (113-

115) is closed only momentarily and is broken again as the cam passes over its center and completes its stroke, the contact point being held open during practically the entire time the blade is in engagement with the ramp and being restored to normal position again by the action of the shoe returning to normal position in passing out of engagement with the ramp. Under these conditions, the branch circuit being open at the speed control contacts in the shoe circuit breaker, the engineman is unable to maintain the valve magnet energized by closing the push button, and he is, therefore, not able to pass a de-energized ramp above the predetermined rate of speed without receiving an automatic application of the train brakes.

The Ramp and Mounting

The ramp is mounted in brackets clamped to the base of the track rail and held in normal position by coil springs, forming a part of the rail clamps; the ramps are intended to be depressed by a wide snow plow, or passing defective equipment and are then intended to be automatically restored to normal position by the coil springs.

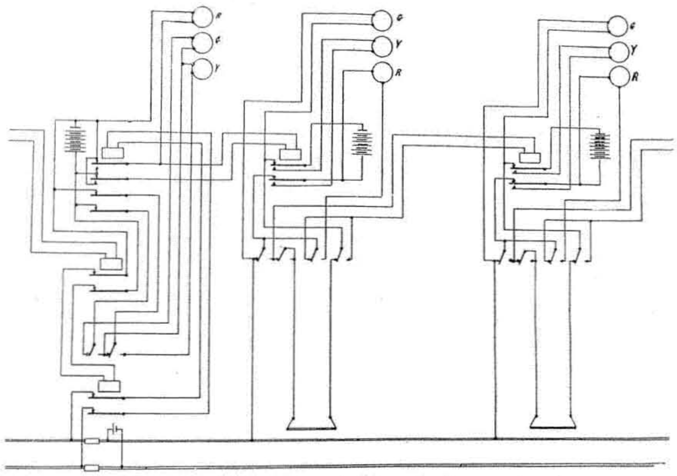


Contact Blade and Device on the Locomotive

A circuit breaker is provided at each end of the ramp, through which the electrical line wire connections are made, and the ramp circuit is broken whenever the ramp is depressed.

In the circuit from the track relay to the ramp there are line relays to detect the removal or displacement of a ramp, and slow acting relays to prevent the track relays from opening when the direction of current flow in the ramp circuits is being reversed. In case a ramp should be torn out or displaced sufficiently to open one of the circuit breakers on either end, the circuit for the line relay at the location immediately in the rear would be broken, and in consequence the line relay, the slow acting relay, and the track relay at that location would be de-energized, setting the signal at that location at stop and de-energizing the ramps controlled thereby.

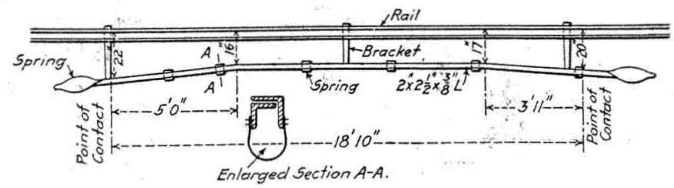
The ramps are made of two overlapping angle iron sections. At each end there is a throat about 3 in. in width and the engine shoe entering the ramp spreads apart the two overlapping sections which are normally held folded together by U-shaped springs, electrical contact being made on both sides of the shoe or blade with the edges of



Circuit Diagram of Signal Apparatus

the angle iron sections. The engine blade is deflected toward the track for a distance of 5 in.; the angle at the entering end of a caution ramp is such that this lateral movement of the shoe is accomplished when the shoe has traveled a distance of 90 in. from the point of initial engagement, and on a stop ramp about 24 in.

The speed control branch of the engine circuits consists of wire 109, leading from positive side of battery to engineer's push button, normally open; wire 111, contact 113, normally open, contact spring 115, which is permanently connected to the speed control cam, and thence through the shoe, wire 105, knife switch, wire 107, valve magnet, to ground. When the contact shoe is deflected upon engagement with a ramp, the cam carrying contact spring 115 is rotated about the stud upon which it is mounted, closing contact 113-115; if the rate of speed is below the speed control limit this contact is maintained closed as long as the engine shoe is in engagement with the ramp, and if the engineman's push button is held closed the valve magnet is maintained energized, even though the ramp is de-energized. If, however, the rate of speed is above the speed control limit, on account of the inertia of the cam and the quicker movement im-



Detail Construction of the Contact Ramp

parted by the engagement between the contact blade and ramp, the cam is thrown over its center and the contact spring 115 is carried past the segment 113; the contact is therefore closed only for the instant the cam is rotating past, and it is immediately broken and help open as long as the contact shoe is in engagement with the ramp. The speed control branch of the engine circuits is therefore open at the blade circuit breaker whenever the rate of speed of a train while passing a ramp is above the predetermined speed control limit. The contact segment 113 is curved and so arranged that on the return movement of the cam the contact spring does not engage the face of the segment 113, but passes on the opposite side and does not make electrical contact except for a very brief instant, when the engine shoe is being restored to normal, at the last of the return stroke.

The contact shoe is made up of a bar of iron 2 in. by ⅜ in. by 9½ in. Pointed ends are provided to help maintain contact and to cut through ice or hard packed snow. In its normal position the arm is inclined about 40 deg. from the vertical and its lower edge is about 17½ in. from the gage side and about 3½ in. above the top of the rail. When the blade passes through a ramp it is deflected toward the track and downward in the vertical position, the movement of its lower edge being about 5 in.

This apparatus is attached to the rear journal box on the right side of the forward tender truck and is insulated from it. When a ramp is engaged, the upper end of the arm is deflected toward the vertical, more or less rapidly, and the cam is rotated to the left by the upper end of the contact arm. Spring 127 breaks its contact, and the speed control contact is made between springs 115 and 113, to the latter of which wire 111 is attached. Spring 115 passes back of segment 113, making contact its whole length. If the engagement with a ramp

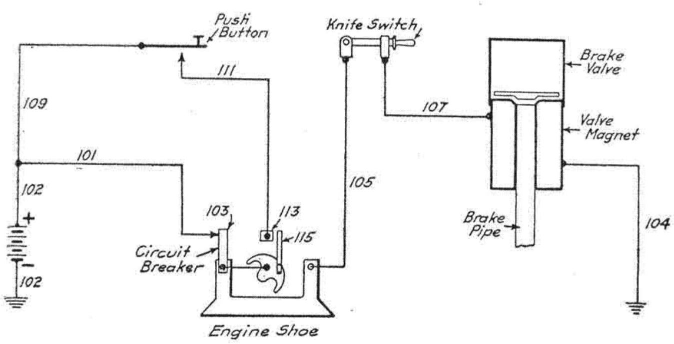


Diagram of Circuits on the Locomotive

is at less than the predetermined limit of speed, the movement will not be enough to give the cam 124 sufficient momentum to carry spring 115 beyond segment 113.

The magnet valve is an electro-pneumatic valve having a resistance of approximately 16 ohms. The connection with the brake pipe is made between the engineman's brake valve and the double-heading cock and consists of a ¾ in. pipe which leads directly to the magnet valve. In service an angle cock in this pipe connection is intended to be sealed in open position.

The magnet armature consists of a circular metal disk, carrying a ball which fits into a valve seat in the end of the brake pipe connection which leads through the magnet core; the ball also serves to hold the armature away from the coil, and its position is adjustable.

Quick Work Replacing Signals

Out on the Idaho division of the Chicago, Milwaukee & St. Paul an automatic signal was recently knocked down the bank by a work train and Supervisor Westmark and his men made record speed to get the signal back in service the same day. About one month later signal 111-2 at Tacoma Junction on the coast division was washed out by a high tide and a flood in the Puyallup River. In order to equal the record of the Idaho crew all hands, including L. W. Smith, assistant signal engineer; "Shorty" Weaver, "Smoke" Johnson, Ed Allen, R. F. Tyler and W. E. Dill, donned hip boots and pulled the signal up on to a temporary foundation of ties. All wires were hooked up and signal tested out by 4:30 p. m.

Committee on Train Control

REPRESENTATIVES of all but three or four of the 49 railroads cited in the Interstate Commerce Commission's proposed train control order met in Chicago on Tuesday, February 14, to consider the action to be taken in response to the Commission's order. At this time it was decided to create a committee of nine members to represent the roads with the understanding that any carrier may supplement such presentation in any manner and to such an extent as it considers necessary. This committee includes C. E. Denney, vice-president and general manager of the New York, Chicago & St. Louis, chairman; B. R. Pollock, vice-president and general manager, Boston & Maine; W. P. Wiltsee, assistant engineer, Norfolk & Western; A. M. Burt, assistant to operating vice-president, Northern Pacific; E. B. Katte, chief engineer electric traction, New York Central; C. H. Morrison, signal engineer, New York, New Haven & Hartford; W. J. Eck, signal and electrical superintendent, Southern Railway; R. W. Bell, general superintendent motive power, Illinois Central, and C. F. Giles, superintendent machinery, Louisville & Nashville.

It was also concluded that those roads which desire to show cause why this train control order should not be entered will appear individually before the Commission on or before March 15 and that R. H. Aishton, president of the American Railway Association, should request the Commission to name a date on which this newly created committee may present its testimony in connection with the provisions of the order which affect all carriers.

A. R. E. A. Program

THE program for the twenty-third annual convention of the American Railway Engineering Association, which will be held in the Congress Hotel, Chicago, on March 14-16, is as follows:

Tuesday, March 14

President's address.
Reports of standing and special committees.
- Yards and Terminals.
- Electricity.
- Ballast.
- Iron and Steel Structures.
- Standardization.
- Signals and Interlocking.
- Ties.
- Track.

Wednesday, March 15

- Shops and Locomotive Terminals.
- Roadway.
- Economics of Railway Location.
- Stresses in Railroad Track.
- Records and Accounts.
- Signs, Fences and Crossings.
- Water Service.
- Uniform General Contract Forms.

Annual dinner at 6:30 P. M.

Thursday, March 16

- Masonry.
- Rail.
- Economics of Railway Labor.
- Wooden Bridges and Trestles.
- Economics of Railway Operation.
- Buildings.
- Wood Preservation.
- Rules and Organization.

Memorial Meeting—John Findley Wallace.
Election and installation of officers.

Friday, March 17

Excursion to Gary Industrial District.