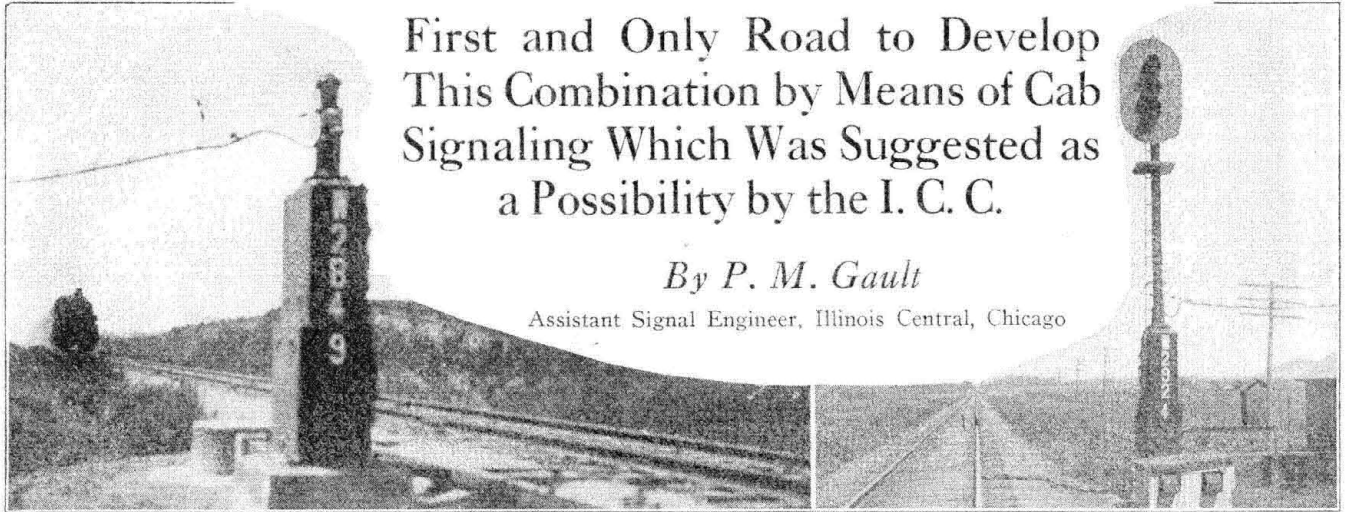


Train Stop Without Permissive Wayside Signals Used on I. C.



First and Only Road to Develop
This Combination by Means of Cab
Signaling Which Was Suggested as
a Possibility by the I. C. C.

By P. M. Gault

Assistant Signal Engineer, Illinois Central, Chicago

Train Approaching Phantom Location

Head-Block Signal on Single Track

THE Illinois Central has placed in service two locomotive divisions of automatic train stop without permissive wayside signals. These are the first complete division installations of this kind that have ever been made. One division, between Champaign, Ill., and Branch Jct., 122 miles of double-track road, was made in compliance with the first order of the commission; the other division, between Waterloo, Ia., and Fort Dodge, 97 miles of single track, was made to comply with the second order. The Union Switch & Signal Company's continuous inductive train stop system with the permissive feature and two indication color-light cab signal is used. No automatic speed control is provided. The district between Champaign and Branch Jct. was formerly equipped with automatic block signals which were removed from service when the automatic train control was installed. This double track installation involves fewer operating problems than the single track installation between Waterloo and Fort Dodge to which the following description will be confined.

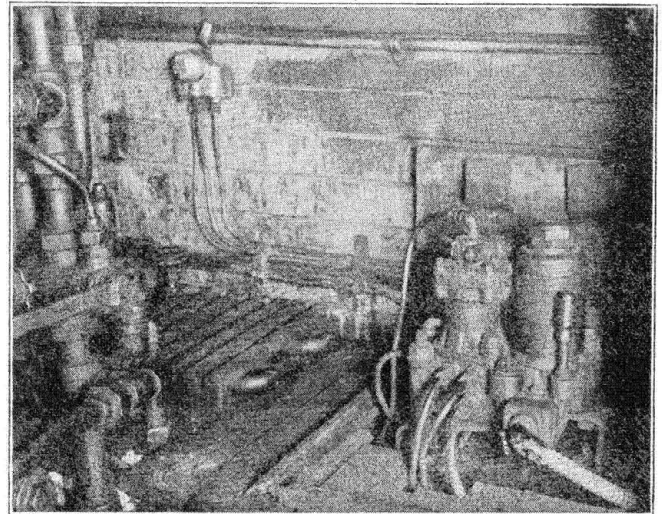
The line between Waterloo and Fort Dodge is through an undulating prairie country with a maximum curvature of $5\frac{1}{2}$ deg. and maximum grade of one per cent for short distances and some long grades of one-half of one per cent. The traffic consists of eight regular passenger trains, five scheduled freight and two local freight trains over the entire territory. In addition two regular passenger trains, two scheduled freight and three local freight trains are operated between Waterloo and Cedar Falls, a distance of seven miles. Extra trains and sections of regular trains are operated as the traffic requires.

The trains are operated by timetable and "19 orders" in addition to the automatic train control. In the equipped territory there are 7 interlocking plants and 21 passing sidings. Interlocking home signals of the semaphore type, electrically lighted, giving two indications "Stop" and "Proceed," are used to govern movements through plants. These signals are not slotted. Prior to the installation of automatic train

control no automatic block signals were in service in the district except for 13 miles from Waterloo west. These signals have been removed.

Absolute Signals Located at Leaving End of Passing Sidings, Others Are Phantom Locations

One two-indication color-light signal is located in advance of the exit end of each passing siding. The indications of this signal are green for "Proceed" and red for "Stop." Circuits are arranged so that for op-



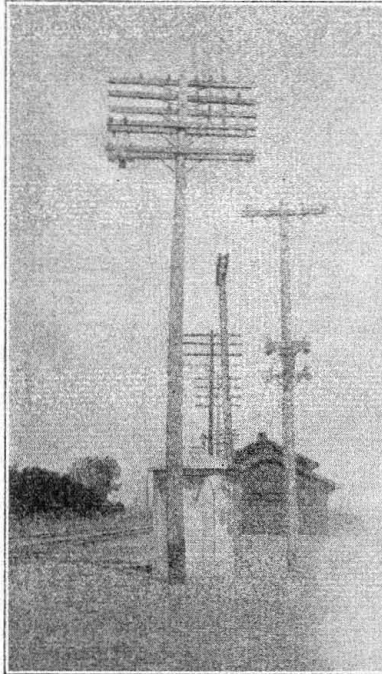
Acknowledging Valve on Window Sill and Brake Application Valve Group With Engineman's Seat Box Removed

posing moves this signal shows red when a train passes the opposing signal at the next passing siding while for following moves it changes from red to green when a train passes the first phantom location in advance of the passing siding. The sole function of this signal is to inform engineman whether he may proceed. When a train is stopped by a stop-signal it must stay until authorized to proceed, or in case of a failure or lack of communication it may pro-

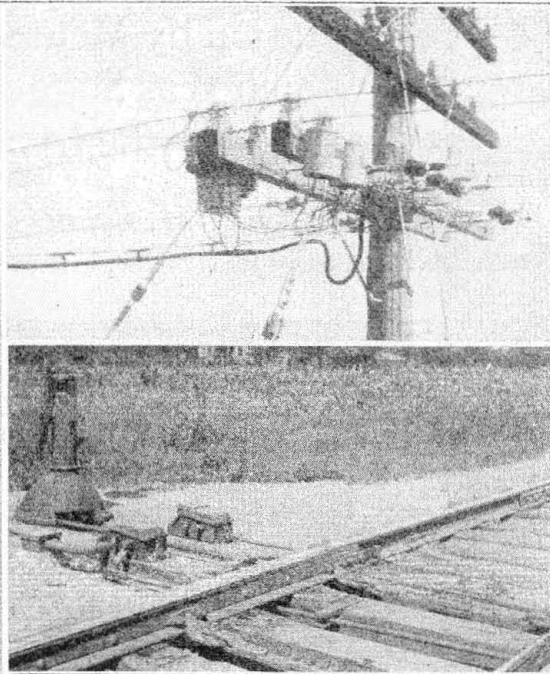
ceed when preceded by a flagman. The engineman is required to govern the speed of his train in accordance with the indication of the cab signal.

The track between the passing sidings is divided into sections or blocks, the length of which is not less than braking distance. These block points are called, for convenience, phantom locations, being the locations at which signals would be installed if sig-

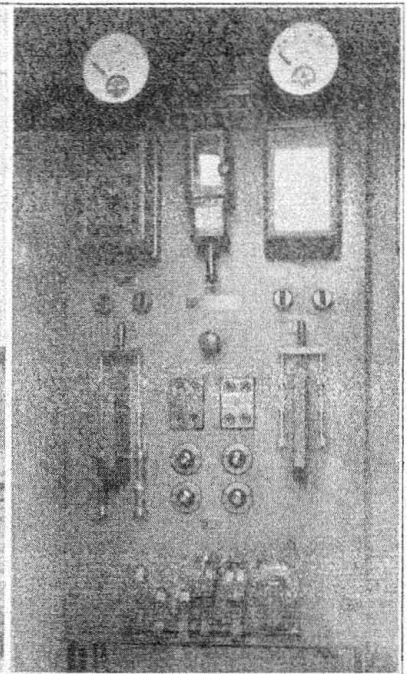
nals were used. Each phantom location is the "B" point for the next signal or phantom ahead, for following movements. Station to station blocking is effective for opposing movements. When two opposing trains approach a meeting point each receives a red cab signal at the first phantom location in the rear of the meeting point.



Sub-Station Is Located in Concrete House



Above—Pole Mounting at Signal
Below—Switch Box for Each Point



Automatic Substation Switching Panel

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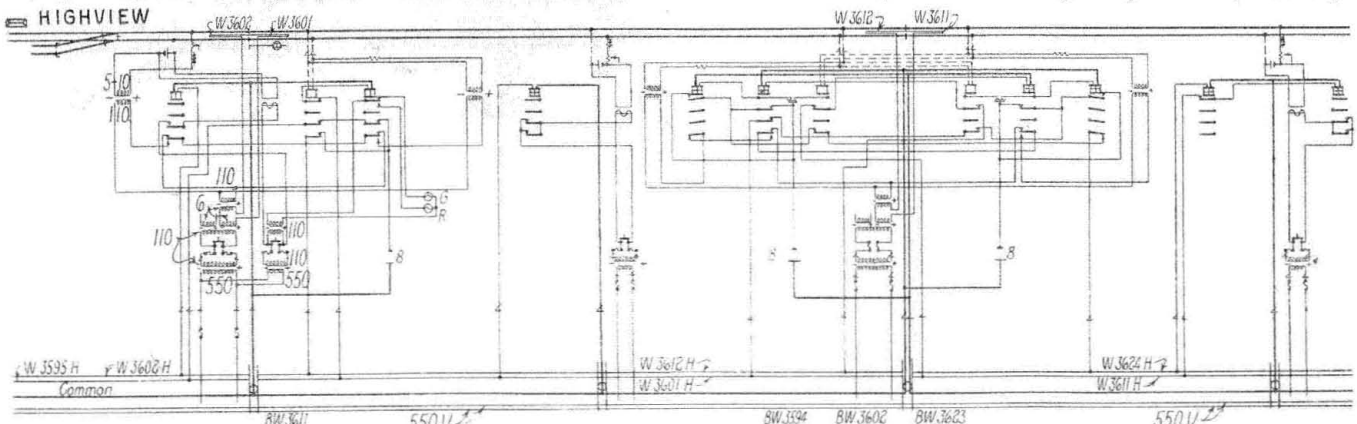
Power Supply and Circuits

Power is purchased from public service companies serving the territory and transmitted at 550 volts single-phase on two No. 6 A.W.G. weatherproof copper wires carried on the end pins on the track side of the lower cross-arm of the telegraph pole line. Each cross-arm is stenciled "Danger 550 Volts" immediately below these wires. Transpositions are made to prevent interference with the communica-

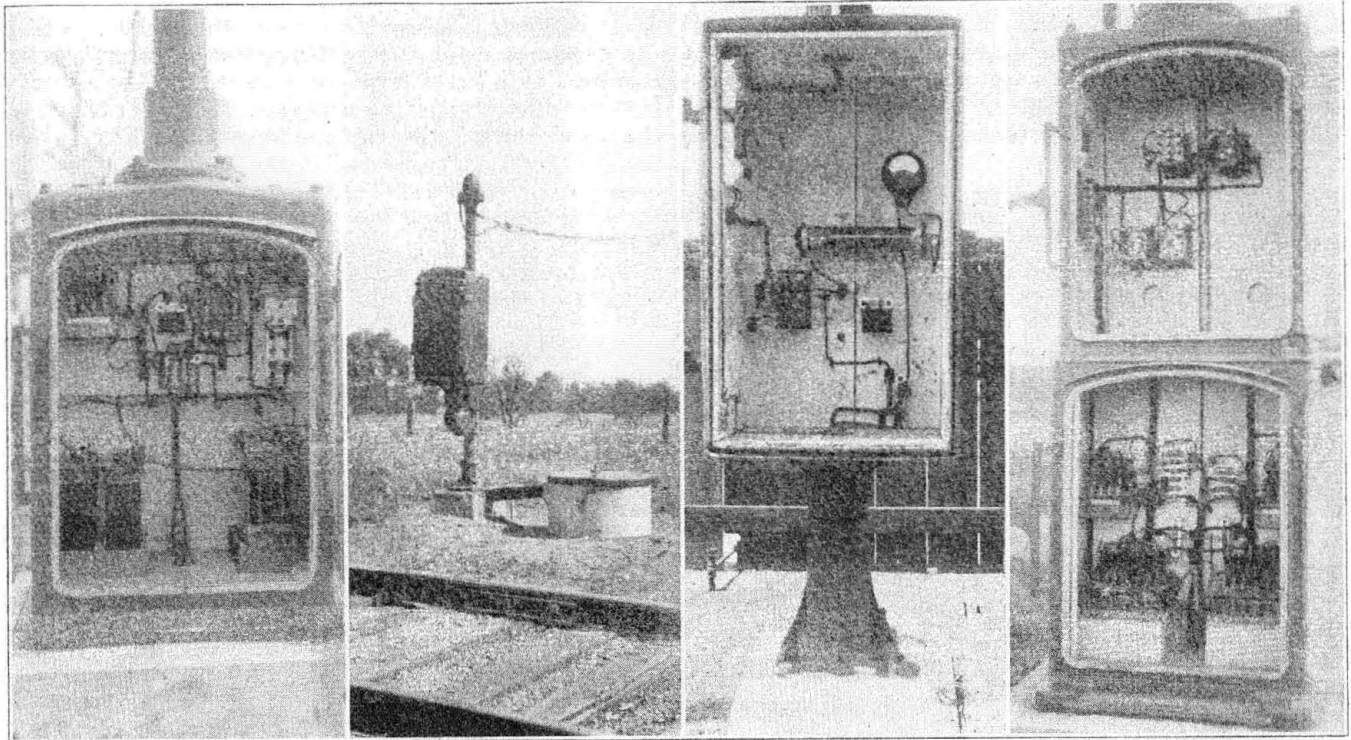
tion circuits. Nine automatic substations control the supply of current for the system. The substation equipment is operated so that each alternate station is either a preferred or emergency source of power. In case of a failure of power at any station the adjacent stations either way, will cut in automatically and serve the territory for which the station has failed. Once cut in, a station will continue to feed

until it fails or the service has been restored to an adjacent station manually. Track circuits longer than 4,000 ft. are center-fed with one cell of lead type storage battery. Two-ohm relays are used. Storage cells are trickle charged through Balkite electrolytic rectifiers from the a.c. power line. A special circuit is employed so that when a track circuit is occupied the charge is cut off to insure against improper operation of locomotive equipment due to pulsating current.

Wherever power is taken from the line a 550 110-volt transformer with lightning arresters and plug cutouts is mounted on the cross-arm of the pole line. This transformer furnishes all of the power required for operation of the automatic train control at the location. At the ends of passing sidings an additional transformer is provided for lighting the wayside sig-



As Shown in the Diagram Above the Wayside Circuit



Interior of Double Track Feed

Battery Track Feed Location

After Trip Pit Test Box

A Phantom Signal Location

nal. Double mechanism and relay cases are used at each signal and phantom location to house the relays, transformers, resistance and reactance units. All line relay circuits are operated from primary battery housed in concrete battery boxes.

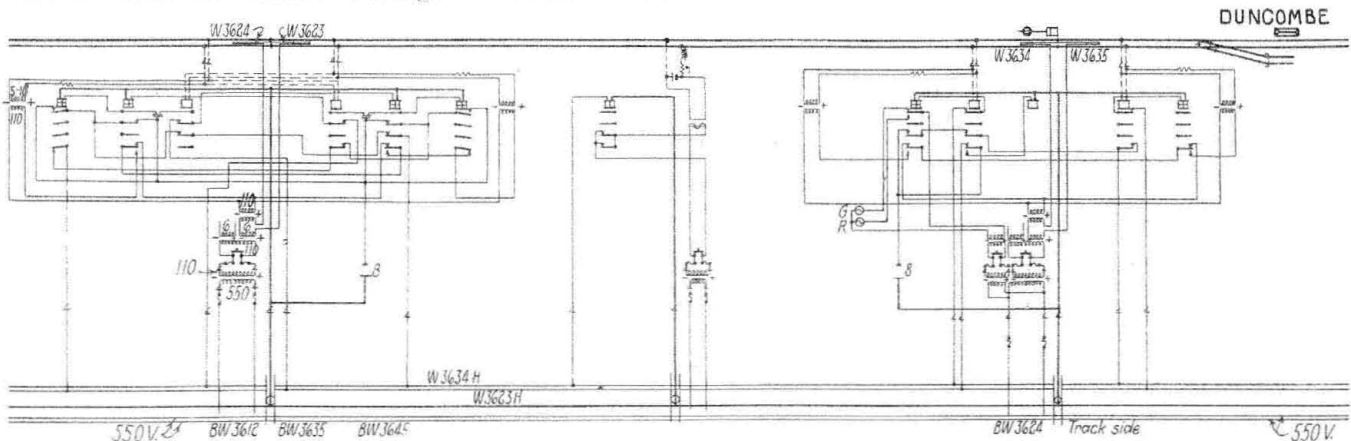
Roadside Train Control Circuits

Alternating current at 110 volts is carried into the instrument housing through a cable line drop where it is stepped down to 6 volts through a small transformer known as the reset loop transformer. The secondary of this transformer is connected through the recurrent acknowledgment loop in series with the primary of the reset check transformer which steps the current up to 110 volts. This 110-volt current is taken through contacts of the control relays after which it is impressed upon the primary of the track transformer. The secondary of the track transformer is connected through a resistor to the leads from the track relay to the rails; in case of a battery location instead of a relay location, this secondary is connected in series with the track battery and its variable external resistor through a reactor. The

proper functioning of the system is dependent upon alternating current being fed to the exit end of track circuits which is accomplished by the direct current control circuits. Normally, there is no alternating current in the rails as one "home" relay must be energized and the opposing "home" relay de-energized to complete the circuit, thus making the circuit self-checking.

The recurrent acknowledging loops are provided to require recurrent acknowledgment by enginemen at successive stop blocks. Being in series with the transformers which feed the track circuits in the rear, a broken loop circuit results in the cutting off of energy from the track circuit approaching the location. The loop is made up of 3/8-in. copper-weld strand stapled to the tops of the rail bases and extending 50 ft., either way (200 ft. of wire) from the block location.

Parkway cable has been used in all new work throughout the installation. The track wiring is single-conductor No. 9 A.W.G. and the circuits from instrument cases on the line side to the apparatus across the track are carried in four-conductor No.

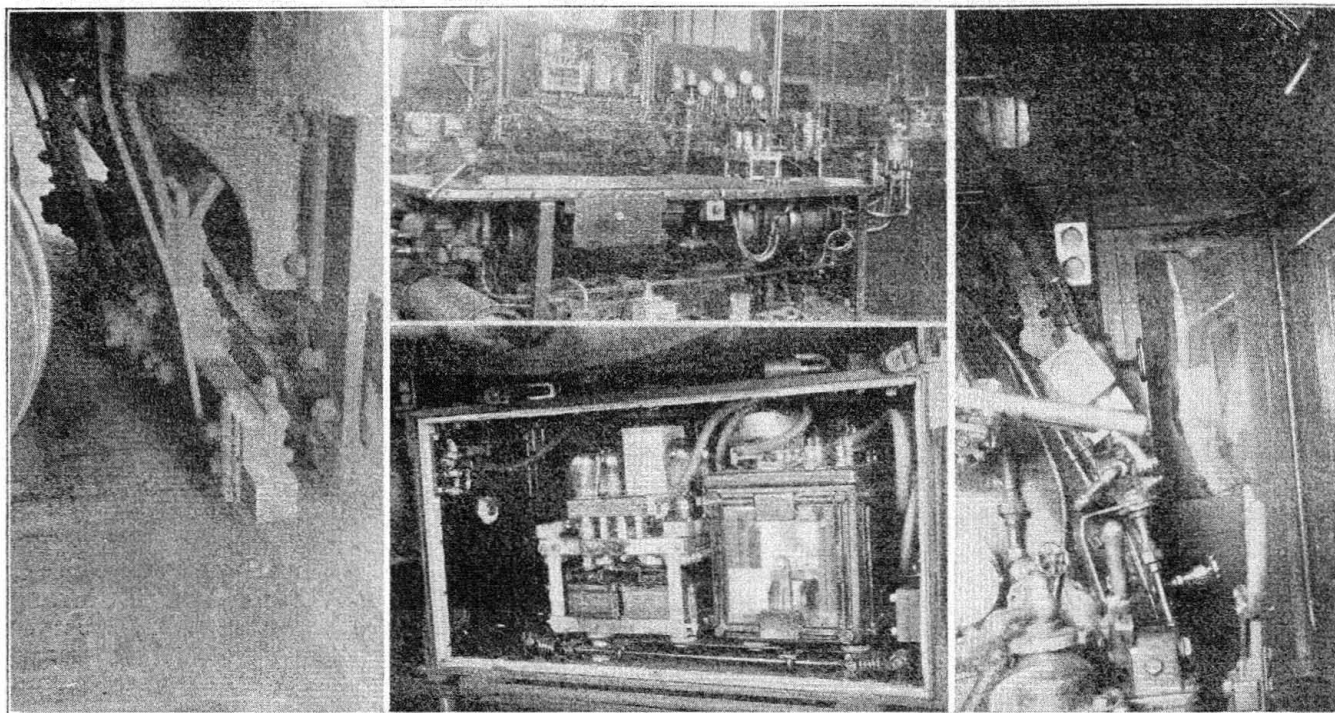


Arrangement Is Less Complicated Than for A. P. B. Signaling

9 A.W.G. Parkway cables. All main track switches are equipped with two shunt boxes, one connected to each switch point. One wire is run from each rail to each shunt box. Connection to the rail is made through a double bootleg terminal and the shunt box ends of wires are terminated on porcelain terminals in a cast-iron box mounted on a concrete pier. Stranded wires from this terminal box are carried through flexible conduit to the shunt box. Lifting type derails on all turnouts, except passing sidings, are also provided with shunt boxes. Appropriate

sheet metal box suspended from the smoke box and the dynamotor which furnishes the plate current is mounted on a bracket on the end of this box. Wires between the cab and the equipment box are carried in the hand rail on the right side of the boiler, while headlight wires are carried in the left hand rail. The brake application valve group is located underneath the engineman's seat box where it is protected from freezing.

The pneumatic circuit controller is mounted on the outside of the cab to the left of the door leading to



Collector Coils Mounted Beneath the Pilot

Above—Test Rack in Roundhouse
Below—Case Mounted Under Smoke Box

Cab Signal and Voltmeter to Left
Cut-out Switch Upper Right

signs designating the start and end of train control territory have been erected. Telephone communication has been provided at each passing siding where the indication of the leaving signal cannot be seen from the telegraph office at the station.

Locomotive Train Control Equipment

Thirty-eight locomotives, 10 passenger and 28 freight, have been equipped. Four additional passenger locomotives assigned to the territory west of Fort Dodge are now being equipped for emergency service. Two switching locomotives working between Fort Dodge and Gypsum have been equipped for operation in either direction while all of the remaining locomotives have been equipped for forward movement only. The locomotive equipment consists of receiver coils, relay, amplifying unit, dynamotor, brake application valve group, pneumatic circuit controller, acknowledging valve, reset cock, cab signal and voltmeter together with necessary wiring and piping.

The receiver coils are mounted ahead of the forward engine truck so that they clear the running rails about six inches. The windings of these coils are connected so that they are additive for rail current flowing in opposite directions in the rails. Power for the locomotive apparatus is supplied by the headlight turbo-generator.

The relay and amplifying unit are enclosed in a

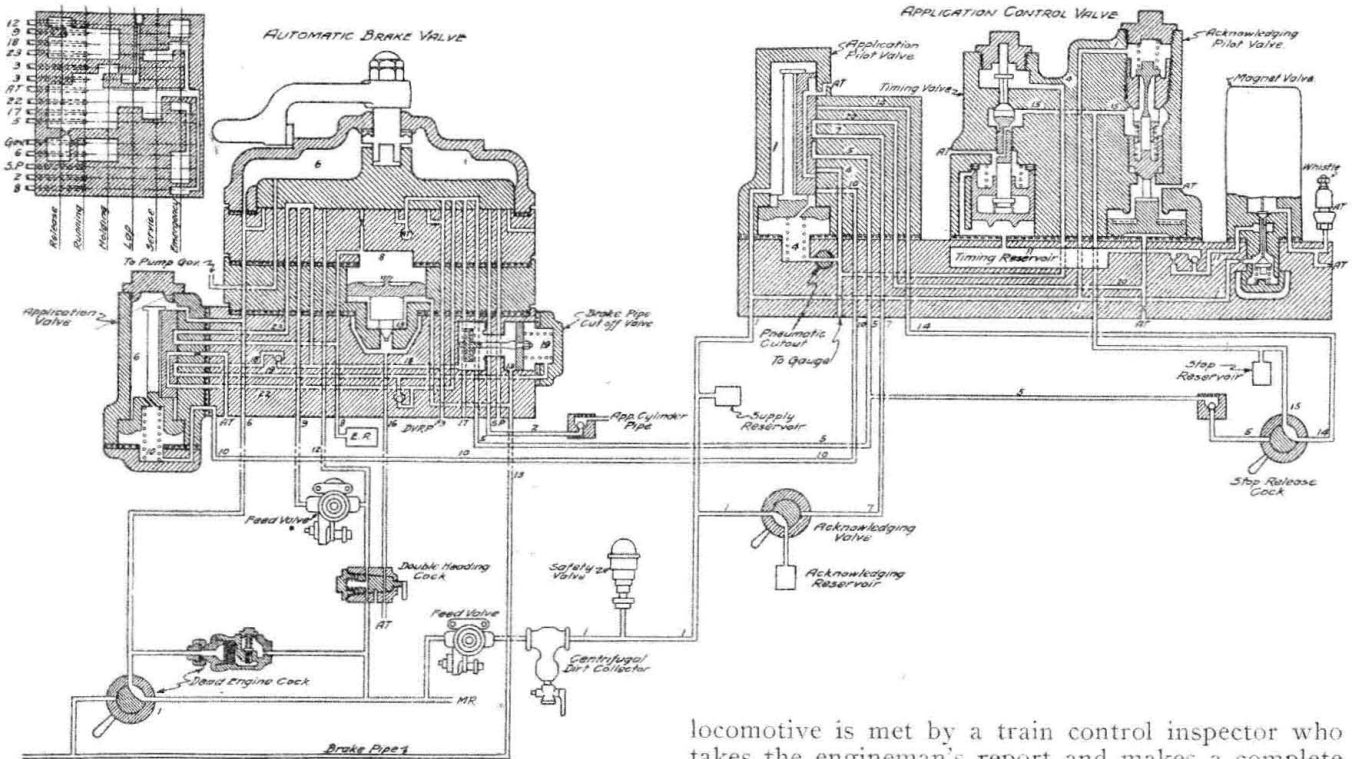
the right hand running board. The acknowledging valve located on the wall of the cab within convenient reach of the engineman is provided so that he may, if alert, forestall an automatic application of the brakes. To be effective this valve must be operated less than 10 sec. previous to a change in the cab signal indication from Green to Red and not more than 6 sec. after this change.

The cab signal giving two indications, Red or Green, is mounted on the front wall of the cab on the engineman's side so that it is in his line of vision. A voltmeter mounted on a bracket on the side of the boiler indicates the voltage being delivered by the headlight generator. The reset cock is located outside of and underneath the cab where it cannot be reached except from the ground, thus insuring that a stop must be made before the brakes can be released following an automatic application.

The engineman's automatic brake valve is similar to the H-6 except that two small valves, part of the automatic brake system, are included. One of these, the brake pipe cutoff valve, lies within the pipe bracket casting while the application valve uses the position that the feed valve occupies with the Type A pipe bracket, the feed valve being mounted separately. The space occupied by the new engineman's valve is substantially the same as with the H-6 with feed valve attached so that the existing clearance is not reduced.

A small whistle connected to the exhaust port of the magnet valve provides an audible warning of a change in indication. A long blast of this whistle is sounded when the cab signal changes from Green to

Test loops are provided at locomotive terminals to facilitate the testing of locomotives immediately on arrival and prior to departure. After-trip test loops are located at the inspection pit where every



Pneumatic Diagram of Automatic Train Stop Equipment on Locomotive

Red and a short blast when the change is from Red to Green, thus giving ample warning for the engine-man to operate the acknowledging valve.

A manual emergency brake application may be made at any time regardless of whether an automatic brake application has been initiated. When locomotives are double-headed the automatic stop equipment, except on the leading locomotive, is automatically cut out of service by closing the double heading cock on the second locomotive. This does not prevent a manual emergency brake application being made on the second locomotive at any time.

locomotive is met by a train control inspector who takes the engineman's report and makes a complete test and inspection of the equipment, entering all data on proper form as shown herewith. These forms are bound in a book which contains 50 sets, a set consisting of the original, a yellow sheet which is bound solid in the book and remains in the book at the test house at the pit, and the two tissue sheets which are carbon copies and are perforated for easy removal. One of these is for the supervisor of automatic train control, the other for the division electrical foreman. Pit electricians report on these forms all engines they handle in and out, whether equipped with train stop or not. These reports also include a statement of all work done on engines and a brief statement of any trouble sustained by engines on the road.

B100 bks. 5-26 FC 5-5-26

ILLINOIS CENTRAL SYSTEM

Form GSMP 142

DAILY TEST AND INSPECTION REPORT AUTOMATIC TRAIN STOP AND HEADLIGHT EQUIPMENT

DATE *7-27-26* LOCATION *Champaign* HOURS *7A-3P* INSPECTOR *John Smith*

| ENGINE | DIR. | HD. LT. EQUIP. | A. T. S. EQUIP. | VOLTAGE | STEAM PRESS | HOURS | MILES | REMARKS |
|-------------|------------|----------------|-----------------|--------------|-------------|------------|------------|-----------------------------|
| <i>1979</i> | <i>IN</i> | <i>Tested</i> | <i>Tested</i> | <i>34-32</i> | <i>180</i> | <i>9'5</i> | <i>122</i> | <i>One 15-Watt Cab Lamp</i> |
| <i>1800</i> | <i>OUT</i> | <i>"</i> | <i>Insp.</i> | <i>33-33</i> | <i>190</i> | <i>-</i> | <i>-</i> | |
| <i>4937</i> | <i>IN</i> | <i>"</i> | <i>-</i> | <i>-</i> | <i>-</i> | <i>-</i> | <i>-</i> | |
| <i>710</i> | <i>OUT</i> | <i>"</i> | <i>-</i> | <i>-</i> | <i>-</i> | <i>-</i> | <i>-</i> | |

A Record of Every Engine Is Entered By Electrical Inspector on This Form.

A portable test set is provided for making tests on locomotives in the roundhouse. This set includes all apparatus necessary to make complete test of locomotive equipment including emission tests of amplifying tubes. A motor generator set for converting 110 volts a.c. into 32 volts d.c. is included in the set. A plug receptacle in the cab and a long cable with plug is used to connect the 32 volt d.c. generator to the train control circuit when the headlight generator is not operating. A track transformer in the set, connected to wires mounted on small grooved pieces of lumber which may be placed under receiver coils, furnishes the necessary track circuit energy. With this outfit an engine may be tested "cold" in any stall of the roundhouse where 110 volt a.c. is available to operate the set. In addition to the portable test set one complete locomotive equipment has been set up on a rack for testing individual pieces of apparatus and for instruction purposes. Air and elec-

condition to operate in accordance with conditions existing ahead.

While carrying a green cab signal a train may proceed at authorized speed. Immediately upon a change from Green to Red, the engineman is required to reduce speed and proceed at not exceeding 15 miles per hour. If for any reason the equipment fails or a red indication persists the fact must be re-

FC 10-25 AY 25M 12-25

GSMP 119

ILLINOIS CENTRAL SYSTEM**Union Automatic Stop After Trip Report**

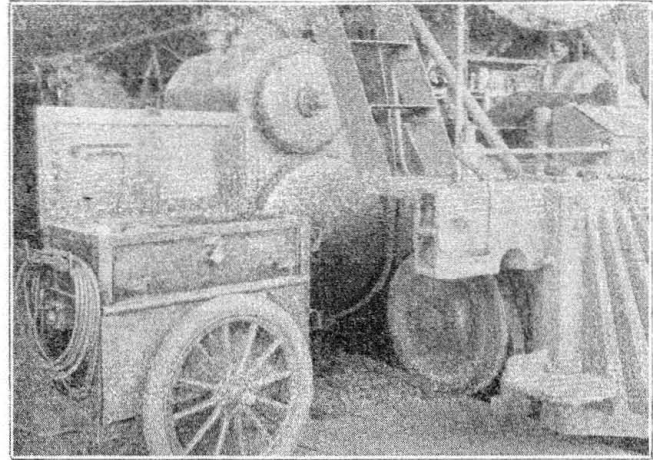
Eng. # 920 Train # 94 Engr. Chapman
 Departed Centralia 7-24 1926 6:40 A.M.
 Arrived Champaign 7-24 1926 10:40 P.M.
 Steam Press 175 lbs. M. R. Press 100 lbs.
 Brake Pipe 70 lbs. Control Press 60 lbs.
 Generator Voltage #1 TCL 34 FL 32
 Ground Voltage POS .26 NEG 0
 Margin Pick Up .24 Amps.
 Delay Time 7 Sec. Reset Time 7 Sec.
 Control Reduction 20 lbs. in 10 Sec.
 Pilot Valve Releases 49 lbs. applies 40 lbs.
 Flash Time 1 Sec. Short Release 3 Sec.
 Supply Press 60 lbs. Supply Line Drop 4
 Brake Pipe Cutoff Valve O.K.
 Emergency O.K.
 Acknowledgment Delay Time 19 Sec.
 Was Equipment Drained Yes
 Condition of Seal O.K.
 Adjustments made None

Testman John Smith Maintenance Man J. H. W.
 Maintenance Man J. C. M. Pneumatic Man C. A. D.

This Form Printed on Card Is Used as a Record
of Every Trip

trical energy are supplied to this rack so that operating conditions may be duplicated exactly.

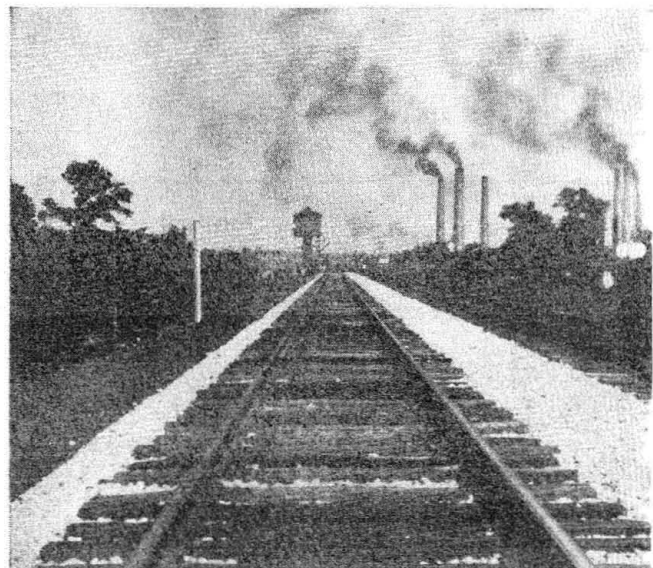
Departure test loops are located where it is necessary for an engine to be run over them before coupling to a train. Two departure test loops are provided. In passing over one of them the engineman does not acknowledge an automatic brake application and stop results; at the other, he acknowledges the change of the cab signal and proceeds without an automatic brake application to pick up his train. Just before entering train control territory a short permanently energized track section has been installed to clear the cab signal and put the equipment in



Portable Testing Set in Roundhouse

ported to the dispatcher at the first point of communication. A pneumatic cut-out is provided for use in case of an electrical failure and the engineman may in an emergency cut out the train control system, pneumatically, by reversing the cut-out lever which is sealed in the cut-in position. The electrical equipment may operate when the condition which caused its failure is removed regardless of the position of the cut-out lever.

When necessary to run non-equipped locomotives or to detour foreign line trains over automatic train control territory they are double-headed with an equipped locomotive coupled ahead. The roadside equipment is maintained by the signal department forces while the locomotive carried apparatus is maintained by mechanical department forces.



On the Single Track Territory of the Erie