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.

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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 Jet., 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 Jet. 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 3½ 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 opposing 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 signals 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.

**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 communication 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 charging 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-

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**Sub-Station Is Located in Concrete House**

**Above—Pole Mounting at Signal**

**Below—Switch Box for Each Point**

**Automatic Substation Switching Panel**
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 ties about six inches inside 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.
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

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
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 Red and a short blast when the change is from Red to Green, thus giving ample warning for the engineer 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.

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 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.

ILLINOIS CENTRAL SYSTEM

DAILY TEST AND INSPECTION REPORT AUTOMATIC TRAIN STOP AND HEADLIGHT EQUIPMENT

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<th>DATE</th>
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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 electrical 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 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 reported 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.