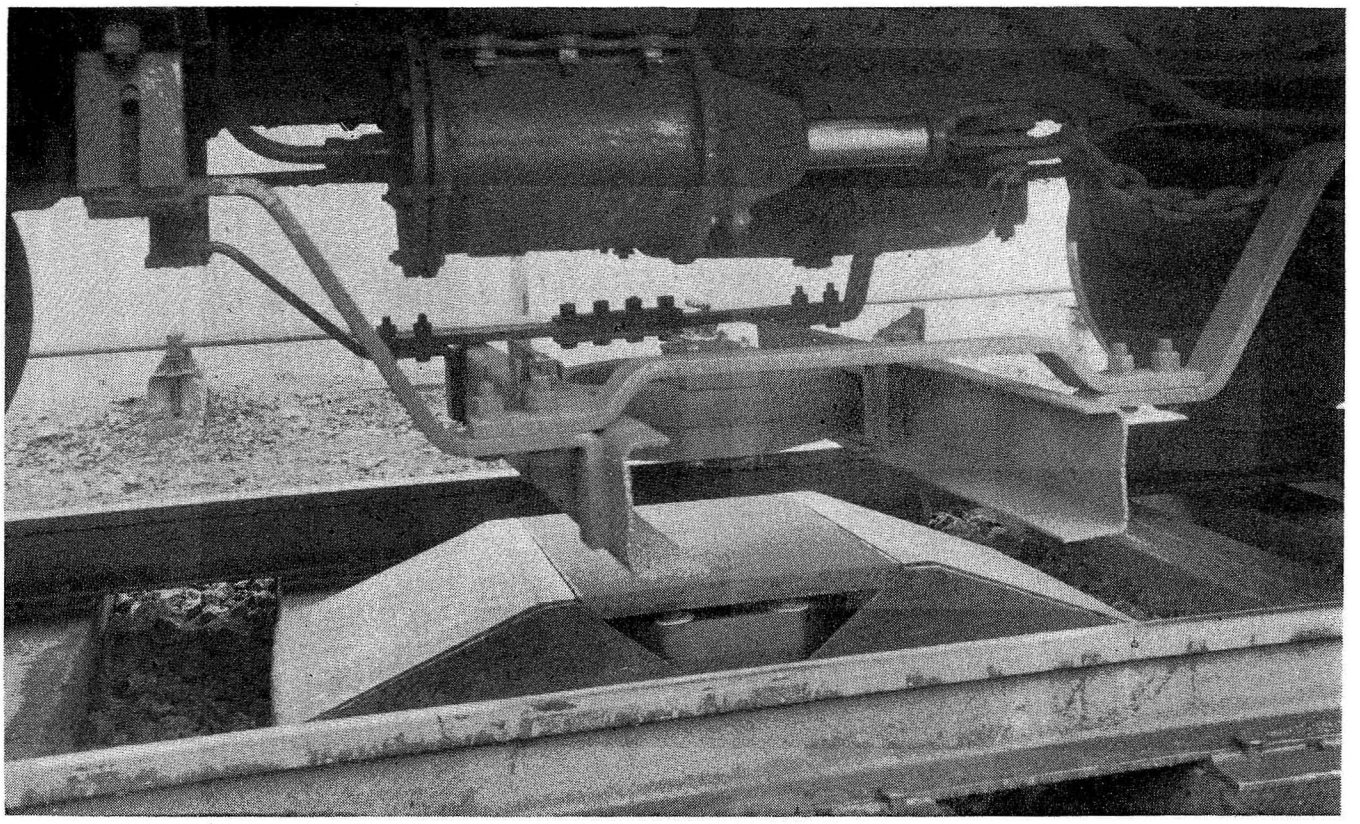


The track coil is under a ramp cover between the rails, and the caboose coil is in a frame under the car

Erie - - First to Install Train Identification System

Electronic system, based on fail-safe principle, remotely controls manual block signal, and positively identifies trains that are leaving manual block territory at an outlying unattended junction

This caboose was identified as it passed over track coil

THE ERIE has established another 'first' by installing a newly-developed fail-safe electronic train-identification system, which automatically reports—to the dispatcher's office at Salamanca, N.Y.—the passing of trains from single-track manual block to double-track automatic block territory at an unattended junction at Waterboro, N.Y., 22 miles away.

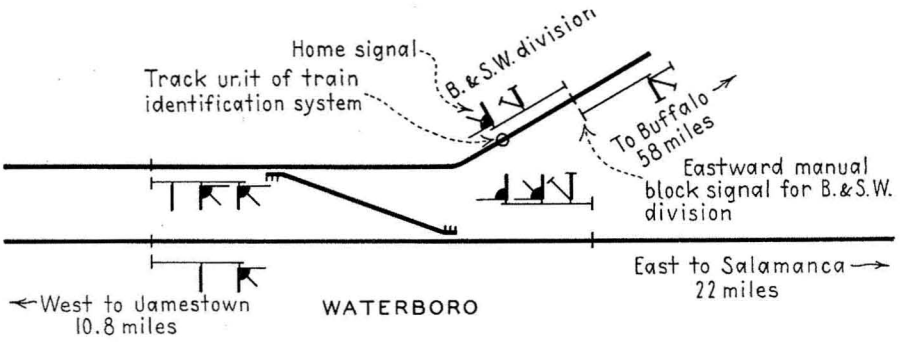
Also, in this system the dispatcher at Salamanca controls the manual block signal at Waterboro, these controls as well as return of indications to his office being on the fail-safe principle. The basic equipment in this electronic system was manufactured by the General Railway Signal Company. Signal engineers of the Erie, in cooperation with the G.R.S. Co., developed the application herein described.

Why Identification Was Needed

From Buffalo, N.Y., the B.&S.W. division of the Erie extends southwest 58 miles to Waterboro which is a junction with the east-and-west line of the Erie between New York and Chicago. The B.&S.W. division trains use the double track, main line between Waterboro and Jamestown, N.Y., 10.8 miles. Waterboro is 22

miles west of Salamanca where the main-line dispatcher is located.

Train movements on the B.&S.W. division between Buffalo and Waterboro are now, and were previously, authorized by manual block, no track circuit controlled signaling being in service on this 58 miles. Previously the junction at Waterboro was included in a mechanical interlocking, operated by an operator-leverman, who also operated the eastward manual block signal on the B.&S.W. division. When westbound trains from the B.&S.W. division passed Waterboro and proceeded toward Meadville, the leverman sent an "OS" to the dispatcher at Salamanca.



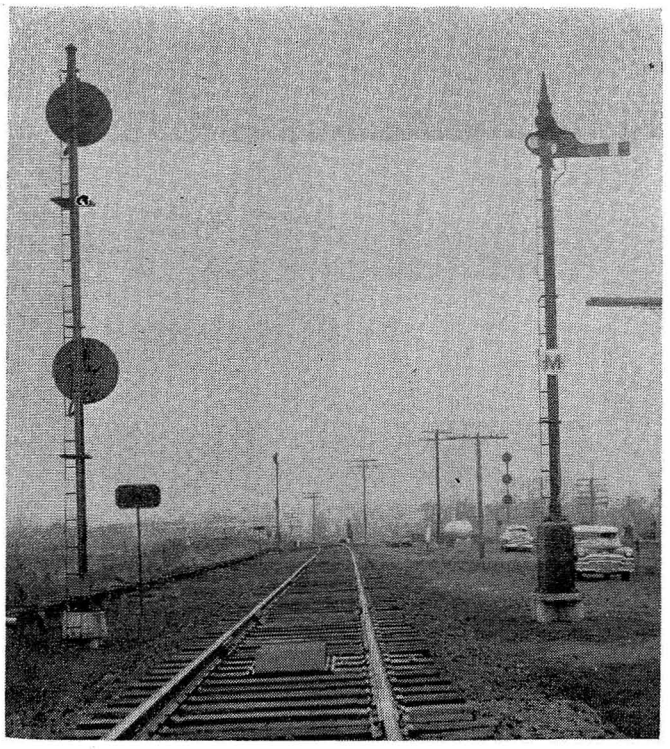
Track and signal plan of layout at Waterboro

All Done By Line Carrier

As part of a progressive program, this mechanical interlocking at Waterboro has now been replaced by electric switch machines which are part of an extensive traffic control project controlled from a machine in the dispatcher's office at Salamanca. Separate from this project, but placed in service at the same time on October 26, is the new system which, (1) provides means whereby the dispatcher at Salamanca controls the eastbound manual block signal for B.&S.W. trains at Waterboro and (2) when the caboose of a westbound B.&S.W. division train passes Waterboro, an individual identification of that train is sent automatically to the dispatcher's office.

In this new installation the outgoing controls and indication codes, sent back and forth between Salamanca and Waterboro, are all handled by coded carrier which is superimposed on two existing line wires, therefore no new line wires were required for the manual block signal at Waterboro, or for the train identification system. GRS code transmitters, the same as ordinarily used for coded track circuits, are employed in this new system. Various code transmitters operate at the rates of 75, 120, 180, 240 and 405 times per minute. The carrier equipment, made by the G.R.S. Co., is the same as used on coded carrier for traffic control system installations. For transmitting controls from Salamanca to the manual block signal at Waterboro, the carrier is 11.1 kc; the signal indications are sent from Waterboro to Salamanca by 19.2 kc; and the train identification indications are sent in by 17 kc. The eastward manual block signal at Waterboro, which governs trains entering the B.&S.W. division, is a three-position upper quadrant semaphore, a semaphore being used purposely because it is distinctly different from the color-light interlocking home signals at this junction.

When the dispatcher's lever for control of the manual block signal is in the normal position, 75 code is being sent continuously to Waterboro. This code, (or absence of code) controls the manual block signal to display the red (Stop) aspect. When this semaphore blade is in this position, inverse 75 code feeds back over the line to Salamanca, to cause a red signal lamp to be lighted over the normal position of the signal lever. When the dispatcher places the lever at the caution position, 120 code goes out to cause the signal to operate to the 45 deg. position and then 120 inverse code goes back to light a yellow lamp over the permissive position of the lever. When the dispatcher throws the lever to the



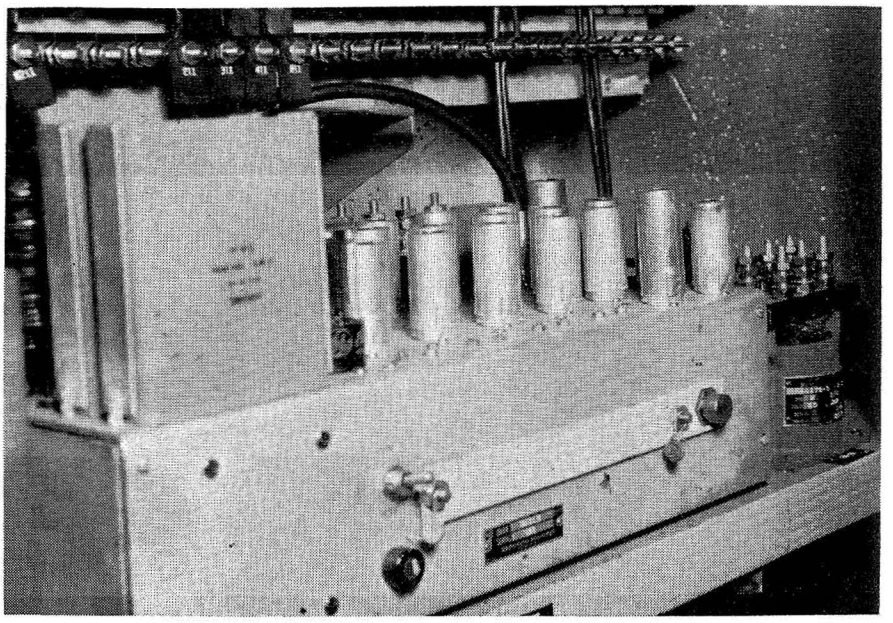
This semaphore is the manual block signal

Train identification lamps on the CTC panel

clear position, 180 code goes out to cause the signal to operate to the vertical position, and then inverse 180 code is sent back to light a green indication lamp over the clear position of the lever. The lever and signal must be in the corresponding position to operate the corresponding indication lamp. Code, at the proper rate, must be transmitted continuously to control the signal, therefore this fail-safe principle is equivalent to the closed-circuit principle.

Each Train Identified Individually

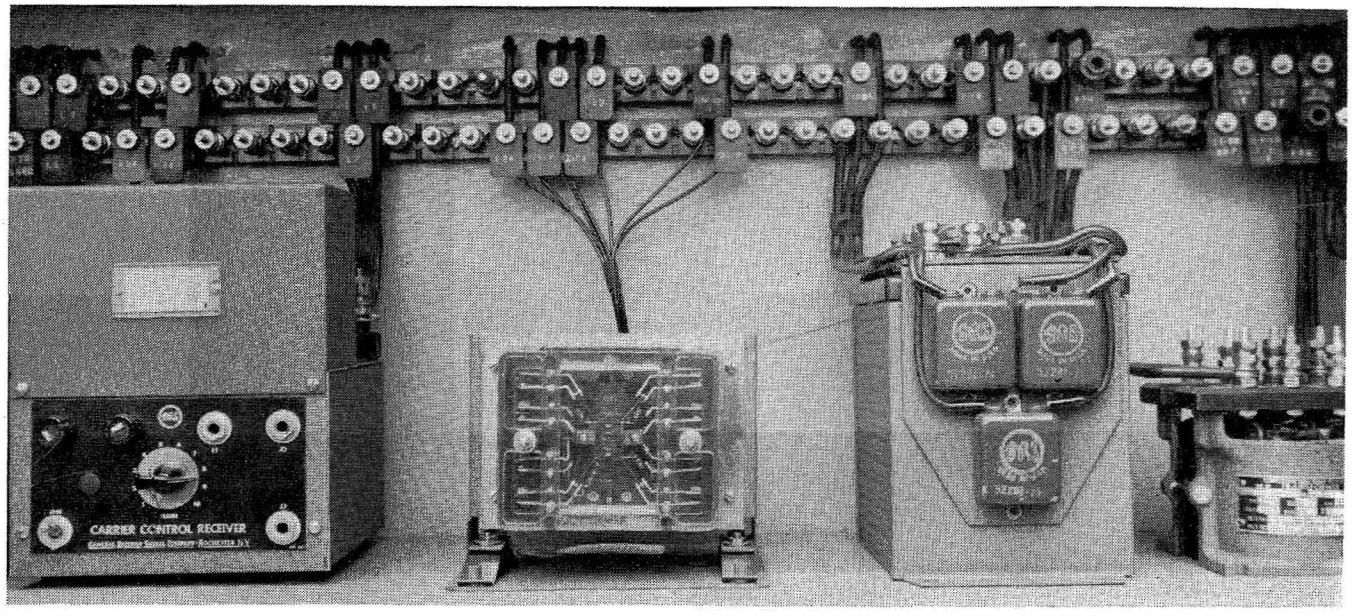
No passenger trains are operated on the B.&S.W. division. A local freight goes east one day, and west the next, except Sunday. A certain caboose is assigned regularly to the crew for this local train. The through freight trains are operated by crews which start at Buffalo, and make a round trip to Meadville. Two crews are assigned to make such a run each day, and each of these crews has an assigned caboose. A fourth caboose—normally held at Buffalo—is available for use on an extra train when operated. Mounted on an angle-iron frame under each of these four cabooses, as shown in the picture herewith, is a moulded rubber doughnut about 18 in. in diameter. The doughnut lies in a horizontal plane with the lower side about 7 in. above the level of the top of the rail. This doughnut includes a few turns of wire connected directly to a condenser located in a waterproof compartment on the rubber casing. The coils on all the cabooses are the same, but the condensers are of different microfarad capacities, so that each coil is thereby tuned to a certain resonant frequency. The four different frequencies are in the range between 160 kc and 310 kc. Each coil is distinctly numbered. Each coil is normally locked in place in its hanger under a certain caboose. However, a coil can easily be changed from one caboose to another if necessary. These caboose coils are inert, which means that no battery or other form of electrical energy is required on the cabooses.



This is the electronic tube oscillator

At Waterboro, another coil encased in rubber, lies flat on the ties between the rails at a location 22 ft. west of the eastward manual block signal. This coil is protected by sheet-metal ramps to deflect any object that might fall from, or be dragging from a train. A cover of wood, which is non-magnetic, extends from ramp to ramp over the doughnut. This cover was removed when the picture was made. This track-mounted coil is connected, by a coaxial cable, to electronic equipment in the concrete instrument house near the track. The heater elements in the vacuum tubes in this equipment are normally energized from a 12-volt a.c. supply, obtained from a transformer connected to the commercial lines. A power-off relay transfers the heater circuit to a local 12-volt storage battery supply, in the event of failure of the a.c. source.

When a westbound B.&S.W. division train approaches Waterboro, it occupies the approach track circuit AAT which causes the plate circuits in the vacuum tubes to be energized and also starts operation of the code transmitters, 120, 180, 240 and 405.

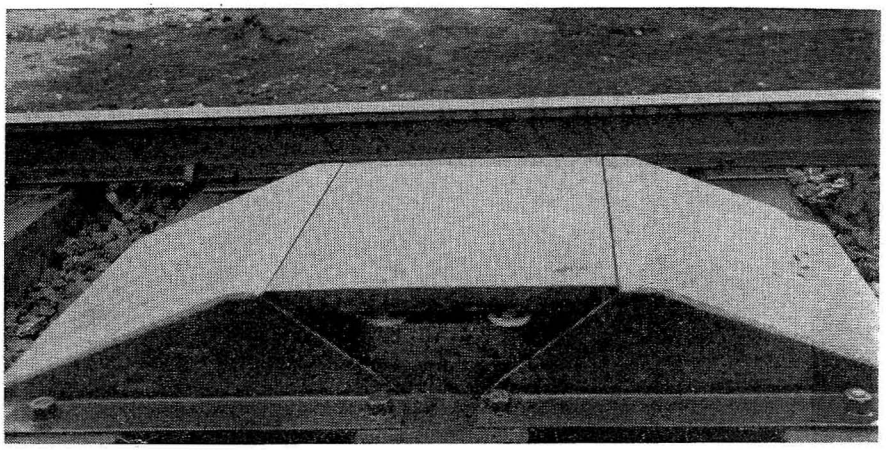


Lef to right: Carrier control receiver, code following line relay and master transformer

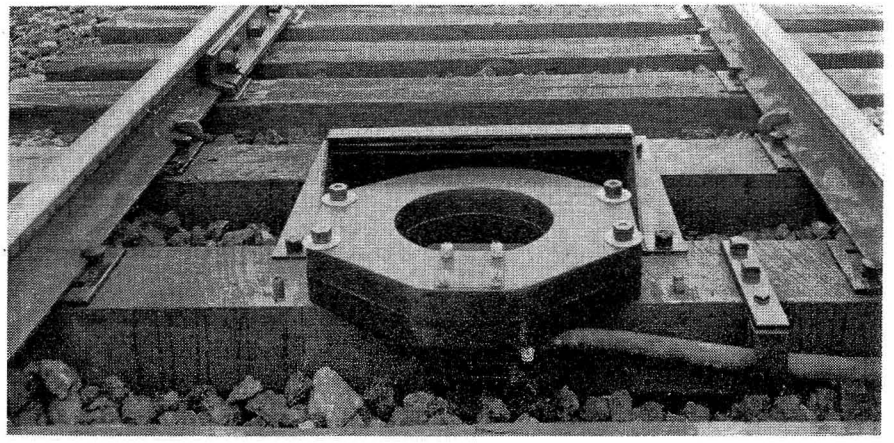
The special track circuit AT, only 300 ft. long, is fed by 3 cells of primary battery; has a resistance in series with the relay and with the battery; and has a special 4-ohm relay that picks up in 0.09 seconds. When the entire westbound train, including the last pair of wheels on the caboose, passed off track circuit AT, the pick up of track relay AT starts a timing interval of six seconds, during which the system is capable of making a train identification. This time, and the location of the track coil, are such that a caboose traveling at a speed as low as one m.p.h. will pass over the coil within this six seconds, and be identified. Also the system operates so fast that it will identify a caboose at any speed up to the maximum at which trains can be operated.

During the six seconds, the electronic vacuum tube oscillator, in the instrument house, feeds the track coil a sweep frequency, back and forth, between 160 kc and 310 kc, several hundred times each second. This range includes the resonant frequencies to which the individual caboose coils will react, i.e., each caboose coil reacts only to its frequency. As a caboose coil passes over the track coil, the two coils are coupled, which produces an abrupt reduction in the output of the wayside oscillator.

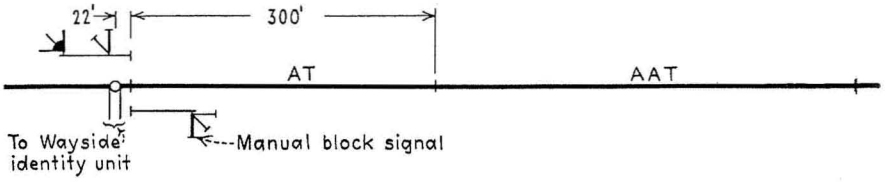
By means of suitable circuits, the oscillator reaction is employed to develop a series of pulses which are applied simultaneously to a group of relay control channels. These channels, however, are arranged to remain cut off unless gating voltages are also present. The gating voltages are derived from a group of resonant circuits, at the wayside location, tuned to the same frequencies as the



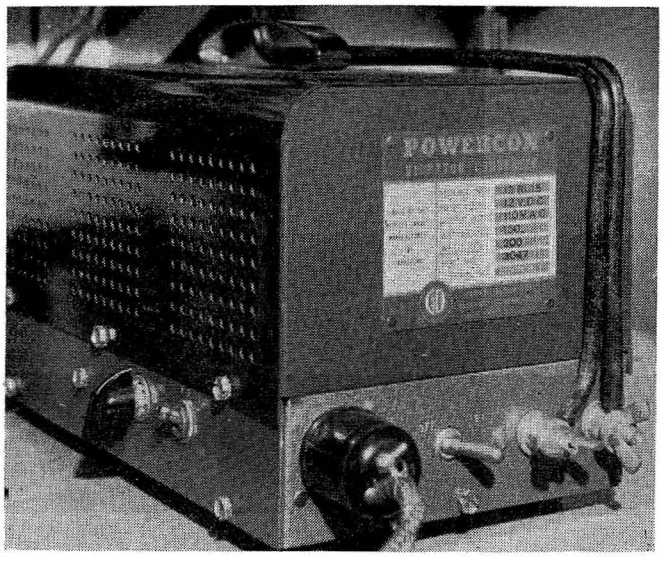
Track coil is protected by ramps and a cover



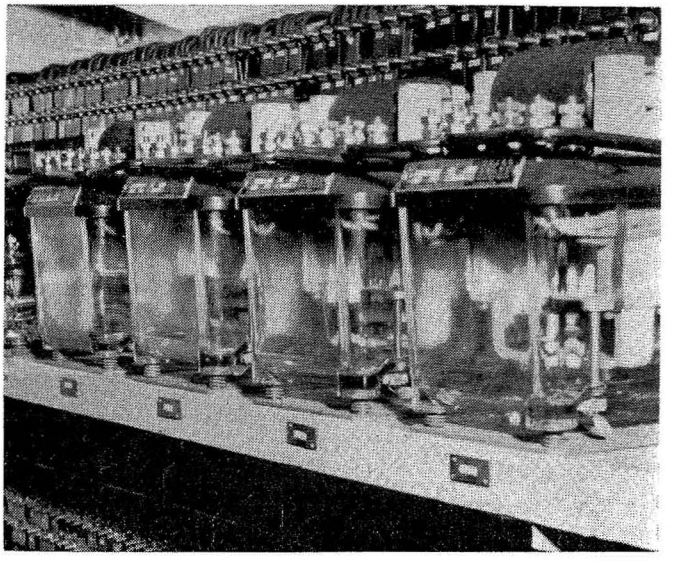
Cover removed to show track coil mounted flat on cross tie



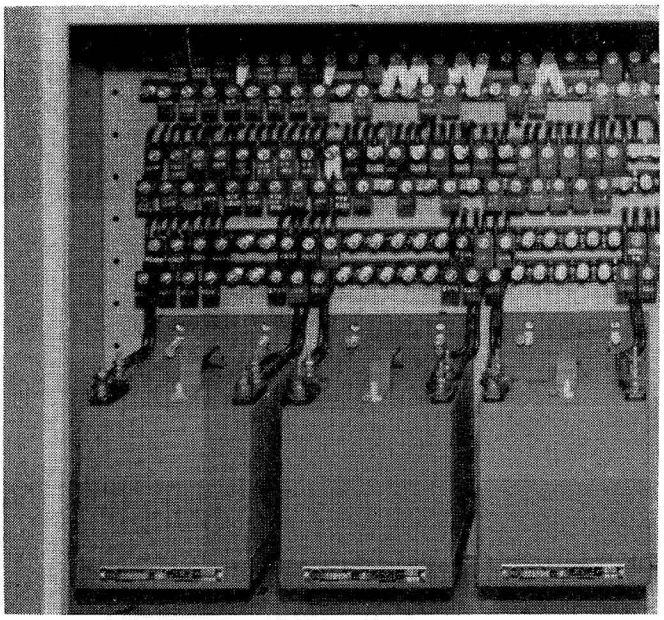
Track circuits for directional and timing control



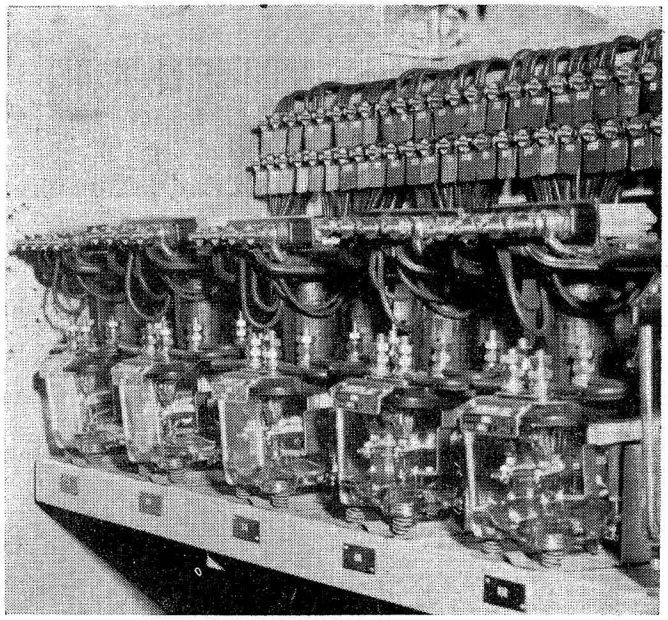
Vibrator converter for 110-volt standby



These devices originate the codes



These are decoding units at Salamanca



Selector relays at Waterboro

various caboose coils. These resonant circuits cause the appearance of a series of gates as the oscillator frequency sweeps past the resonance frequencies, and these gates are in turn applied individually to the relay-control channels associated with the resonant frequencies. A coincidence arrangement is thus set up by which the appearance of the oscillator-reaction pulse on all relay-control channels indicates the presence of a caboose loop, and the simultaneous appearance of a frequency-determining gate on one, and only one, of the relay control channels identifies the frequency of the caboose coil. The channel which receives both an oscillator-reaction pulse and a frequency-determining pulse gate, thereupon picks up an associated relay to identify the frequency of the passing caboose coil. A number of successive oscillator reaction pulses are necessary to pick up the relay. Because of the rapid rate at which the oscillator sweep is repeated, this requirement is met during the time the caboose coil is passing over the track coil, even at high train speeds. The relay then selects the proper code transmitter, which keys the 17-kc carrier at the selected code rate for approximately three seconds. The code rate is at 120 for identification No. 1, at 180 for No. 2, 270 for No. 3 and 405 for No. 4. This coded carrier is superimposed on the line going to Salamanca, where it is decoded and used to energize a relay which lights one of the four "OS" lamps on the dispatcher's panel, rings a buzzer, and causes a corresponding pen in the train graph to move ⅛-in. to the right. When the dispatcher acknowledges, by pushing a button, the lamp goes out and the pen returns to its normal position, thus leaving a record on the train graph.

At Waterboro, when the rear of the train passes beyond home signal limits, the operation of the four code transmitters is stopped, and the power supply for the plates in the electronic tubes is cut off. The plate power supply requires 110-volt alternating current, and is normally fed from a transformer. If this a.c. power fails, a Cornell-Dubilier vibrator-inverter operates from battery to supply 110 volts a.c. to the plate power supply.

No False Operations

The circuits which produce the oscillator-reaction pulse are so designed as to produce output only when the oscillator reaction is of an abrupt nature. This type of reaction is produced by the sweep frequency action only when the track coil is coupled to low-loss (high Q) resonant circuits such as caboose loops, and is not produced by random conducing objects. The reaction does not, however, depend upon the speed with which the caboose coil moves over the track coil. As a result, the train identification circuits are not operated by the passage or presence of large metallic masses, steel cars, wheels, etc.

Identifications are required only for westward trains, not for eastward. Therefore, circuits are arranged so that no identification can be sent unless track relay AT has dropped out, and then picked up again, before the caboose coil passes over the track coil. Direction is thereby established for westward trains only.

The train identification system is fail-safe. Failure of the 17-kc. carrier circuit, resulting from failure of power, equipment, or line, will automatically prevent the transmission of indications to Salamanca. There remains, however, the possibility that the 120-rate and 180-rate coded carriers, used for signal control, might get into the train identification circuits through carrier cross-talk and be accepted by the decoding circuits at Salamanca as "OS" coded carriers for identifications 1 and 2, since the 120 and 180 code rates are used, respectively, for these identifications. To avoid such a possibility, the circuits at Salamanca are arranged so that the "OS" decoding equipment is disabled except when the signal control lever is in the normal (red) position, putting 75-rate coded carrier on the line for signal control. Similarly, at the field location, the circuits are arranged so that no train identification indication can be transmitted until it has been checked that only 75-rate signal control and 75-rate signal indication carriers are on the line. By turns proving that 75-rate code is the only code being transmitted at both ends of the circuit for signal control and indication, it follows that any 120-rate and 180-rate coded carrier received in the "OS" circuits at Salamanca must have originated in the field "OS" circuits, and cannot be the result of cross-talk.

This installation of manual block control and train identification was planned and installed by Erie signal department forces, under the direction of W. S. Storms, signal engineer, the principal items of equipment being furnished by the General Railway Signal Company.