solid copper wires, all wires, both iron and copper, being carried on No. 42 glass insulators. At dead-ends, porcelain strain insulators, spaced about 32 in., are employed.

Within a year the ends of double track at both ends of the single-track territory from Bena to Tehachapi will be extended to the next siding as indicated by the dashed lines on the condensed track plan. The end of double track at the west end will then be located at Ilmon. Similarly the end of double track at the east end will be at Cable. This will reduce the single-track mileage eight miles. It is also planned ultimately to control all of the remote power switches in this territory from a central point, thus eliminating train orders.

Automatic Crossing Signals Used in Congested District

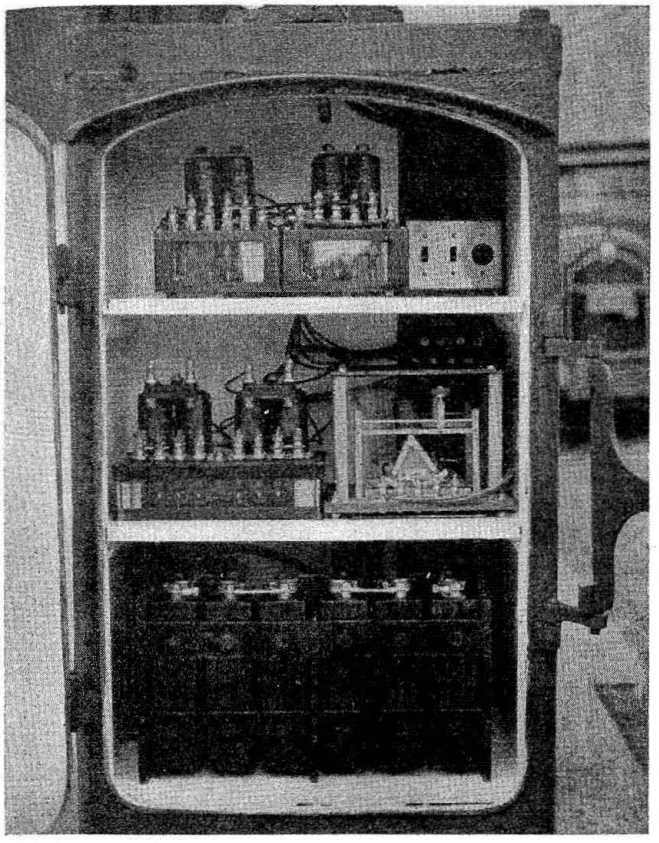
Equipment and unique control circuits solve difficult problems on Manufacturers Railway in St. Louis — $9,000 saved annually

THE Manufacturers Railway, a terminal company operating in the industrial area of St. Louis, Mo., has recently completed an installation of automatic flashing-light crossing signals at 11 street crossings. The traffic consists entirely of slow-speed switching movements into and out of various power houses, manufacturing plants and warehouses. The crossings were previously protected by crossing watchmen, on duty during the hours of switching. The desire on the part of the railroad to make a change in the type of protection was occasioned by the increasing number of accidents to automobiles on these crossings. Broadway is a heavily traveled street with a car line, while Seventh street is a boulevard with fast passenger automobile traffic. Traffic was so heavy on these streets that watchmen on the ground could not stop the automobiles when trains were approaching. In fact, one watchman was run over and killed by an automobile.

With the idea of providing better protection, the railroad secured permission from the city and state authorities to install flashing-light crossing signals with vertical "STOP" light units on Broadway, the installation being placed in service in June, 1927. These signals were controlled automatically by the track circuits extending about 200 ft. in each direction. These tracks are laid in the middle of Dorcas street and, therefore, many difficulties were encountered in bonding the joints and installing the insulated joints. During the first few months that this installation was in service, no accidents occurred, and after a thorough inspection the state and city authorities approved the installation. This approval was of considerable importance, because the ordinance permitting the railroad to operate over tracks in the street required that watchmen be on duty at the crossings. After the signals on Broadway had demonstrated the effectiveness of this type of protection, permission was granted by the city and state authorities to install signals at the remaining crossings as shown in the diagram.

The signals include, the Signal Section flasher lights, an illuminated "stop" sign and a bell

Color-light signals, designated as indicators are used for the information of the enginemen



Relays and battery are housed in the same case

The entire system is meeting the need for additional safety to street traffic, the number of accidents being decidedly reduced. Although this increased safety was the primary object in providing the signals, it so happens that the wages of the 16 crossing watchmen who have been relieved, represents an annual saving of about $12,000, while the maintenance and operation of the signals, including interest and depreciation, is only about $3,000 per year. In other words, the signals afford increased safety and save $9,000 annually.

The signals are all controlled automatically by track circuits. On account of the slow speed of all movements, the track circuits are short, in most cases provided in approach of the signals. Ohio Brass Company gas-welded rail bonds were applied to all track circuits. In many cases, it was considered better practice to throw these short track sections in series to provide better shunting of the relays. Owing to the short distances between some of the signals, it was necessary to overlap the controls. Various movements are made, back and forth over these crossings, while pulling and setting cars on the different house tracks. Special circuits had to be designed for the control of the signals at each crossing.

As an indication to the engineman that the crossing signals are in operation as a train approaches, two-indication color-light signals are provided at each street. The green light indicates that the signals are

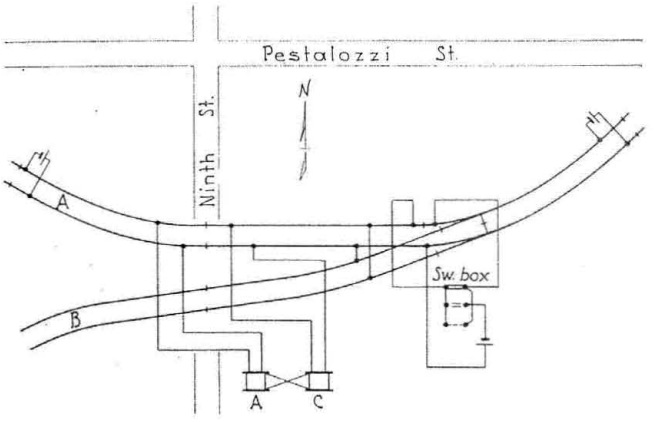


Fig. 2—Track circuit arrangement which accomplishes desired operation for busy switch leads

operating and, in case the signals are out of order, a red light is shown instead of the green. These color-light units are the same size as those used for the flasher crossing signal units.

These indicators, in connection with the crossing signals, are utilized at one point to provide interlocked automatic signal protection for the crossing of two railroad lines. One track running down the center of Second street is crossed by the main lead coming out of the "Bevo" plant. Trains on the "Bevo" switching lead, or the track to Dorcas street, operate the flashing-light signals on Second street. The indicators, shown as *X* on the diagram, have at this location three color-light units, two green and one red. The red indicates to an engineman that either the flashing signals are out of order or else a train is approaching on the cross line down Second street. One green light indicates that the flashing signals are operating and the other green light indicates that the cross track is unoccupied.

It is the practice to leave cars standing for several hours at a time on the track sections marked *A* and *B* in Fig. 1. A special circuit is provided to cover this circumstance so that the flasher signals will not operate continuously. Push buttons are arranged on the posts of the indicators *X*, which in effect cut the track circuits *A* or *B* out of the control for the signals involved.

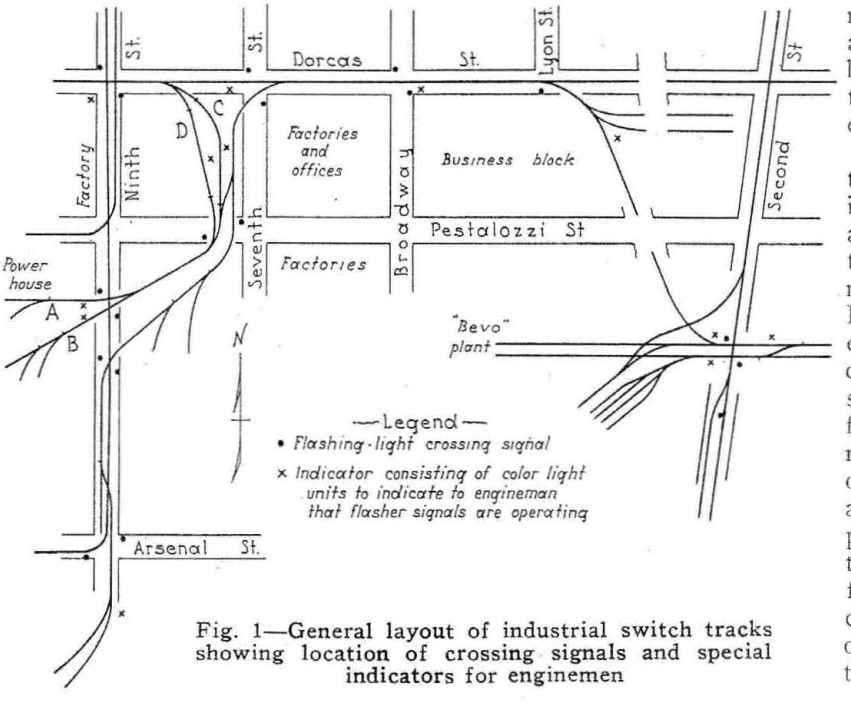


Fig. 1—General layout of industrial switch tracks showing location of crossing signals and special indicators for enginemen

In order to prevent an engine from pulling these cars out over a crossing with the signal inoperative, indicator signal *X* indicates red until the push button switch is open, at which time the flasher signals are returned to normal control, and, when operating, the indicator changes from red to green and the train can proceed.

The plan shown in Fig. 2 applies to the two crossings of Ninth street, just south of Pestalozzi street. A switch engine pulling cars out of track *A*, down past the switch to *C*, would cut out the interlocking relay and stop the signal when the rear truck passed Ninth street. If the next move is to push the cars up track *B*, which is a regular movement, the signal would not indicate for the approaching train because the *C* side of the interlocking relay is on the hook. In order to accomplish the desired purpose, the circuit shown in Fig. 2 was used. When the switch is thrown, the contact made momentarily at the central portion of the stroke of the switch circuit controller feeds battery to the track to pick up the *C* side of the interlocking relay to get it off the hook, Therefore, as the circuit controller completes its stroke, the track circuit is returned to normal feed, which is shunted by the cars so that the *C* side drops to make contact that operates the signals. The same operation would follow for a move from *B* to *C* and then to *A*.

These are only a few of the unique circuit arrangements designed to solve the problem of providing automatic control for all of the flasher-light crossing signals. The signals, relays and accessories were furnished by The Railroad Supply Company and the circuits were designed with the co-operation of the engineering department of this company. The signals were installed by the forces of the Manufacturers Railway Company under the direction of Hollis Marsh, chief engineer, to whom *Railway Signaling* is indebted for the information in this article.

Pacific Electric Has Signals on Its Busiest Sections

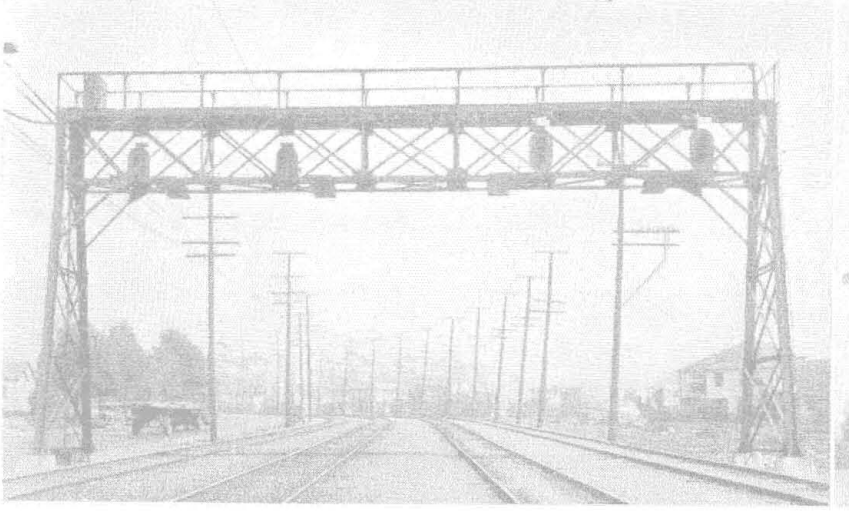
AUTOMATIC block color-light signals have been installed on numerous short sections of heavy traffic lines of the Pacific Electric Railway, an electric interurban line, operating out of Los Angeles, Cal., and reported to be the largest all-electric railway line in the world. This road has 615 miles of road or 837 miles of equivalent single-track line. The two most extensive stretches of automatic signaling are on the lines running to Venice, Cal., to San Pedro harbor, to North Long Beach, to Glendale and to Oneonta. To protect users of the highways at highway-railroad grade crossings on the Pacific Electric System, a total of 584 autoflags have been installed.

A-C. Color-Light Signaling

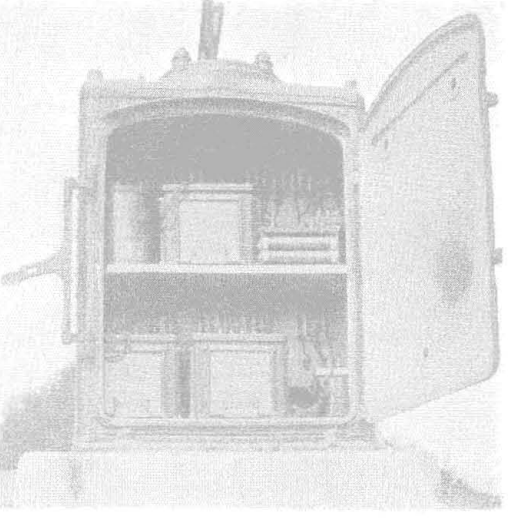
A brief description of a recent installation of signaling on the Pacific Electric will suffice to give an idea of the type of automatic signaling installed on this railroad. The signaling of a three-mile section of four-track railroad between Newton Park (in Los Angeles) and Oneonta is typical of practically all Pacific Electric signaling. During rush hour periods, the headway between trains is two minutes. Union Type-H color-light signals, having green, yellow and red signal lamps, are mounted on four-track signal bridges spaced one-half mile or less. The lamps are 115-volt, 36-watt and are operated without any storage battery reserve. Owing to the 600-volt d-c. propulsion current, all of the signaling is of the a-c. type. An unique feature of this installation is that, on account of there being a highway on each side of the tracks, the right-of-way is only 60 ft. wide. There is exactly sufficient room to erect a four-track signal bridge and maintain the standard clearance with the relay cases on the top decks of the bridge.

Track Circuits

The track circuits in every case extend the length of the block, the track transformers having 110-volt primary windings and variable secondary steps from 1.5 to 15 volts. The track relays are the two-position, Model-15, while the line relays are the 110-volt vane type. The local elements of the track relays are wound for 110-volt operation. All of the rail bonding was applied with the aid of the electric arc and by electric brazing. Union impedance bonds with a carrying capacity of 1,000 amp. per rail are installed between track circuits. Switch indicators are used at all main-line switches. These indicators are designed for 110-volt a-c. operation. Track circuit connections to the signal bridges are carried in wooden trunking to the legs of the bridge. From there the wires are carried in conduit to the relay case mounted at one end on top of the bridge.



Union Type-H color-light signals are mounted on four-track signal bridges spaced one-half mile or less



Alternating current relays are employed—Transformers have steps from 1.5 to 15 volts