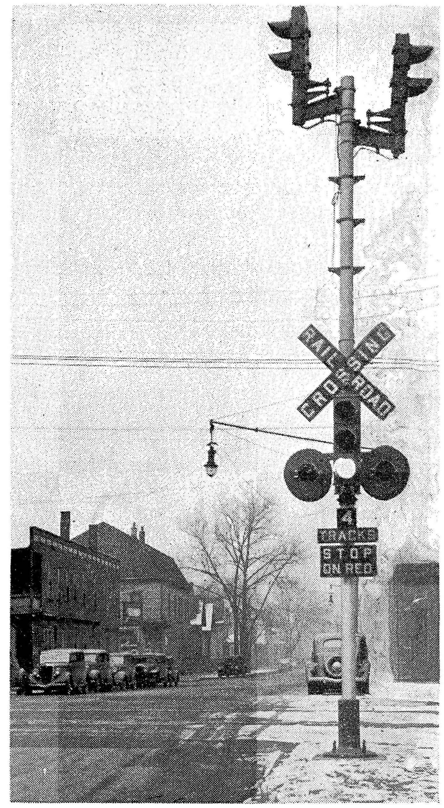
Crossing Protection Includes Signals for Directing Trains

Michigan Central installation on the Belt Line involving 17 crossings eliminates six interlockings and eight manually-operated crossing gate layouts



Combination signal as viewed by motorists

As a Means of providing more adequate protection to motorists and street railway traffic, expediting traffic of all kinds, and effecting economies in operating expenses, the Michigan Central has now completed a street crossing signal project of major proportions in Detroit, Mich. Involving 17 city street crossings, six of which include one or more tracks of the Detroit street railway, the new signaling has made possible the retirement of six interlockings of various sizes ranging up to 20 levers, some with derails, and 8 manually-operated gate installations. Five crossings formerly requiring watchmen are now protected by automatic signaling particularly adapted to each location. Manual controls have been provided at certain of these crossings to supplement the automatic controls and these are operated by switching crews by means of key circuit controllers.

Within Detroit, the Michigan Central operates the Belt Line branch in serving a series of industries from Wight avenue to Mt. Elliot avenue near the Belt Line junction, a distance of approximately 3.5 miles. The 17 street crossings mentioned are included within this distance, together with ladder tracks, turnouts, crossovers and sidings to the extent required in serving the adjacent industries. The track configuration is such that the number of tracks crossed by the various streets ranges from only one at Gratiot avenue to 12 at Charlevoix avenue, and both of these include double-track streetcar lines in addition to motor-traffic lanes.

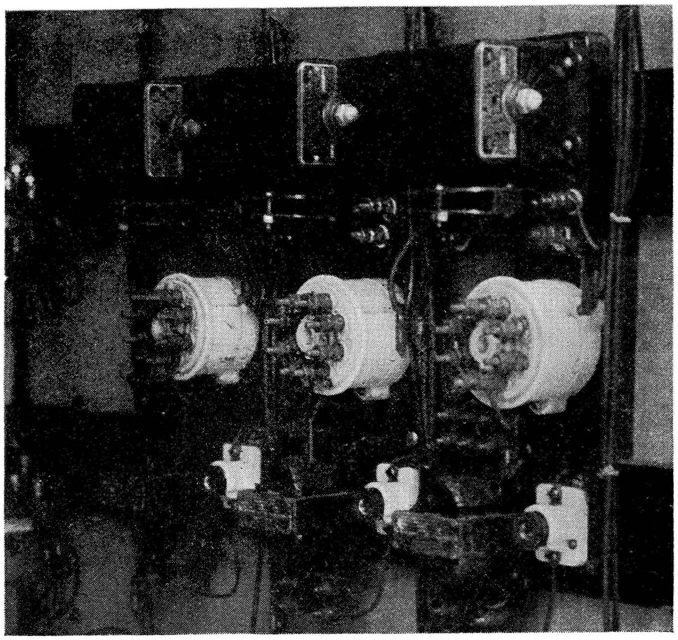
Under these circumstances an inclusive statement as to the number of switching movements over these crossings cannot be made, especially in view of the fact that the number of "through" movements is small in comparison with those arising from ordinary switching. Of course, no passenger trains are run over these tracks. Nevertheless, it is estimated that on one of the busiest crossings a total of 50 train movements has been made within a 24-hour period. Motor traffic, on the other hand, is unusually dense at certain of the crossings involving multiple tracks. Vernor highway, a wide city thoroughfare, is an outstanding example, involving nine tracks. This is one of the main traffic arteries leading from the downtown area to outlying business and residential districts.

Considering the various factors involved in the problem of providing adequate protection for motor and railway traffic alike, under conditions prevailing on the Belt Line branch, it is apparent that a satisfactory solution is by no means simple of attainment. The possibility of extensive grade separation is recognized, but the obviously prohibitive cost of such a project makes it utterly impracticable from the standpoint of the railroad and also the city. Furthermore, a crossing flagman cannot easily give proper protection on a busy thoroughfare which crosses as many as nine switching tracks, without considerable hazard to himself. The use of manually-operated crossing gates has been found to involve excessive maintenance and operating expenses, and gate breakages have been frequent. Delays to motor traffic have also been found objectionable at certain of the gate installations.

Traffic Signals Co-ordinated With Railroad Signals

After thorough study and negotiation with civic authorities, occupying a comparatively long period of time, agreement was reached on a new type of signaling, the features of which are unique in character.

All of the street crossings involved in the recently-completed installations are equipped with standard flashing light signals mounted back to back. Each signal mast is also fitted with reflectorized number-of-tracks, stop-on-red, and railroad-crossing signs, together with a bell, in accord with the standard requirements of the Michigan State Highway Commission. The flashers are controlled automatically by approaching trains in the conventional manner. In addition to this equipment each signal unit incorporates a two-way, three-indication traffic signal of the type used throughout the city for motor traffic. These normally display green indications, changing to yellow and later to red upon the approach of a train.



Part of the a-c.—d-c. track-circuit equipment at Vernor highway

As all train movements in this locality are made at low speed, there is no necessity for the usual kind of automatic block signaling. The unusual feature of the crossing signal protection, however, is that two-indication color-light signals govern train movements over the crossings. These signals face in both directions parallel with the track, and apply to all approaches to the crossing. Normally displaying a red indication the railroad signals automatically change to the yellow aspect upon the approach of a train.

The yellow indication is not immediately displayed owing to the time-delay apparatus which withholds the proceed aspect for a definite time interval after the flashing lights have begun to operate. In no case is it possible for the railroad signals to display a permissive aspect coincident with the green or yellow aspect of the traffic signals; the reverse is also true. In a sense, therefore, such an installation is like a modified automatic interlocking wherein one route is normally set up while the opposing route, after due delay, can be set up whenever a counter movement is impending. Of course, there is no relation between occupancy of the crossing by a vehicle and the operation of the signals.

Mounting of Signal Units

The signal units at each crossing are mounted to meet local requirements with respect to clearances and view from the approaches. Some of the crossings involving several tracks have two railroad signals for each direction of traffic, one on each side of the tracks. Others have one unit for each direction, situated between the tracks, where clearances permit. Separate masts are used for each signal in some instances; in others two units are mounted on brackets on the same mast, which may also be used for the traffic signals and flashers.

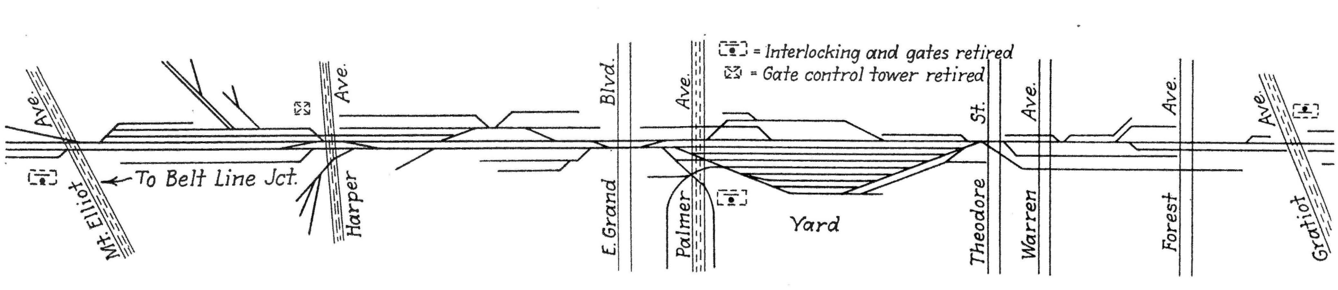
Certain of the traffic signal units are suspended from cantilever supports; however, the flashers and signs are fixed to the mast at the curbing. In such cases the cantilever arm serves also as a track over which the traffic signal can be slid toward the pole for inspection or maintenance. In doing this the maintainer disconnects a rod from the signal mast and draws the units within reach. A special seven-conductor rubber insulated cable with woven web protection extends along the cantilever arm to the signal units.

The railroad signal masts are of sufficient height to enable trainmen to see them even though a row of cars may be occupying an intervening track. Where more than one signal is provided, one or both can be seen by approaching switching crews. The accompanying illustrations are representative of the various methods employed in mounting the signal groups.

Operation of the Signals

As has been indicated, each motor-traffic signal mast is fitted with two three-color traffic signals of the conventional type, mounted back to back, there being one such pair for each street approach. These signals are designated inner and outer signals as they face either toward or away from the crossing. Using these designations, the operation of the signals for an uninterrupted train movement is as follows:

When no trains are occupying the crossing or the approaches, the traffic signals are green, railroad signals are red, flashers are dark, and bells are silent. Immediately after a train occupies an approach track circuit the flashers function



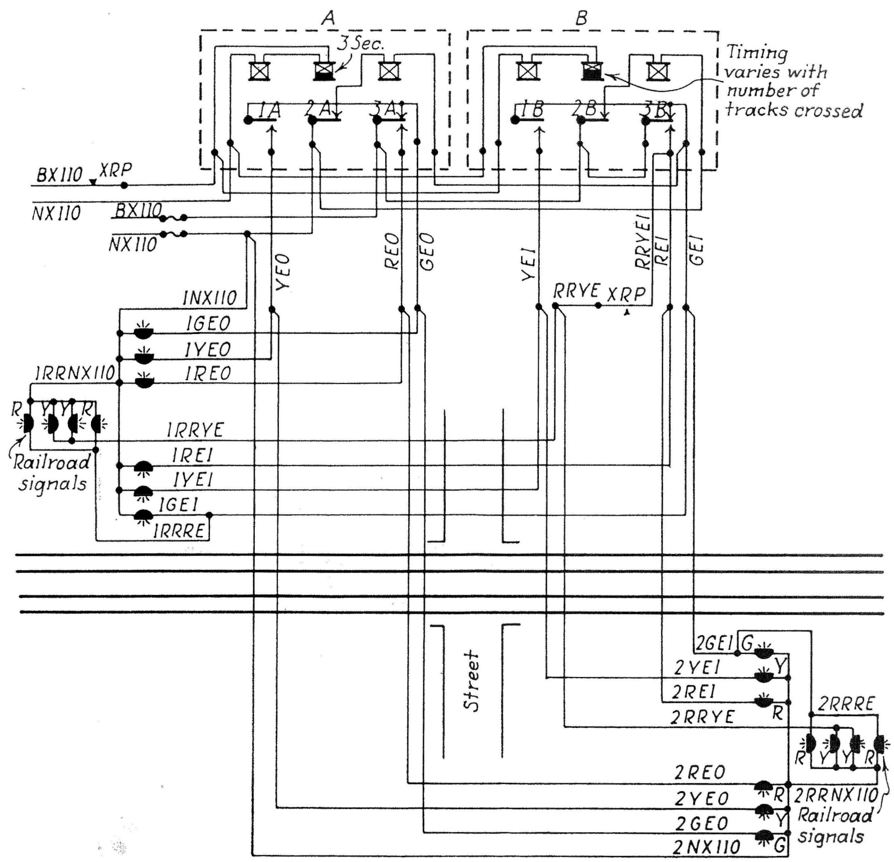
Track plan showing industrial area served by the Belt Line branch—Automatic railroad and motor-traffic and the traffic signals display a yellow light in addition to the green. After a three-second warning the "outside" traffic signals change to the red aspect. The "inside" traffic signals, however, retain the yellow-green warning aspect for a longer period, depending on the number of tracks and depth of the street crossing. After this additional time interval has elapsed, the inside traffic signals also change to red, whereupon the railroad signals show the yellow aspect authorizing a train movement over the crossing.

The control track circuits are of such length as to establish signal authority for the railroad within the time required for a train to pass from the beginning of the track circuit to the crossing in a typical movement, all street traffic meanwhile having received ample warning and the way cleared. The time-delay feature applying to the inside traffic signals enables a motorist occupying the crossing to proceed without being confused by a red traffic light, which might cause him to stop on the track. At the same time the inside signal gives a warning yellow-green aspect. The bells operate simultaneously with the flashers.

Thus, motorists must ignore or fail to see the warning signs, two traffic type signals, two sets of flashers, fail to hear the bells, or overlook the train itself before they proceed over the crossing in conflict with a train. Excepting through willful disregard, failure to observe and obey such signal protection seems highly improbable and remote.

Special Circuits and Apparatus for Time-Delay Functions

The timing of the traffic signals is accomplished by the operation of two three-element mercury-type relays. These are illustrated in the accompanying circuit diagram as relays A and B, the separate elements being designated as 1A, 1B, 2B, etc. The A group controls the outside traffic signals and the B group the inside. Considering the former, it will be noted that relay 1A is normally energized in series with relay 2A and a contact in the main control repeater XRP, from a 110-volt a-c. source. Moreover, relay 2A has a three-second slow-release characteristic, for the purpose of providing the three-second yellow warning on outside signals. It will be noted, further, that relay 3A is energized through a front contact of 2A and is, in consequence, subject to the slow-release feature of 2A.

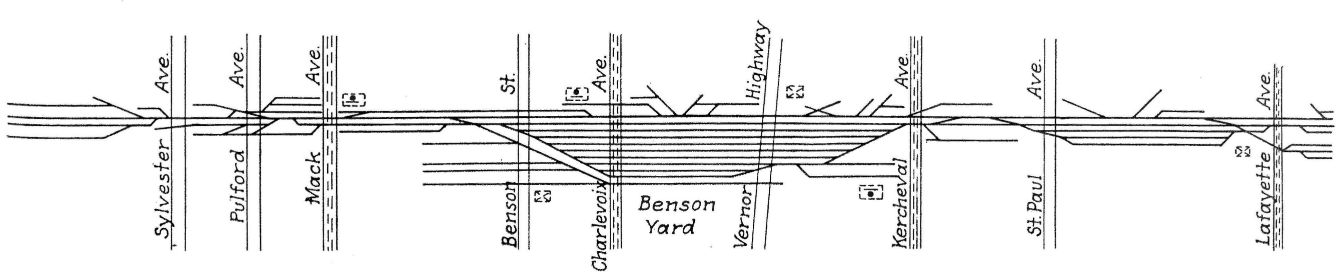


Wiring scheme for railroad and traffic-type signal control

When an approaching train de-energizes XRP, relay 1A immediately drops and, through a back contact, lights the two outside yellow traffic lights. As 2A has a three-second slow-release feature, 3A remains energized during this interval. A front contact in 3A completes both the green and yellow light circuits for both outside signals. After 3A drops, a back contact of 3A feeds energy to the outside red units only, until the closing of contact XRP restores the controls to normal.

The operation of the B relay group and the circuits for the inside units is precisely the same as that of the A group except that 2B may be adjusted to hold the yellow-green aspect on inside traffic units up to a maximum of 20 seconds to accommodate traffic at a multiple-track layout. This unit is carefully adjusted in the field to meet local requirements.

The restrictive aspect of the railroad signals is provided by a circuit connected in parallel with the inside green traffic units. The yellow or permissive unit is fed in parallel with the inside red traffic signals. In this manner the conflicting sig-



signals are now in service at each crossing in place of interlockings and manually-operated gates or flagmen nals are self-interlocking. This scheme is used in the control of all of the major street crossings within the Belt Line industrial area.

Contrary to usual practice, the track circuits in these installations need not fulfill the requirements providing for broken-rail protection and the expensive precautions against interruptions required for interlocking and block-signal operation; for irregular operation cannot cause delay to scheduled trains as there are none. Furthermore, in failing to operate properly, the track circuits cannot deprive the street traffic of full protection, because the circuits are designed for normally-red railroad signals. Such failures are of minor importance since manual controllers are available to the switchmen in every instance.

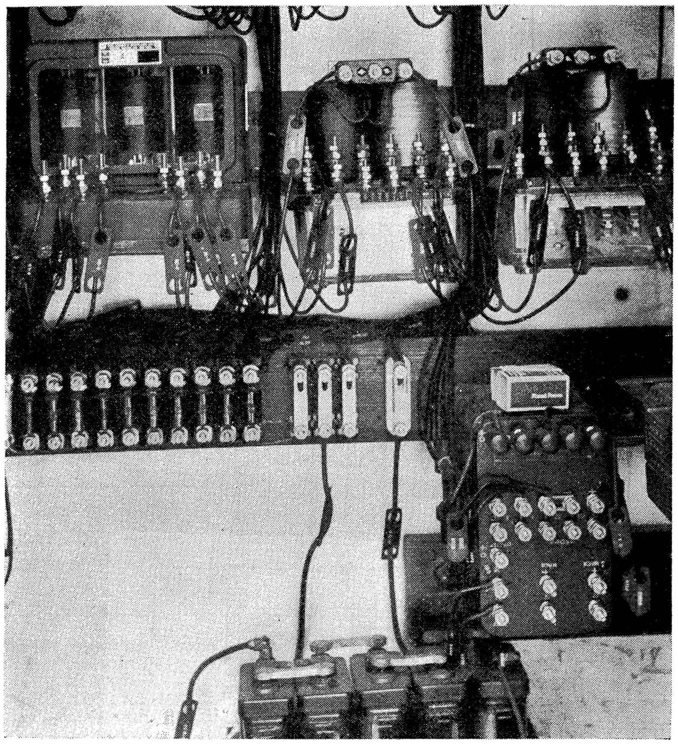
For such applications the economy of alternating-current track circuits without stand-by transfer equipment is obvious. Still further economy of design is attained by housing the a-c. supply and all relays for one crossing location in one housing, including track relays. As a consequence, no outlying housings and very little outside wiring other than the underground cables to track bootlegs, manual controllers and to the signals are required.

Each track circuit consists of a 100 to 400-ft. section of track in which one rail only is insulated. A Type-K½ transformer feeds the circuit through a limiting resistor directly from the central housing. In addition, a full-wave rectifier is connected across the track leads and across a 4-ohm d-c. track relay. Thus, the track leads and rails constitute a multiple shunting circuit only and are not a part of the relay feed in the ordinary sense. Properly adjusted, these track circuits have been found to be entirely satisfactory, functioning as intended.

Power for the track circuits, lights, bells and rectifiers feeding the d-c. control circuit combination is supplied by the Detroit Edison Company at each crossing location. Each 110-volt circuit runs to a separate pole-mounted housing containing the metering, main fuse and switch equipment. Experience with the utility company has demonstrated the reliability of the a-c. service to the extent that stand-by supply was considered unnecessary, especially in view of the fact that no hazard would be created should there be an outage. Switchmen are instructed to protect the crossing by flagging for all movements not authorized by the regular signals.

Owing to the necessity for d-c. stick-relays in the control combination a provision for maintaining the proper stick-relay setup is essential, in event of an a-c. interruption. For this purpose each main relay housing includes a 10-volt Exide battery made up of 2-plate cells, of sufficient capacity to bridge over any ordinary contingency. Raco resistors are used in maintaining the proper load balance to each circuit. A G.R.S. full-wave rectifier supplies the d-c. "bus" for relays only and maintains the battery on trickle charge.

All of the signal lights, excepting the flashers, are operated at 110-volts a-c. with 60-watt lamps. The flasher units require a separate 10-volt a-c. circuit, with 18-watt lamps and a Type-K flasher relay. At a crossing equipped with four railroad signals and four traffic units a minimum of approximately 480 watts is continuously expended for crossing protection in addition to that required by the track and control circuits.



One of the two mercury-element timing relays (upper left) at Vernor highway—Control circuit standby battery below

Key Controllers Important

The successful operation of the Belt Line crossing signals is in large measure dependent upon the proper manipulation of the various key circuit-controllers located at strategic points. Owing to the nature of the railroad traffic, exclusively switching, the variety of train movements is diverse. In many instances a cut of cars must be left on an approach to a crossing while the locomotive proceeds across only to return later. The use of crossovers, switches and sidings further complicates the situation with respect to control circuits. For these reasons automatic controls cannot easily be sufficiently flexible to protect the traffic for all train movements and at the same time minimize false warnings. It is well known that false-danger traffic indications generate a contempt for the signaling system, in the minds of motorists. In recognition of these important factors the railroad has made liberal use of the key stations to insure correct indications.

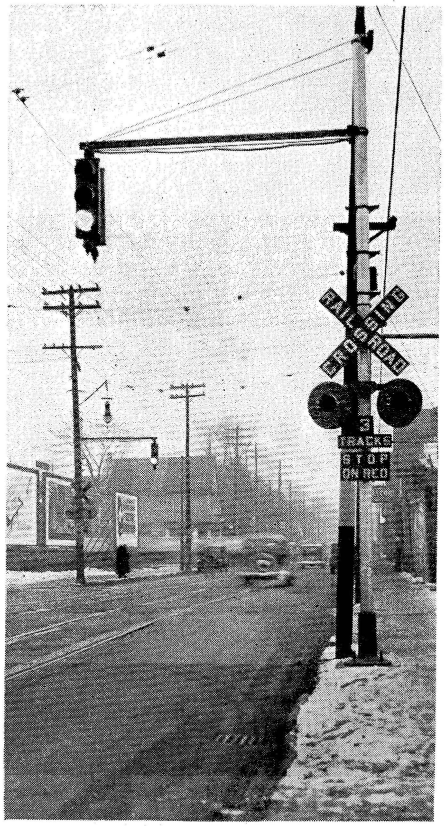
Three kinds of key stations are in use to provide (1) manual operation, flashers "on" or "off," (2) automatic operation "cut in" or "cut out," and (3) combination automatic and manual operation, depending upon subsequent switching operations.

A typical application of the manual controllers involves the use of an approach to the crossing not equipped with a track circuit. The diagram of the Vernor highway layout indicates that a movement over any of tracks No. 1 to No. 6 would require manual control. In order to permit car storage, these tracks have not been equipped with approach circuits. The short energized track sections spanning the crossing, however, serve to enforce the crossing clearance requirements, and, further, to permit a trainman to cancel the manual control set-up while his train is still occupying the crossing, holding the traffic signals at "stop" until the last car clears the circuit. A counter-clockwise movement of a switchman's key in a manual controller breaks the holding circuit of a stick relay which, in turn, interrupts the XR, main controlling circuit. A clockwise movement restores the stick relay circuit, completing the XR circuit and freeing it from the manual set-up.

Use of the "automatic operation" key controllers is typified by a movement involving the use of a turnout within an approach track circuit but *not* requiring use of the crossing. Track circuits 5T and 1T at Vernor highway are of this type. It will be noted that "automatic" stations have been provided at each of the switches included. With 1T or 5T occupied, a counter-clockwise key movement energizes a stick relay which, in turn, bridges around the 5TR and 1TR breaks in the XR circuit, voiding the automatic operation. If a movement involving the street should then become necessary, a clockwise movement of the key restores automatic operation by breaking the stick circuit previously set up. Should the switching crew leave the locality without resetting the controls, the pick-up of 5TR and 1TR interrupts the stick circuit restoring automatic operation automatically.

Use of Auto-Manual Controllers

The diagram of the Vernor highway layout shows that the short track circuit 8T includes tracks No. 4, No. 5 and No. 6, connected in multiple. Moreover, these three tracks originate from a ladder track at points 400 to 600 ft. from the crossing toward Kercheval avenue. Therefore, an auto-manual control station has been located near the



Typical cantilever mounting at Lafayette

three switches leading to these tracks. When a movement involving the crossing is anticipated, the key controller is actuated, breaking the holding circuit of a stick relay and initiating the railroad-signal clearing cycle at the crossing, via the XR relay as usual. By the time the train has reached the crossing the street has been cleared of traffic and the railroad signal changed to yellow, thus avoiding delay and confusion.

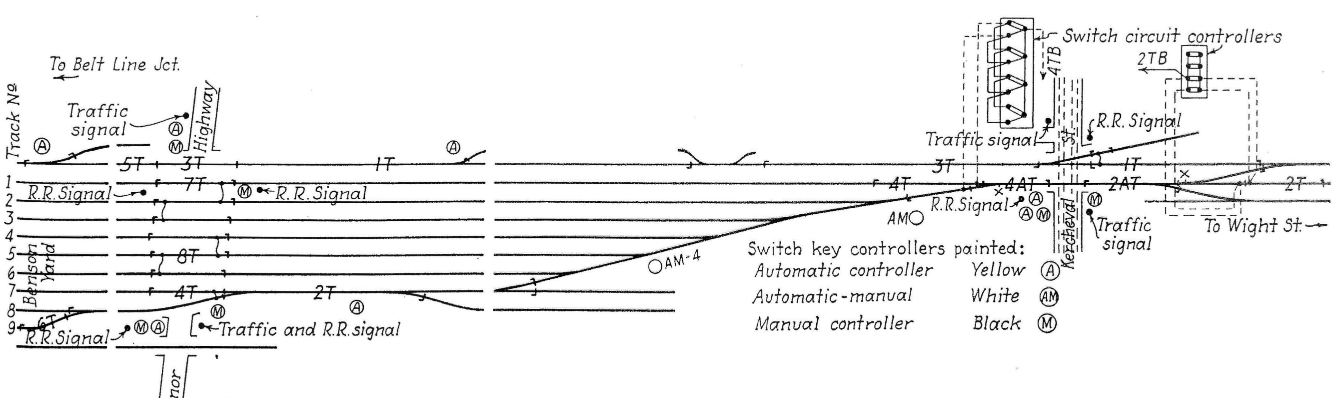
Occupancy of 8T at the crossing automatically restores the stick-relay set-up and normal operation. On the other hand a clockwise movement of the key at station AM-4 serves the same purpose. A similar auto-manual station is situated at the opposite end of tracks 4, 5 and 6 in Benson yard for the same purpose.

These three examples of key controller applications are typical of the entire crossing signal project. Other crossings are perhaps simpler than Vernor, but the principles are the same. The key circuit controllers are of special design, having mercury tube contacts which minimize maintenance and contact resistance. The three kinds of key stations are painted yellow, white and black in order that their function may be easily determined. Switching crews have been carefully instructed in the use of the manual controllers.

Kercheval Interlocking Eliminated

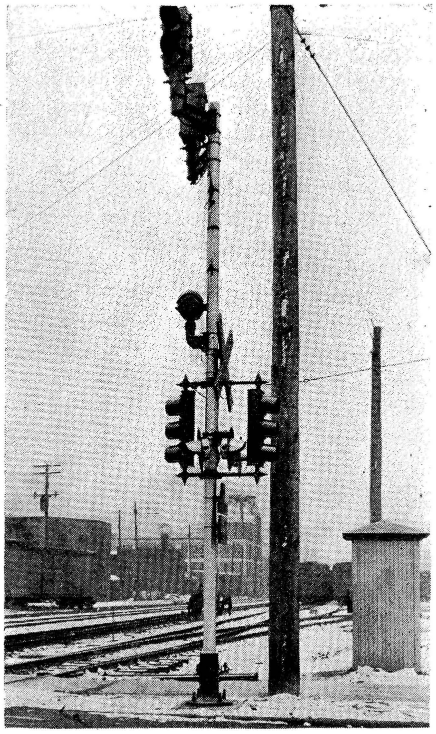
At Kercheval avenue three railroad tracks are involved in addition to double track of the street railway paralleling the street. At this point, a mechanical interlocking with derails protected the rail traffic and manually-operated gates the motor traffic. Both were eliminated upon completion of the present signaling.

The approach track circuit 2T at Kercheval is approximately 300 ft. in length to provide for a continuous movement across the street. In many instances, however, it is desirable to leave a cut of cars on this approach and use the crossover for switching to the other track. In order to eliminate false signal operation in this event, a switch circuit controller has been installed at the crossover switch for shortening the approach circuit 2T.



Vernor highway and Kercheval avenue layouts illustrating track circuits and key control stations

Similarly, a turnout on the other side of Kercheval separates two tracks of about equal importance. A switch circuit controller at this



Combination signal as viewed by enginemen

switch transfers part of the approach circuit 4T from one track to the other, providing for the next movement and permitting a car to stand on the circuit, depending on the position of the switch, without affecting the signals. This design has been effectively applied at several other crossings.

Directional Control Relays

Owing to the double crossing frogs of the street railway, the use of a short track circuit spanning the street is impossible. This and other factors prohibit the use of interlocking relays in the control circuits. Consequently, each approach track relay or its repeater is wired in a stick-circuit arrangement to prevent signal operation while a train is trailing off the circuit.

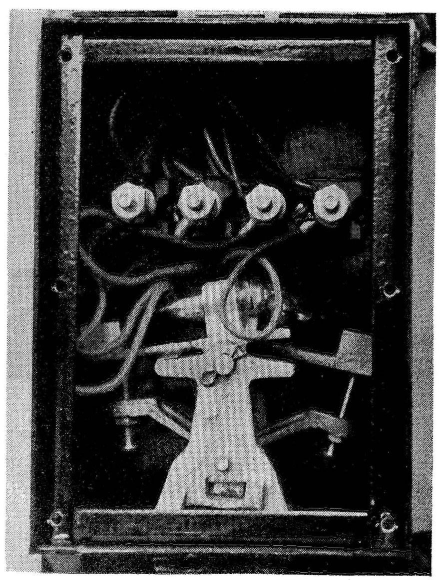
In order to avoid loss of direction and signal protection while a light engine or the rear of a train passes over the frogs (outside the track circuit) a thermal relay has been incorporated in the feed to each XR circuit. These relays are so connected that an operating relay cannot be energized, once it has been dropped, without the thermal element being heated, imposing a time delay. The time interval is adjusted to enable the light engine or rear of the train to proceed clear of the crossing without loss of signal authority. The various XR relays jointly or separately initiate the signal clearing cycle as well as operation of the flasher relay.

All of the concrete foundations for the signal apparatus were poured in place from concrete mixing trucks. These were furnished by a local contractor who supplied the concrete for the entire project.

Trenches Dug Across Streets

One of the most difficult problems encountered was the laying of cable across the paved city streets. On account of the width of some of these, the presence of water, gas and sewer pipes, and underground power or communication cables, it was considered impossible and hazardous to push conduit under the paving. Trenches were dug, therefore, in every case where a cable crossing was necessary. Only half of any one street was closed at one time, so that inconvenience to motor traffic was held to a minimum. All of the outside wiring consists of underground trenchlay cable runs; the cable was furnished by the General Cable Corporation.

The signal apparatus is housed in wooden relay houses. The house at Vernor highway is special in that it



Inside view of mercury-tube key-operated circuit controllers

is made of insulating Transit board on an angle-iron framework.

Practically all of the control relays are G.R.S. Type-K units and many of these must necessarily be slow-release as they are used in the stick-relay control schemes. The major portion of the other apparatus, including the flashing signal units, was furnished by the General Railway Signal Company.

These signal projects were planned and installed by the regular forces of the Michigan Central.

Wood-Preservers Meet

The thirty-second annual convention of the American Wood-Preservers' Association was held at Memphis, Tenn., on January 28, 29 and 30. At these meetings, committee reports dealing with various phases of the subject of wood preservation were presented. One of the outstanding reports was that rendered by the Committee on Poles—Pressure Treatments, of which R. H. Colley, engineer of the Bell Telephone Laboratories, is chairman. This report consists of a series of investigations of treated poles which have been in service for varying periods, together with data and recommendations as to the proper penetration of the preservative, giving suggestions as to proper methods of securing adequate penetration. An explanation is included with respect to certain engineering requirements of the existing specifications for the pressure treatment of southern pine poles, as compared with the proposed revision of these specifications, which was submitted for adoption as a tentative standard.

A report by the Committee on Pole Service Records, of which H. A. Haenseler, engineering department, Western Union Telegraph Company, is chairman, included detailed data on the performance of treated poles in 17 extensive installations. For example, the Gulf, Colorado & Santa Fe installed a line of 857 creosoted pine poles between Somerville, Tex., and Temple, in 1921. This line carries both telegraph and signal wires and was erected in soil consisting principally of sand and loam. An inspection in 1935, after 14 years of service, indicated that the poles are all in service and do not show any signs of decay.

Among the papers of interest to railroad men was one by P. B. Stewart of the Union Gas & Electric Co., Cincinnati, Ohio, describing an extensive investigation of the electrical resistance of wood poles. This investigation showed that it is possible to produce pressure-treated pine poles having electrical resistance as high as that of untreated cedar poles, provided they are seasoned properly before treatment. It was also shown that for it to be safe for linemen to handle an energized 5,000-volt line, the electrical resistance of the pole should be not less than 500,000 ohms.