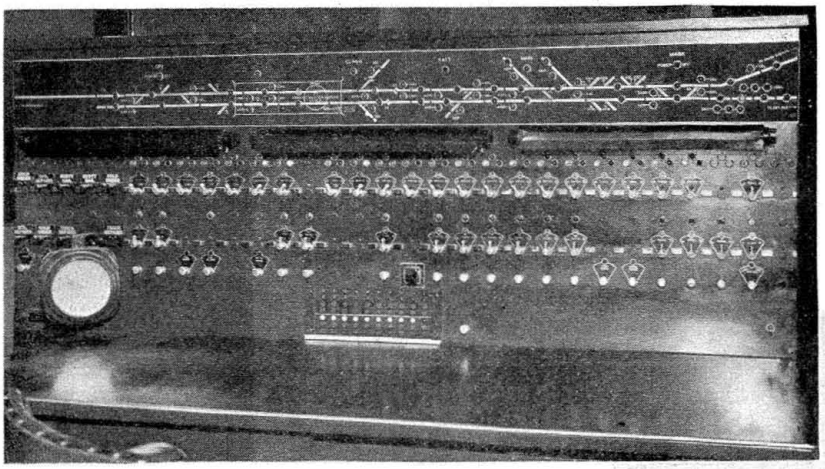
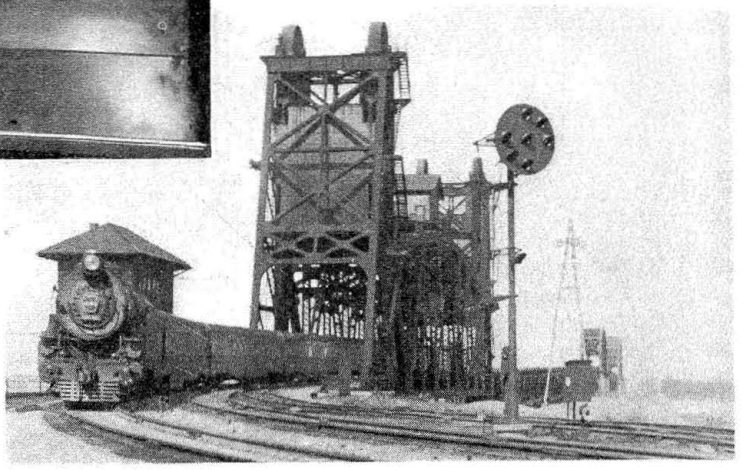


Pennsylvania



Centralized traffic control machine in the tower at Clagg. Right—The "South Wind" inbound leaving the drawbridge

Signaling on the bridge over Ohio river and drawbridge protection over canal, as well as an end-of-double track and three junctions included in project which replaces interlocking

THE Pennsylvania has installed centralized traffic control on 3.08 miles of road and 5.7 miles of track extending from Ore, Ind., over the Ohio River bridge, a drawbridge at a canal, and through three junctions in Louisville, Ky. From Indianapolis, Ind., the main line is single track to Ore, which is the end of the Pennsylvania's freight yard at Jeffersonville, Ind., just north of the Ohio river. A recently completed grade separation project extends from Clagg, on the Kentucky bank of the river, to Mark, overhead railroad bridges being provided to separate grades at 10 street crossings, and 3 crossings at grade were eliminated, in Louisville. The alinement of the tracks was changed in some sections of the route to vacate streets and to reduce curvature, but, in general, the track layout of switches and crossovers is practically the same as previously.

At Ore, the track layout includes two crossovers, No. 15, which is the end of double track, and No. 11, which connects the normally-eastward main track with the yard lead. At Clagg, on the Kentucky side of the river and canal, derails and other protection are provided for the drawbridge over the canal, and also connections are made to the roundhouse on one side of the main line, and to freight houses and team tracks on the other side.

At K. & I. T. Junction, including a single switch and crossover, connections are made with the Kentucky & Indiana Terminal. At Main, including two single switches and a crossover, connections are made with a double track line extending to freight houses and the passenger station of the Illinois Central. At Mark, including two crossovers, one single-track line extends to the Union Station where the Pennsylvania connects with the Louisville & Nashville, and from Mark a second single-track line extends to connect with the Illinois Central main line to Paducah, Ky., and Cairo, Ill. Ownership of the Pennsylvania extends to signal 58L, and between this signal and Mark there are ten turnouts leading to the Illinois Central freight yard and to various industries.

Previous Arrangement

Prior to the grade elevation program, train movements in this territory were directed by manual block, time-tables and train orders. At Ore, power switch machines were in service at No. 15 crossover, which together with the signals formed a remotely-controlled interlocking which was controlled from Clagg tower. At Clagg, a mechanical interlocking included two single switches, two main-line rerails, the signals and protective features for the control of the operation of the drawbridge over the ship canal. The switches and crossovers at K. & I. T. Junction, as well as those at the I. C. Junction, were hand thrown. At Mark, a mechanical interlocking included the two crossovers and signals at that junction. Between Ore and Clagg, automatic block signaling was in service for either-direction operation on the westward track, and for single-direction operation on the eastward track.

Heavy Traffic

The Pennsylvania operates four passenger trains each way daily over this territory, and every other day an additional train, the South Wind, is operated in each direction. The Illinois Central operates three passenger trains each way daily on the Pennsylvainia tracks between Main and Mark. The remainder of the traffic consists of light engine moves between Jeffersonville yard and the roundhouse at Clagg, as well as freight transfer cuts between yards of the various roads or to serve industries. A total of approximately 200 moves are made in a 24-hr. period.

In order to improve safety, expedite passenger train movements and minimize delays for the freight transfer cuts and switching moves, a decision was made to install centralized traffic control, so that all the junction switches and crossovers as well as signals for directing and authorizing train movements throughout could be

Installs C. T. C. at Louisville, Ky.

controlled from a central point, thus obviating time-tables and train orders, as well as manual block, in this territory.

Pedestal Signals Used

In order to secure the maximum utilization of track capacity each of the two tracks on double track are signaled completely for train movements in either direction. In consideration of the fact that the maximum permissible train speed is 30 m.p.h., "pedestal" type home signals are used at K. & I. T. Junction, Main and at Mark Junction. As illustrated in the accompanying views, a pedestal signal is of the position-light type, using only two lights to constitute an aspect of each "arm," in this respect being the same as a position-light dwarf. The pedestal signals are mounted on 3½-in. pipe masts to bring the (neutral) lamp of the top arm 6 ft. above the level of the top of the rail. The high signals at Clagg as well as between Clagg and Ore, are of the conventional position-light type. The dwarf signals throughout are of the conventional position-light type.

Intermediate Signals

The distances between layouts at Mark, Main, K. & I. T. Junction and Clagg are so short that no intermediate signals are required. Eastward signals 26L and 24L, located at the west end of the fixed span on the Ohio River bridge, are intermediate signals, but each is controlled by a lever. The control of these signals is normally stick but if the levers are left in the "L" or "R" positions and the push-button operated, the stick feature is cut out and the signals operate automatically to space following trains and provide protection for the hand-throw switches in the blocks. By placing the respective lever normal, either of these signals can be controlled to the Stop aspect to hold a train, if a move out of one of the hand-thrown switches is to be given preference. In effect, therefore, 24L and 26L are intermediate home signals as well as intermediate automatic signals.

Although certain changes were made in the track alinement as a part of the grade elevation program, the layout of switches and crossovers remains approximately the same as before. Electric switch machines, operated at 20 volts d-c., were installed as a part of the C.T.C. project. The machines formerly used at crossover No. 15 at Ore were continued in service as a part of the new project. With the previous remote control interlocking at Ore, including only the crossover No. 15, forming the end of double track, an eastbound switching train or light engine on the eastward track could not make a move over hand-operated crossover No. 11 into the yard, on close time ahead of a passenger train. To facilitate such moves, power machines were installed on crossover No. 11, home signal 14R was moved back as shown on the diagram and home signal 12R was added.

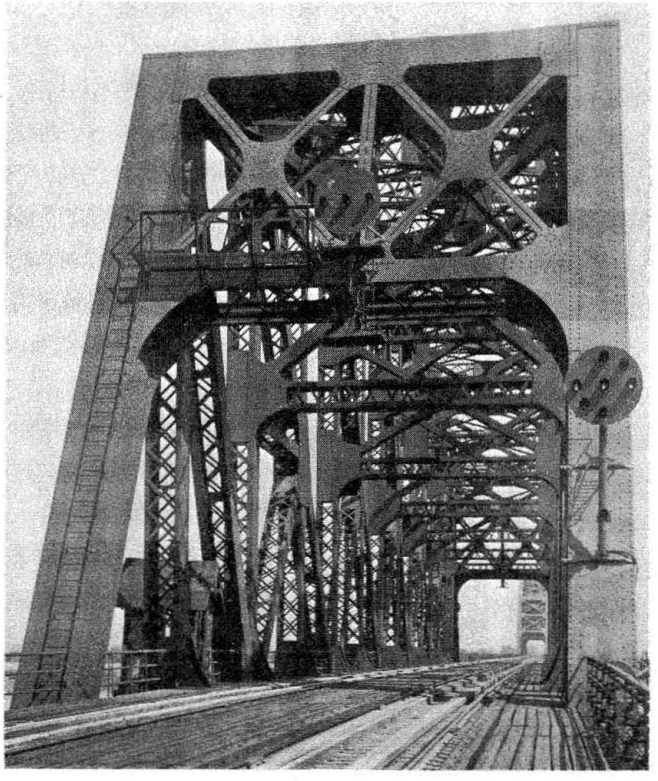
Switch Machine Heaters

To minimize frost and moisture during cold weather, a 65-watt, 110-volt heater unit was installed in the controller housing of each of the electric switch machines. These heaters are cut in or out of service by inserting or removing fuses in the supply circuits.

In addition to the switches and crossovers equipped with power machines as indicated on the diagram, this installation included nine turnouts leading from main tracks to industries. At each of these switches, the previous stand was replaced with Type T-20 manually-operated stand including a facing-point lock with one lock rod and plunger which locks the switch in the normal but not in the reverse position. Each of these stands is equipped with an electric lock which prevents operation of the switch from the normal position unless the lock is released by control from a lever in the C.T.C. machine at Clagg.

Drawbridge Protection

This C.T.C. installation includes protection for the drawbridge over the ship canal, the same as the previous mechanical interlocking at Clagg which was removed. The two eastbound main-track derails were left in place and equipped with electric switch machines. A switch machine,



Signal 26LA at the south end of Ohio River fixed bridge

on the shore at each end, is pipe connected through a bridge pipe coupler to operate the wedge and rail lock plungers, as well as the bridge-position detector, all of which are located on the corresponding end of the lift section of the drawbridge.

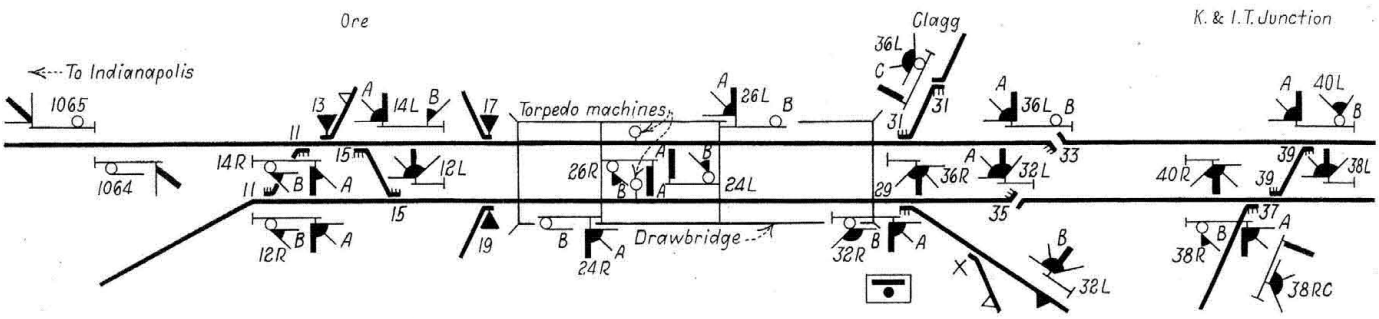
Signals 36LA and 32LA are the two main-track eastward signals for the protection of the draw, eastward signal 32LB governs on the lead from the roundhouse and 36LC governs on the track from the freight house. The westward home signals for protection of the drawbridge are approximately 350 ft. from the draw for special reasons. The fixed span of the Ohio River bridge located approximately at mid-stream, was constructed at an elevation to clear boats. The result is that from the west end of this span, the tracks descend at a grade of 1.4 per cent for the remainder of the Ohio River bridge, and over the drawbridge at the ship canal to the tower at Clagg. Rather than locate the westward home signal for the protection of the drawbridge near the draw, thus requiring trains to stop on this descending grade if the draw were open, the westward home signals 24R and 26R were located at the east end of the fixed span at the crest of the grade. The use of derails on the Ohio River bridge, as protection when the draw over the ship canal is open, would not be practicable. Torpedo machines were used previously and are continued in service. The machines place ordinary track torpedoes on the rails prior to opening the drawbridge. Only if and when trains inbound to Louisville pass either signal 26R or 24R, in the Stop position, with the controls set up for the draw to be raised, will the train hit the torpedoes. In order to make switching moves and light-engine moves into and out of the roundhouse and freight house tracks, without running the entire distance up the grade to get beyond signals 24R and 26R, additional home signals 32R and 36R were located close to the facing-point switches 29 and 31, respectively.

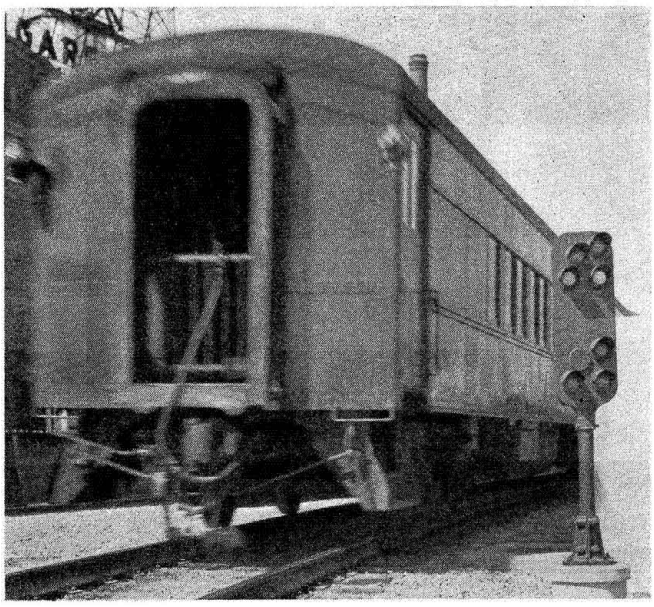
Locking of Switch X

The spacings between tracks and the lengths of tracks available for storing locomotives, and other local conditions, made it desirable not to use a power switch machine on switch X on the lead to the roundhouse. For this reason, this switch is equipped with a hand-throw stand which is pipe connected to two derails at the clearance points. A facing-point lock on this switch is operated by a second hand-throw stand equipped with an electric lock which prevents raising the operating lever from the normal position. The control of this lock is automatic in that it is released at all times when all main-line signals involved are displaying the Stop aspect and no trains are within home signal limits. Signal 32LB governs moves on either of the two tracks. This use of the hand-throw stand at switch X, together with the facing-point lock and electric lock, provides an arrangement which meets the special requirements.

The C. T. C. Control Machine

The C.T.C. control machine is located on the second floor of the tower at Clagg, in approximately the same position as the previous mechanical interlocking machine. This C.T.C. machine has 16 levers to control 32 signals, 13 levers to control 20 single switches and crossovers, 1 lever to control two torpedo-placing machines, 1 lever to control the rail locks and bridge-position detector on the draw, and 5 levers to control electric switch locks on hand-throw switches, as well as 1 lever to control manual block signals 58R and 58L on the I. C. south of Mark.

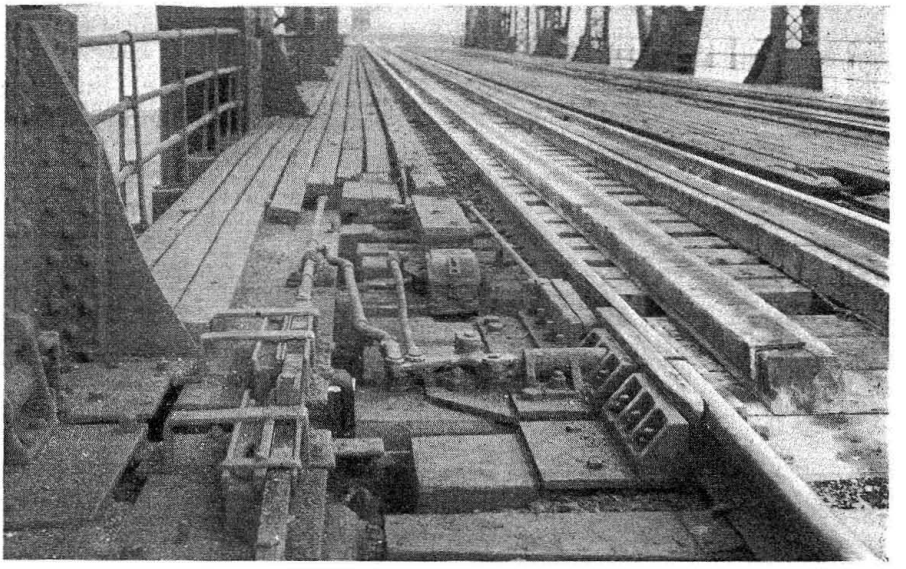




Signal 54L is one of the typical two-"arm" pedestal type

In the illuminated track diagram on the lines representing the tracks, lamps indicate track occupancy of all sections of main tracks. Likewise, each signal is represented by a symbol included in an indication lamp which is lighted when the corresponding signal is displaying a proceed aspect. Above each signal lever there is a single indication lamp which is lighted when the corresponding signal is displaying the Stop aspect. A special feature, therefore, is that both the Stop aspect and a proceed aspect of each signal are indicated on the C.T.C. machine. The signal levers stand normally on center, being operated to the right to clear a signal for one direction and to the left to clear signals for the opposite direction.

Each switch lever has three indication lamps, the left one, green, being lighted when the switch is in the nor-



The bridge detectors and rail end locks are pipe connected to a switch machine on the shore

mal position and locked, and the right one, amber, when the switch is reversed and locked. The center lamp, red, is lighted when the electric switch locking in the field is in effect to lock the switch, thus this lamp informe the leverman that nothing will be accomplished by throwing the lever, in other words, it is a "hands-off" light.

Three indication lamps are provided above each of the levers which control electric locks on the stands of hand-thrown switches. The lamp to the left, green, is lighted when the corresponding switch is normal and locked by the facing-point lock and by the electric lock. The lamp at the right, amber, is lighted when the switch is unlocked or more than 3-16 in. from normal position. The center lamp, red, is lighted when conditions in the field with reference to aspects displayed by signals and track occupancy are such that the switch cannot be unlocked by operation of the lever on the control machine, in other words, the center light is a "hands-off" light.

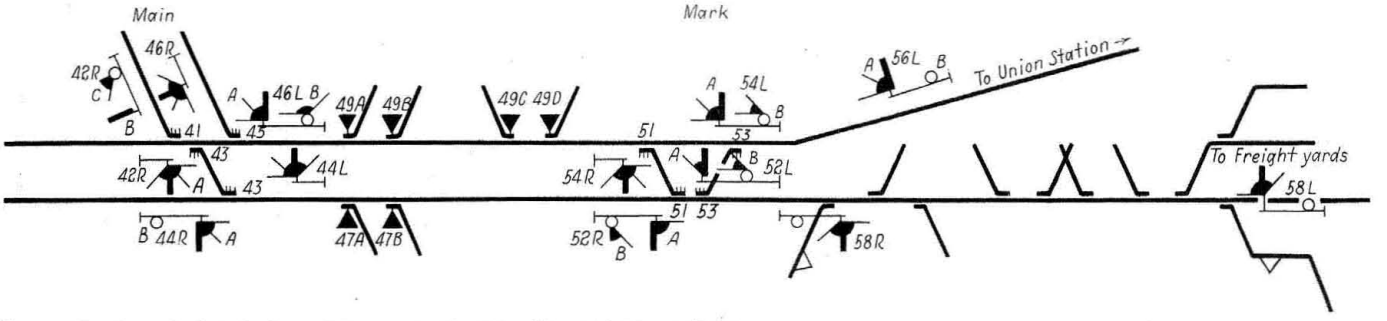


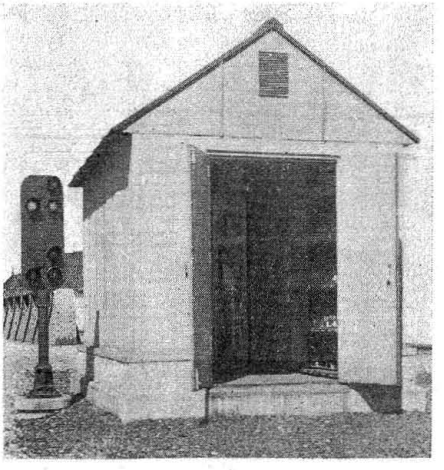
Fig. 1—Track and signal plan of the centralized traffic control territory

Direct-Wire Circuit System

When planning this project, a thorough study was made on the basis of first cost, maintenance and replacements, to determine whether to install the coded system of control using two wires to handle all controls and indications between the control machine and the field locations, or to use the direct-wire system including individual circuits to control each switch or crossover, and each signal or two opposing signals, and to use individual wires for handling each indication or a group of indications. In view of the fact that a considerable number of switches and signals were involved in each of the major field locations, and, furthermore, that the distances from the control station to these major field locations were comparatively short in terms of the lengths of cables required, a decision was made to use the direct-wire system.

In this installation, the same as in any C.T.C. project using coded line, the locking, with respect to track occupancy, switch position, and checks of normal aspect of opposing and conflicting signals, is all accomplished locally at the respective field stations by interconnections of circuits.

For this reason each control circuit between the tower and the field locations is designed on the basis of one wire in connection with common. For the control of a switch machine, to both the normal and reverse positions, one wire, in connection with common, extends from the tower to a polar relay at the field station. Two opposing signals are controled by one wire and connections to common, which control a polar relay at the field station. Thus in connection with common, only one control wire is required for each switch, crossover or two opposing signals. An important feature is that the controls between the tower and the field stations are based on the closed-circuit principle, and, furthermore, the controls are constant, and are instantaneously effected, depending on the movement of the corresponding levers, if circuit locking is not effective.



An insulated instrument house

Prevention of Switch Control Storage

This installation includes a new form of protection to prevent "preconditioning," otherwise known as "storage" of the control of a switch,

i.e., sending out from the tower a control for a switch operation when the switch is electrically locked in the field by occupancy of track circuits, approach locking or other features of electric locking. The objective of this prevention of pre-conditioning feature is to prevent operation of a switch under a train or when approaching, if the train loses shunt of the track circuit and the control has been sent out.

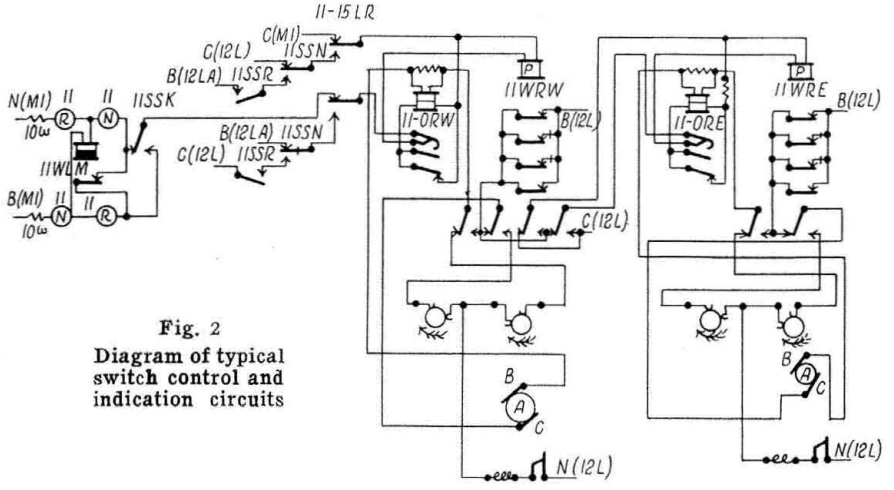


Fig. 2
Diagram of typical switch control and indication circuits

Figure 2 shows a typical switch control circuit to control the polar relay at the field location. The normally closed front contact 11-15LR in this circuit at the field location is a contact in the lock relay which is de-energized whenever the switch is locked electrically in the field. At the tower, relay 11SSK is a polar relay which repeats the position of the switch in the field. This is a retained polar relay which retains its last position until reversed. Also at the tower, a slow-acting neutral relay marked 11WLM is connected in series with the switch control circuit, and the contact in the 11WLM relay is used until the switch in the field corresponds with the position of the lever.

With a switch positioned to correspond with that of its lever and with the lock relay energized, the 11WLM relay is energized and its contact is closed. When the LR relay is de-energized, the 11WLM relay is released because the circuit is open at the contacts 11-15LR in the field. Under these circumstances, if the lever is reversed, no controls go out. The operator must restore the lever and wait until the locking has been released in the field as will be indicated when the "red" hands-off light is extinguished.

Controls of Indications

Indications on the control machine are controlled from the field by circuits each including one wire and connection to common. One such circuit is used to handle two indications, both or either of which may be effective in the display of a lighted indication lamp on the control machine. This result is accomplished by circuits and equipment as shown in Fig. 3. The indication wire from the field extends to the tower and through rectifiers, as shown, to two d-c. neutral relays, the rectifiers being so arranged that positive current from the field will cause relay 11SSNH to be energized, and negative current will cause relay 11SSRK to be energized. This arrangement, to indicate either but not both of two field conditions, uses either positive or negative steady d-c. energy for indicating the normal or the reverse positions of switches and crossovers.

For indicating two circumstances, either or both of which may be in effect or not in effect at one time, steady-flowing energy either positive or reverse does not meet the requirements. For example, the occupancy or non-occupancy of two track circuits is to be indicated over a circuit of one wire and common, similar to that shown in Fig. 3. In this instance, however, the feed to the field end of the indication circuit comes through contacts of certain track relays from a code transmitter, which puts out positive and negative impulses alternately at the rate of 180 per minute. When both of the track circuits being discussed are not occupied, the positive impulses go through the rectifiers at the tower and maintain indication relay 19WKMK in the energized position, and also the negative impulses go through the rectifiers and maintain relay 19LK in the energized position. If track circuit A is occupied, the positive impulses are cut off at the field station by contacts in the track relay, and indication relay 19WKMK at the tower is released, but indication relay 19LK stays energized until such time as the negative impulses are cut off due to occupancy of track circuit B. Thus either or both of the two indication relays can be energized or released, and the control is all over one wire with a connection to common.

Likewise this indication circuit using two indication relays with coded positive and negative impulses is used to repeat two different aspects of a signal or of signals, and the same arrangement is used for indicating that two of the hand-throw switches are normal, locked by the facing-point lock and the electric lock. An important point is that the closed-circuit principle is followed in repeating unoccupied track, Stop aspects of signals, and the locking of hand-throw switches.

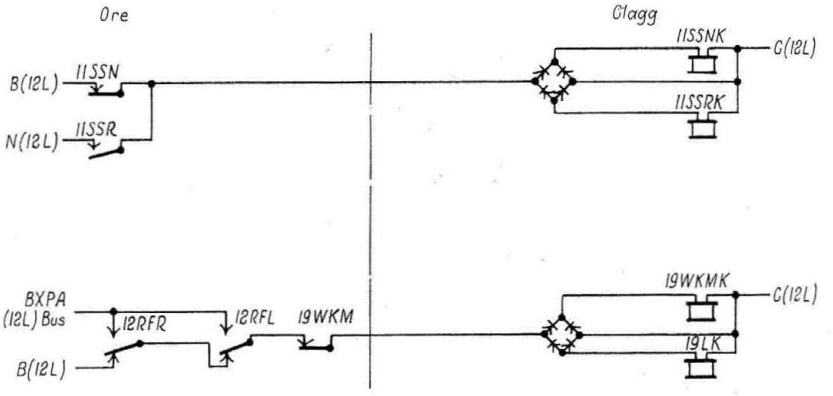


Fig. 3—Two indication controls over one wire

Small Relays in Machine

All of these indication relays are of the small-sized type, and are of the plug-in quick-detachable mounting arranged in sheet-metal, dust-proof cases, which are hinged to swing into space enclosed as a part of the rear of the C.T.C. control machine. The principal function of these relays is

to control indications, in other words, to illuminate corresponding lamps on the face of the control panel.

Route Network Checking

With the indication circuits as previously explained and with the indication relays on the C.T.C. machine, route check network circuits, the equivalent of mechanical locking, were incorporated in the wiring and interconnections in the machine. In each respective instance the indication relay in the C.T.C. machine is energized to repeat the corresponding safe condition in the field, i.e., a switch positioned accordingly and locked; a signal displaying the Stop aspect; a track circuit unoccupied; and a hand-throw switch in the normal position, locked by the facing-point lock and the electric lock. Thus in so far as safety is concerned, the closed-circuit principle is followed, and, therefore, circuits in the C.T.C. machine through front contacts of respective indication relays constitute a route check network which is not only equivalent to mechanical locking but also duplicate equivalent of the circuit interlocking at the field locations.

The advantage of route check locking is, if circumstances are such that a switch would not operate to follow the movement of its lever, the route check locking would prevent control from going out of the C.T.C. machine to clear a signal if a signal lever is thrown for a route over that switch.

For example, at Main, signals 42RA and 42RC are both controlled by lever 42 in the R position. If the leverman placed switch lever 41 in the reverse position and placed signal lever 42 in the R position with the intention of clearing signal 42RC but the switch in this instance did not operate from the normal position, the only feature, which prevents signal 42RA from clearing, is the route network in the field and the C.T.C. machine. In the situation discussed, no hazard would be involved, the only result, if the network in the machine were not used, would be that if a train were waiting at each of the two signals, the second train would be advanced first.

Cable Distribution

On the Ohio River bridge aerial-type cables are used, and they are supported by cable straps from stranded messengers attached to the pipe railings. On the remainder of this installation the wiring distribution is in underground cables. The control and indication circuits are on No. 14 wires, the battery feeds to the switch machine and also the track connections are No. 6, and the two-conductor cable for the 440-volt a-c. power distribution also is No. 6. The cables were buried 30 in. below the level of the top of the ties, and the cables were covered with 1½-in. creosoted pine planks to prevent damage by careless digging with picks. The locations of cable runs are shown by cast-iron cable markers at the ground surface, with arrows pointing in the directions which cables extend.

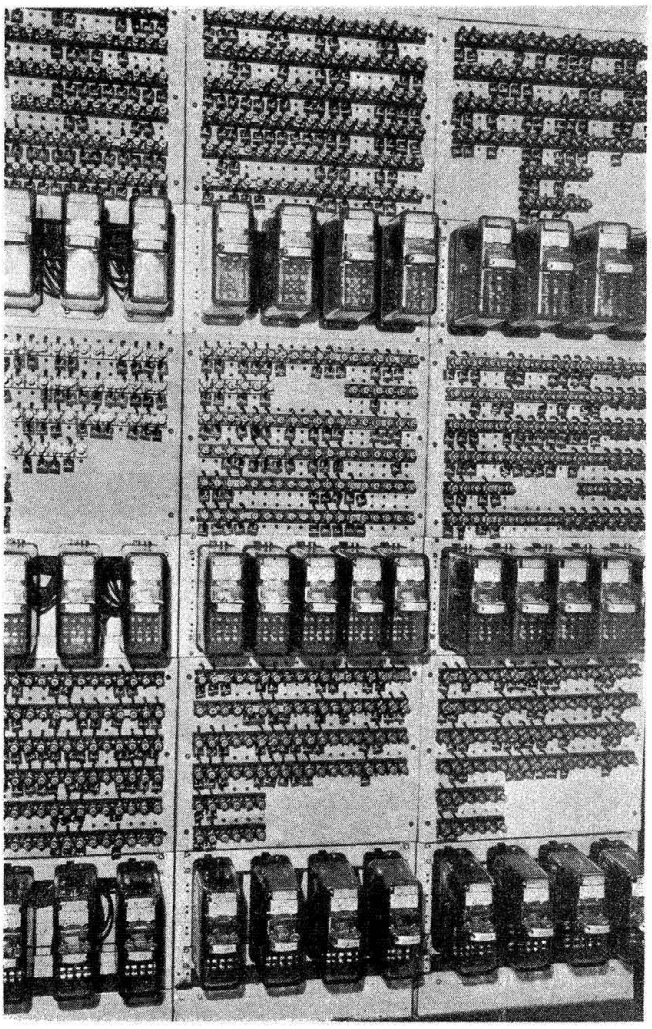
Cable at Switch Machine

At switch machines, the underground cable comes up through a 3-in. pipe riser to a junction box where the solid wires are joined and soldered to flexible conductors extending through flexible conduit to the switch machine. This construction minimizes wire breakage caused by vibration of the track. The voids in the pipe risers below the junction boxes are filled with a mixture which can be removed easily if repairs are required. Placing this mixture in the pipe risers prevents condensation of moisture in the box which would be caused by warm air rising from the earth through the pipe.

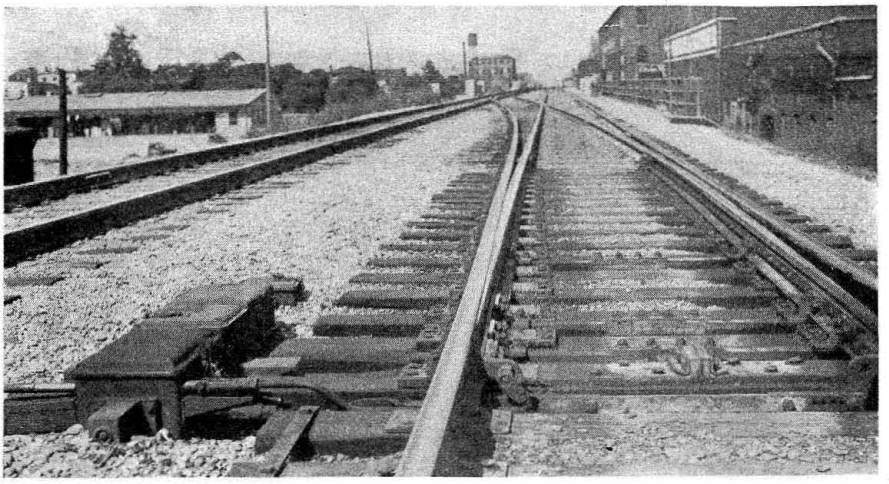
At each of the principal field station layouts, Ore, K. & I. T. Junction, Main, and Mark, an 8-ft. by 12-ft. house is provided to contain the relays and batteries. These houses are constructed of angle-iron uprights in which panels are fitted to form the walls, ceilings and roof. These panels are 1 in. thick, being constructed of sheet-metal over a layer of insulating material, and the doors are of the same type of construction, thus the houses protect the instruments and batteries from extreme outdoor temperatures, either heat or cold. A recording thermometer, which registers the temperature of the battery and the air temperature indoors as well as outdoors, has been installed in one of these houses. During summer weather the indoor temperatures are from 6 to 10 deg. lower than outdoors during the heat of the day and approximately 6 to 10 deg. warmer during cool nights. Records are to be kept during the coming winter to determine results during low temperatures.

Types of Relays

As mentioned previously, the small sized type relays are used for indication circuits and are housed in cabinets



Modern plug-in type relays in the tower mounted on an asbestos board



Typical low-voltage power switch machine layout using insulated gage plate and rail braces

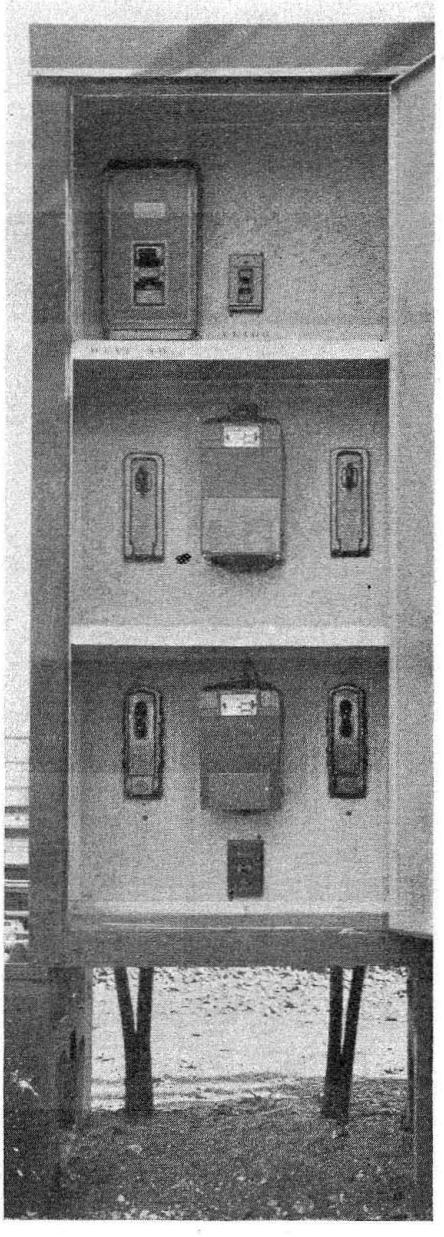
on the machine. The other relays required at the Clagg control station are of the plug-in quick-detachable type mounted on a panel, as shown in one of the illustrations. This panel includes a spare receptacle base for each type of relay, and wires from the receptacle contacts extend to terminals on the board. With this arrangement, a relay to be tested can be replaced by a spare relay, and then plugged into the spare receptacle while testing, after which it can be restored to its original position, if it withstands the tests. The relays elsewhere than in Clagg tower, on the project, are of the conventional types, but all polar relays are equipped with plug-in quick-detachable adapters, the purpose being to prevent improper connections to the coils of polar relays when making tests or changing out relays.

Power Supply

Power, at 440-volt single-phase a-c., is distributed over the entire territory on No. 6 conductors in cable. At each location, where required, a line transformer reduces the voltage to 110-volts, for operation of rectifiers and to feed low-voltage transformers for operation of lamps, etc. Each of these field substations is enclosed in a sheet-metal case. A feature of the construction is that the transformer fused-cutout plugs, sectionalizing switches, circuit breakers and primary fused cut-out plugs, are mounted on a ½-in. sheet of insulating asbestos board, and all connections to these devices are behind the board. The switches, cut-outs and circuit-breakers are of the enclosed type. Thus the construction is "dead-front," and a person cannot touch any part carrying either 440 or 110 volts.

The switch machines, which are rated at 20 volts d-c., are fed from batteries, each of which include 14 lead-acid type 240 a.h. cells. One such battery serves to operate all the switch machines in one layout, as, for example, four machines at Mark, four at Main, and six at Clagg. A switch machine operates and indicates in a period of about 13 sec. Each track circuit is fed by one cell.

The signal lamps are fed normally from transformers, but in case of an a-c. power outage are switched to batteries. The lamps in the high signals are the single-filament type rated at 9 watts, 12 volts. Each lamp unit in the pedestal type signals and in the dwarfs is equipped with two sockets and two 21 c.p. lamps.



Interior of case containing 440-volt transformers, plugs, etc., all being dead-front

Special Detectors

As a means for checking for grounds quickly, a ground detector panel was installed at Clagg and at each of the four outlying instrument houses. This panel includes a voltmeter, two knife switches for different polarities and a radial switch by means of which connections can be made to circuits fed by each of the several batteries in a house.

In order that the towerman, when operating the drawbridge, may know the exact position of the lift span, a special dial-type indicator was devised and installed. The instrument is a voltmeter calibrated with figures showing feet. A potentiometer mounted on the bridge operating mechanism is adjusted gradually as the span is lifted or lowered. A 1.5-volt battery, the effective portion of the potentiometer and the voltmeter are connected in parallel. The indicator repeats the position of the bridge accurately to within ½ in.

Installed by the Pennsylvania

This centralized traffic control project was planned and constructed by the signal forces of the Pennsylvania. Passenger trains save about 5 min. in this territory, as compared with previous operation, but the most important consideration is that safety of operation has been increased and the switching moves and transfer trains are saving considerable time.