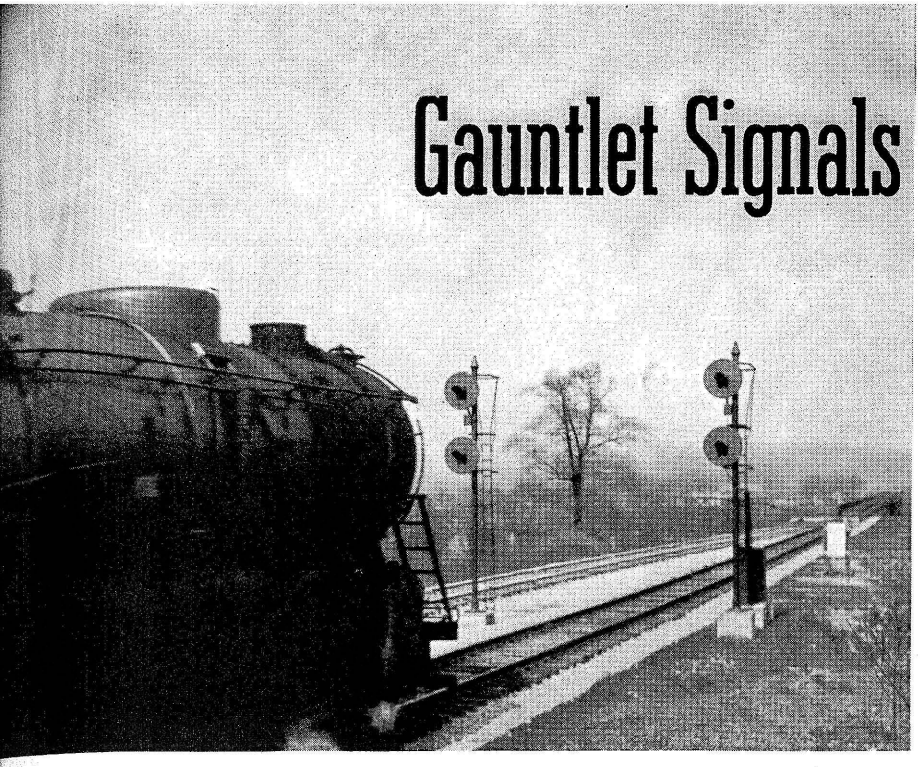
Gauntlet Signals on the B. & L. E.



Remotely-controlled signals direct train movements on gauntlet track, thus replacing a mechanical plant

Northbound train approaching signal 2R

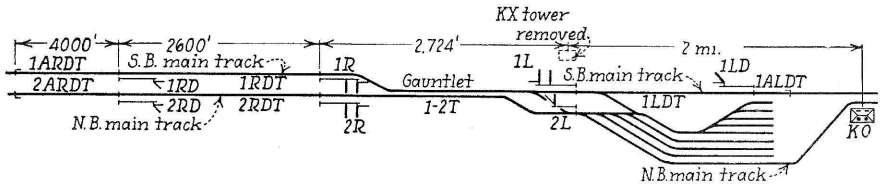
In 1902, the Bessemer & Lake Erie constructed a single-track low-grade line extending around the east side of Greenville, Pa., from KO Tower to KY Tower, 8.9 miles, this new line having much better grades and reduced mileage as compared with the original line which follows down through valleys and passes through the main section of the city at a level of 125 ft. lower than the other line. In 1917, second track was added to the freight line between KO and KY. However, at a viaduct, 3.5 miles north of Greenville, the second track was laid as a gauntlet with the original track, because the expense of constructing such a long and high viaduct for the second track was not justified. The bridge structure is 1,724 ft. long, and, including sections of gauntlet track on both approaches, the distance between points of standard track clearance is 2,724 ft. In the length of the viaduct, the freight line crosses the Little Shenango river, the tracks of the Erie and the New York Central as well as the old main line of the Bessemer & Lake Erie.

As a means of directing train movements over this section of gauntlet track, a mechanical interlocking, known as KX Tower, had been installed previously at the clearance point of the tracks at the north end of the viaduct. This interlocking machine had six levers to control mechanical signals on both tracks at KX and to control electric signals on both tracks at the south end of the viaduct. A leverman was on duty each trick at KX Tower. During the early years of the recent depression, KX interlocking was taken out of service as a means of reducing operating expenses, the entire plant, together with the signals at the south end, being dismantled. Following the removal of KX interlocking from service, train movements were directed by train orders.

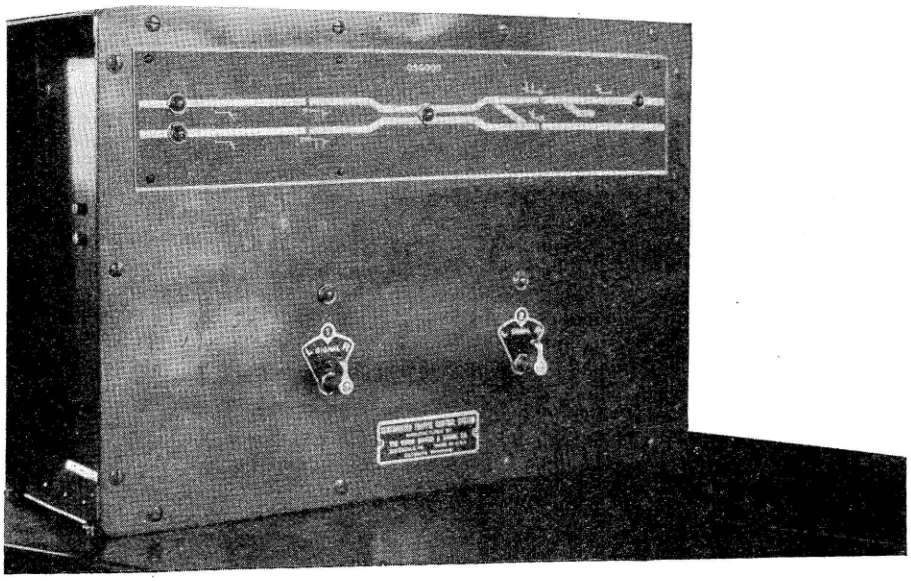
The traffic on this line varies from four to eight trains each way daily, depending on the day of the week and the season of the year. The northward traffic consists of manufactured steel products and coal from the Pittsburgh district, moving northward to connections or to docks at Conneaut Harbor. Southward traffic consists of manufactured products, and, especially during the navigation season, iron ore is moved in large quantities from the docks at Conneaut Harbor to Pittsburgh. Each train consists of up to 125 loaded cars, about 7,400 net tons being handled in each train. All freight trains on this railroad are operated as extras.

As traffic increased in the latter part of 1935, it was evident that numerous train stops and delays were being caused by protecting train movements over the gauntlet track by train orders. The train orders had to be set up in advance and it was impossible to determine the exact time at which trains would approach the gauntlet track. As a result, some trains were required to stop unnecessarily.

In order to correct this condition, it was decided that train movements should be directed over the gauntlet by signal indication, independent of train orders. Of course, it would have been possible to control the signals automatically by track circuits, using circuits practically the same as for an automatic interlocking at a crossing of two single track lines. However, in this case of the B. & L. E. gauntlet track, it is highly desirable that preference be given to southbound trains which at this location are ascending a 0.6 per cent grade. In order to meet these requirements, a semi-automatic control arrangement was provided by means of which the signals are controlled not only by track circuits in the gauntlet section, but also are controlled manually by levers in a small desk type machine on the op-



Track and signal plan of gauntlet layout



Control machine is located in KO tower

erator's desk in the KO Tower, located two miles north of the viaduct. The signaling for directing train movements over the gauntlet track is, therefore, in effect, a remotely-controlled interlocking.

Signaling Layout

The home signals at each end of the gauntlet track are located opposite the clearance points. Normally, the trains are operated right-hand running; however, a considerable number of trains are run northward on the normally southward track. Therefore, it was decided that standard high interlocking home signals should be provided for these three routes, these signals being numbered 1L, 2R and 1R on the plan. Each of these signals has two "arms," the top unit being of the searchlight type, to display red for "stop" and green for "proceed," the standard aspect for a home interlocking signal being completed by the lower arm which is a constant-burning red light. Located at braking distance in approach to each of these three home signals there is a high distant signal, using a searchlight unit normally displaying yellow for "caution" and green for "clear." The fourth possible route over the gauntlet, that is, a southward movement on the normally northward track, is seldom used and, therefore, a dwarf signal was considered adequate. This signal is a searchlight unit operating to display red normally for "stop" and yellow for "proceed."

Control Machine at KO

The control machine on the operator's desk in KO Tower has two levers, together with an illuminated track and signal diagram. Lights in the track diagram indicate the position of trains when occupying the gauntlet section between the home signals or any of the three approach sections. The two levers are left normally in the center position, causing all signals to display their most restrictive aspects. Lever No. 1 controls the signals for directing trains in either direction on track SB, being thrown to the left to clear signal 1L to direct a southbound train on the normally southward track SB; and this same lever, when thrown to the right, causes signal 1R to clear to direct a northbound train to use the normally southward track SB. Lever No. 2 controls the signals for train movements in either direction on the normally northward track NB. This lever, when thrown to the right, clears signal 2R for a northbound train on the normally northward track NB. When the signal controlled displays the proceed aspect, this fact is indicated to the operator by the illumination of the small indication lamp over the lever.

Lever Control

The levers are of the miniature type and are not interlocked, but interlocking is accomplished electrically by interconnection of circuits so that signals for conflicting routes cannot clear. In addition to the control of the signals affected by the levers, all home signals are track-circuit controlled so that these signals indicate stop at all times when the track circuit over the gauntlet section is occupied. Approach locking is accomplished by time-element relays so that if the operator lines up a route for a train which has occupied its approach section and he then places the signal to stop, a period, long enough to permit the train to be stopped, must elapse before any other signal can be cleared.

Control Circuits

The control of the signals and the return of indications to the machine is accomplished by the direct-wire system, using five line wires between the signal layout and the KO Tower two miles away. By means of polar circuits, one wire in connection with common, controls signals 1R and 1L, another wire controls signals 2R and 2L, while two additional wires, in connection with common, are used to bring in the indications as to track occupancy.

For example, say that lever 2 is thrown to the right for the purpose of clearing signal 2R. A circuit starting with battery N goes to the 10-ohm resistance, through the band on lever 2R reversed to the right, through the band 1N on lever 1 closed normal, through back contact 1HSR, over the line and through back contact of 1HR to relay 2HR. This is a 500-ohm DP-14 type polar relay, the selection between the control for signals 2R and 2L being effected by the polar contacts in one position or the other, depending on the polarity of the line circuit, which is determined by movement of the lever to the right or to the left.

The interconnection of circuits to prevent clearing signals for conflicting routes simultaneously is effected in two ways. Lever 1 must be normal to keep band contact 1N closed in order to clear a signal controlled by lever 2. Furthermore, when lever 2 was thrown, as explained previously, stick relay 2HSR was picked up, which opens a contact that cuts off the line circuit from lever 1. After this stick relay 2HSR is picked up by a circuit through lever 1 normal and lever 2 reversed, this relay will stick up through its own front contact as long as lever 2 is reversed, so that even though lever 1 may be thrown, no control of signals will be effected by such action because relay 2HSR, being energized, holds the line control open.

The feed to the local control relays for the two signals starts through a neutral front contact of relay 2HR and then through one or the other of the polar contacts and to signal relay 2R or 2L, the circuit also being selected through relays repeating the position of the cross-over just south of signal 1L, then through track circuit 2T over the gauntlet and through the time-element release relays for the approach

locking. These local controls of the individual signal relays, being practically standard practice, are not shown in the diagram.

Signal Indication Circuits

The next point of interest is to explain how the signal line control wires are used also to repeat the signal indications on the control machine. As explained previously, line wire 2HR1-1HKR1 was used to control signals 2R and 2L. While using this wire, the other control line wire 1HR1-2HKR1 cannot be used for controlling signals 1R or 1L, because any possible feed to this wire from the control machine is cut off by the positioning of lever 2 and its stick relay. When lever 2 was thrown to the right, as mentioned previously, a second band contact was closed that completed a circuit from C through stick relay 2HSR, causing it to be picked up. Contacts in this 2HSR relay are included in the line circuit 1HR1-2HKR1 so that with 2HSR picked up, this line circuit at the office end extends to 2HKR. At the field end of line circuit 1HR1-2HKR1, this circuit goes through a contact of 2HR, which at this time is picked up so that the line circuit extends through contacts in relays which repeat the searchlight signal mechanisms 2R and 2L, so that if either of these signals is displaying a proceed indication, the corresponding relay 2RLSR or 2LLSR will be released, thus completing the circuit to pick up relay 2HKR at the control station which, by means of a local circuit, causes the indication lamp above lever 2 to be lighted, thus indicating to the operator that the signal has cleared. Thus, it is evident that the indications for one set of signals are brought to the control machine over the line wire for the control of the other set of signals.

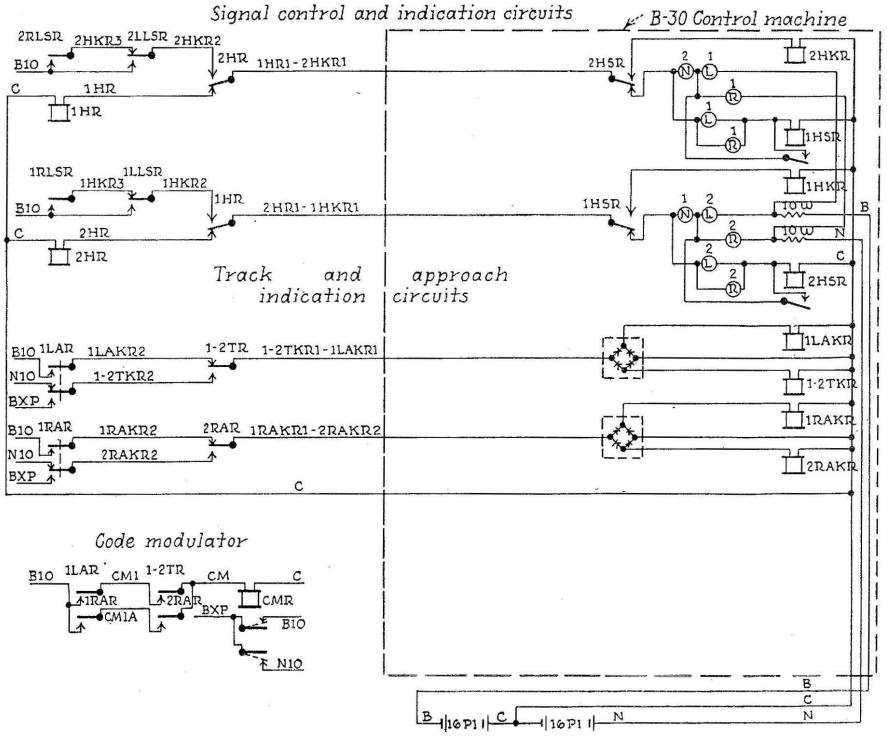
Track Occupancy Indications

The illuminated track diagram on the control machine is equipped with lamps to indicate the occupancy of four sections of track: Northward approach on NB track up to signal 2R; northward approach on track SB up to signal 1R; southward approach on track SB up to signal 1L; and the tracks over the gauntlet between the home signals.

Slow-acting relays located at the field station are controlled through track relays. Relay 1RAR repeats the track sections 1ARDTR and 1RDTR; the relay 2RAR repeats 2ARDTR and 2RDTR; relay 1LAR repeats 1ALDTR and 1LDTR; and relay 1-2TPR is controlled by 1-2TR. The point of special interest is that indications as to the occupancy of any or all of these four sections of track are carried from the field location to the control machine over two wires only, with a connection to a common wire. This result is accomplished by using a split battery feed in combination with a code-modulator, and a selection of circuits at the field end, and a combination of rectifier elements at the control station to select the different indication relays.

Referring to the diagram, say, for example, that a train occupies track circuit 2ARDT, thus releasing 2RAR, thus closing a back contact on this relay, and, with 1RAR energized, a circuit is complete to feed N10 out on the line 1RAKR1-2RAKR2. As negative current is being fed, it goes down through the rectifier against the direction of the arrow and on to pick up relay 2RAKR. By means of a local circuit, this relay controls a lamp in the track diagram. On the other hand, with all tracks clear, if a train entered track circuit 1ARDT, relay 1RAR would be released which would put positive current on line circuit 1RAKR1-2RAKR2, which would go up through the rectifier with the arrow and pick up relay 1RAKR, and cause the corresponding lamp in the track diagram to be lighted. In case both approach sections are occupied simultaneously, both of the relays 1RAR and 2RAR will be released, which causes BXP to be fed out on the line. This BXP feed consists of positive and negative current interruptions fed alternately, so that they feed through the rectifiers to pick up both relays 1RAKR and 2RAKR, causing both of the lamps in the track diagram to be lighted. Approach an-

Diagram of control and indication circuits

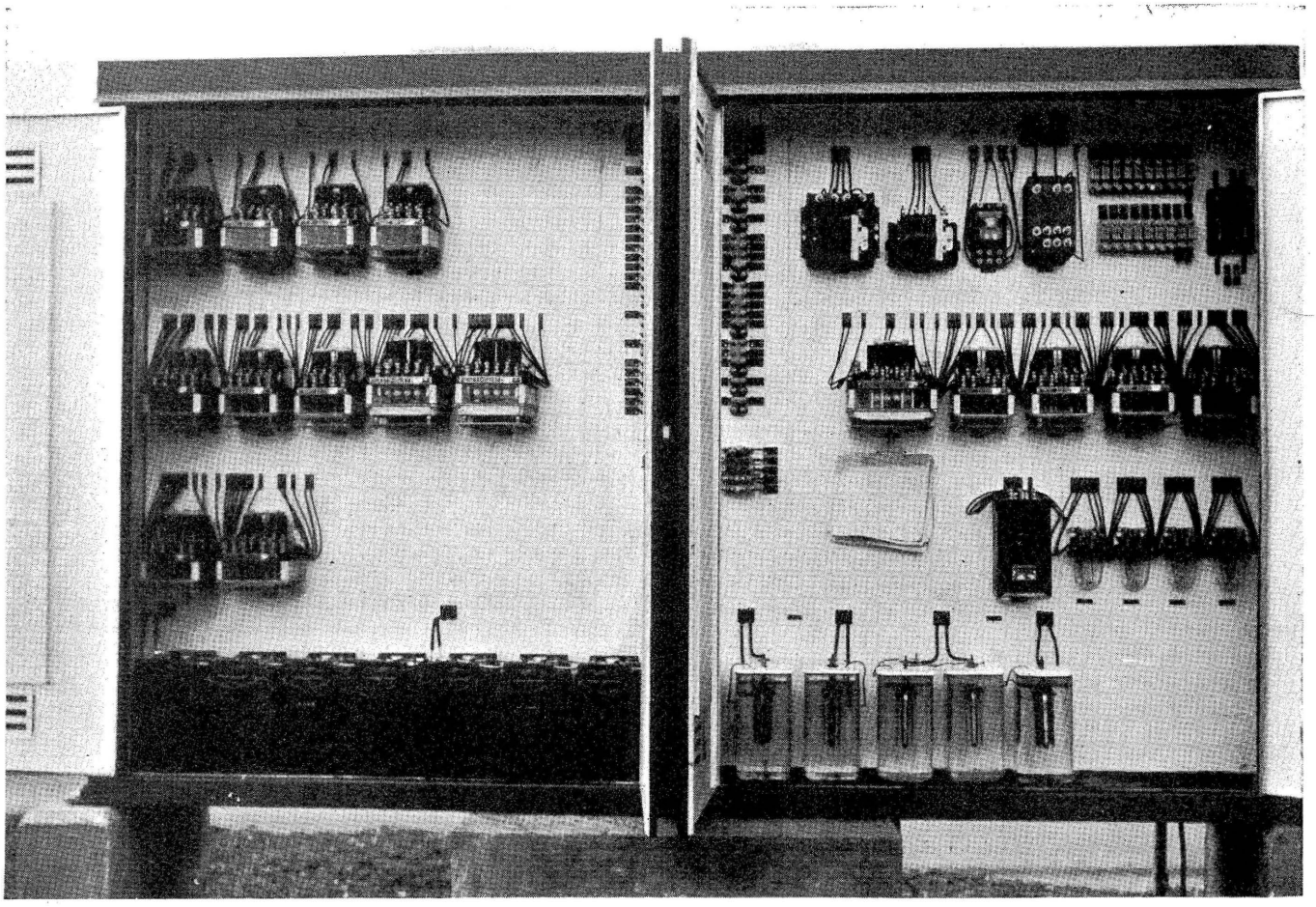


nunciator bells are also controlled through the AK relays. This BXP current comes from a code-modulator at the field station, which puts out 10 volts interrupted and reversed 120 times per minute, the alternations being required to operate through the rectifiers at the control station end.

feed for local controls and the line indication circuits, and also as a stand-by supply for the signal lamps. The signal lamps are normally fed from an a-c. supply, but in case of an outage of the a-c., the lamp feed is switched by a power-off relay to the battery. At the home signals

false back or mounting wall being made of plywood board 5/8 in. thick. These cases were wired up complete with instruments in place at the Union Company's factory.

All underground wiring is in Okonite cable. The control circuits between the instrument case and the



Welded sheet-metal instrument and battery housing at north end of gauntlet

The modulator is controlled so as to operate only when 1LAR and 1-2 TR or 1RAR and 2RAR are occupied.

Power Supply Arrangement

At the control station, the line control circuits as well as the local relay and indications lamps on the machine are all fed by 32 cells of Edison 500 a.h. primary battery, a center connection being used to effect the split-battery feed for the line control circuits. At each of the three distant signals, a set of 16 cells of primary is used for signal operation and line circuits; likewise, each track circuit is fed by a set of primary battery. At the home signal layout at the north end of the viaduct, a set of 16 cells of Edison B4H storage cells is provided as a

at the south end of the viaduct, a set of eight cells of the same type of storage battery feeds local controls and acts as a stand-by for the lamps. These batteries are on floating charge through Union rectifiers.

Features of Construction

This installation was designed and installed by the Union Switch & Signal Company under the jurisdiction of F. R. Layng, chief engineer of the Bessemer & Lake Erie. The concrete foundations for the signals and instrument cases were precast in the factory and on arrival at the location were set in place by a power derrick. The instrument cases are made of welded sheet steel, with doors opening to the track side, and removable sections at the rear to give access to the wiring space, the

signals are in No. 14 parkway cable made up with protection, including lead sheath and steel tape. This type of cable is run up inside the signal mast to a junction box mounted just below the signal head, and from this box, single conductors are run through flexible conduit to the signals. The track connections are in single-conductor No. 9 cable with the same type of protection as explained above. Each cable is run to a Union Type U bootleg outlet, from which a stranded conductor extends to a 3/8-in. plug in the rail.

The line control circuits are on No. 9 hard drawn copper wire with weatherproof covering run on pyrex glass insulators. For a distance of 1,800 ft. over the length of the viaduct, the line circuits are run in a 15-conductor aerial cable supported from the bridge structure.