

C.T.C. panel is in the center with the telephone train dispatching ringing keys mounted in the wing sections of the cabinet

C.T.C. on the Bessemer and Lake Erie

As a means for improving safety and expediting train movements, the Bessemer and Lake Erie has installed centralized traffic control on various sections of single and double track totaling 88.2 track miles between Meadville Junction, Pa., and Filer, Pa., the road-mile distance between these points being 42.9 miles. The reason for installing C.T.C. in this territory is that it is one of the bottlenecks on the railroad as a whole between North Bessemer, Pa., and the ports at Conneaut, Ohio, on Lake Erie.

At North Bessemer, near Pittsburgh, the Bessemer and Lake Erie connects with the Union Railroad which serves numerous industries and connects with other railroads in the Pittsburgh area. On Lake Erie, the Bessemer and Lake Erie has dock facilities at Conneaut, Ohio, and important interchange facilities near Erie, Pa. A large percentage of the traffic consists of coal northbound and iron ore southbound. A large yard is located at Albion, Pa., so that between Conneaut, Ohio, and Albion, Pa., 15 miles, as well as between Erie, Pa., and Albion, 25

miles, the operations are of the nature of transfer moves. Southbound road trains are made up at Albion, and northbound road trains are broken up at this yard. Each through freight train is handled by

Installation on 88 miles of track on 43 miles of road includes four junctions and four ends of double track—Modern coded track circuits used

two locomotives, one at the head end and one at the rear, just ahead of the caboose. The grades between Albion and KO junction are such that southbound trains handle more tonnage between Albion and KO than between KO and North Bessemer. For this reason, southbound trains stop at KO to set off cars. Certain crews originating at Greenville pick up the overflow at KO and move it southward to North Bessemer.

During the season of open navigation on the Great Lakes, about 12 freight trains are operated each direction daily between Albion and KO. On this territory the line is double track, and right-hand running is standard practice. This same statement applies also with reference to the territory between Filer and North Bessemer, 66.4 miles.

Special Circumstances Between KO and Filer

Between KO and KY the original single-track line of the B. & L. E., which passes through the business section of Greenville, Pa., includes steep grades descending into and out of the valley of the Shenango river. On the other hand, the double-track high line between KO and KY is shorter and at lighter grades. The old line through Greenville was retained not only to serve the industries in this city, but also on account of the interchange connections on this old line with the New York Central at Osgood (OW), and with the Pennsylvania and the Erie at Shenango. Certain freight trains in

either direction, which have cars to be set out or picked up at connections, are operated via the old line through Greenville. In addition, one passenger train is operated in each

power switch machines and color-light searchlight signals being installed as a part of the C.T.C. system. At OW, on the old line between KO and Greenville, the switch leading to

part of the C.T.C. system. At Filer, the hand-throw stands on the two crossovers are lined by the operator on duty at this office.

Thus this C.T.C. project involves

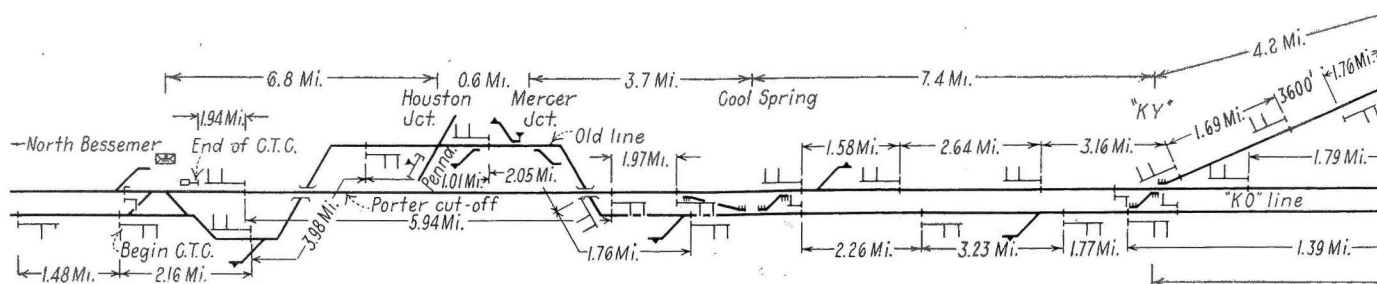


Fig. 1—Track and signal plan of the centralized

direction daily. An interchange and storage yard is located between Greenville station and Shenango, two main tracks being provided in this section which is about 1.9 miles long. Between Shenango and KY, the B. & L. E. old main line is single track, the same as between KO and Greenville.

On the double-track high line between KX South and KY, the northward track is signaled for northbound train movements only, but the other track is signaled for train movements in either direction. This permits the northward track to be used for storage during the periods of closed navigation. On the sections of double track between KX North and Meadville Junction, as well as between KY and Cool Spring, each of the two tracks is signaled for one direction only. Thus the project includes 88.2 track miles of

an interchange connection with the New York Central had previously been equipped with a hand-throw stand. A power switch machine and signals were installed at this switch as a part of the C.T.C. system.

The switch at the south end of the 1.9 miles of double track main line in Greenville is operated as a part of the Shenango interlocking which also protects the crossing with the Erie. The switch at the north end of the double track at Greenville station is equipped with a hand-throw stand, which is operated by an operator at GV.

Previously, the two main tracks over the Osgood viaduct were gauntlet. This arrangement was objectionable because of eccentric loading on the steel structure. For this reason, as a part of the improvements, one of the gauntlet tracks was removed, and the remaining single

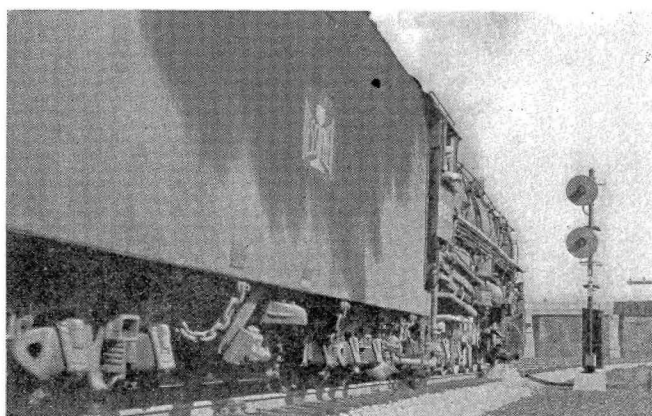
four junctions of single track and double track each including a single switch, except at Shenango where a crossover and derails are involved and four such junctions, two of which include a single switch and a crossover and two of which include two crossovers. A peculiarity of this project is that no passing tracks as such are involved, but, on the other hand, nine junctions are included. In normal operations the freight trains are of equal importance so that there is no occasion to run one around another. The sections of single track are so short that there are no occasions for opposing moves; therefore, no passing tracks are required.

Aspects of Semi-Automatic Signals

The signals are of the searchlight type with 10 volt 13 + 3.5 watt lamps. Each semi-automatic C.T.C. controlled high signal has two units which display an aspect of red-over-red for Stop. If either lamp is burned out, a single red light is likewise a Stop aspect, or, if both lamps are burned out, this is equivalent to a Stop aspect.

The turnouts and crossovers are No. 16, good for freight train speeds of 30 m.p.h. When a train is to make a diverging move a Medium Clear aspect, red-over-green, is displayed. When a train is to close up on another train, the Restricting aspect, red-over-yellow, is displayed. When the immediate block is unoccupied, but the next signal is displaying its most restrictive aspect, a signal displays the Approach aspect, yellow-over-red. The dwarf semi-automatic signals each have one unit only, and display the aspects red, yellow, or green.

An outstanding feature of this Bessemer & Lake Erie project is



Searchlight signals are used, each signal being of the two "arm" type and mounted at the immediate right of the track governed.

which 38.4 miles is signaled for either direction and 49.8 miles is signaled for one direction only.

Junctions Involved

Previously, the single switch, crossover and signals at KO Junction were operated by a mechanical interlocking. As a part of the new project this plant was removed,

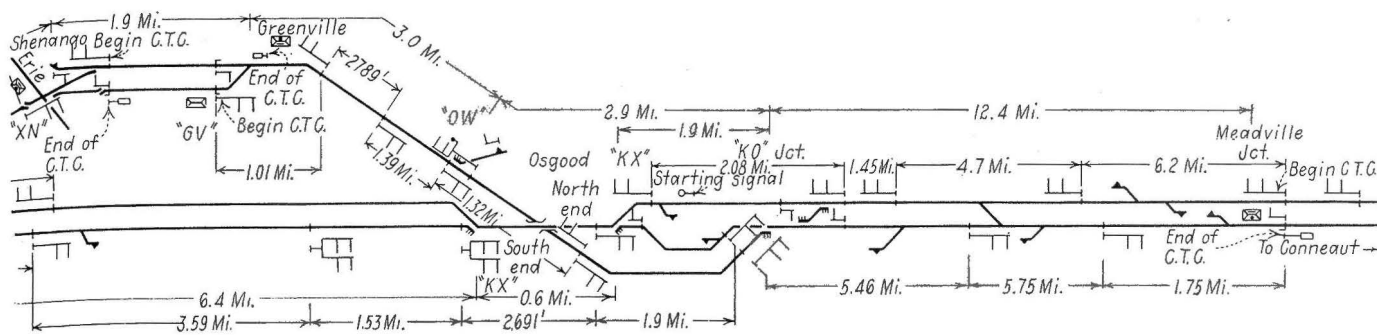
track was centered on the structure. This change introduced a single switch at each end of the double track, power switch machines and signals being installed as a part of the C.T.C. system.

The switches and crossovers at KY and at Cool Spring were formerly operated by hand-throw stands, but are now equipped with power switch machines and signals as a

that the intermediate automatic block signals do not display the Stop-and-Proceed aspect, A.A.R. Rule 291; but rather the most re-

"arm" constitutes the Restricting aspect. Otherwise the lamp in this lower arm is extinguished while the upper "arm" displays the conven-

L. E. are such that if an engineman prepares to stop his train, the stop, in most instances, must be made. The practice of providing the Ap-



traffic control territory between Filer and Meadville Junction

strictive aspect of these signals is red-over-yellow, Restricting, which directs a train to proceed at restricted speed, no stop being required at the signal. When proceeding at restricted speed, enginemen are required to watch for broken rail, mis-

tional aspects of green for Clear and yellow for Approach.

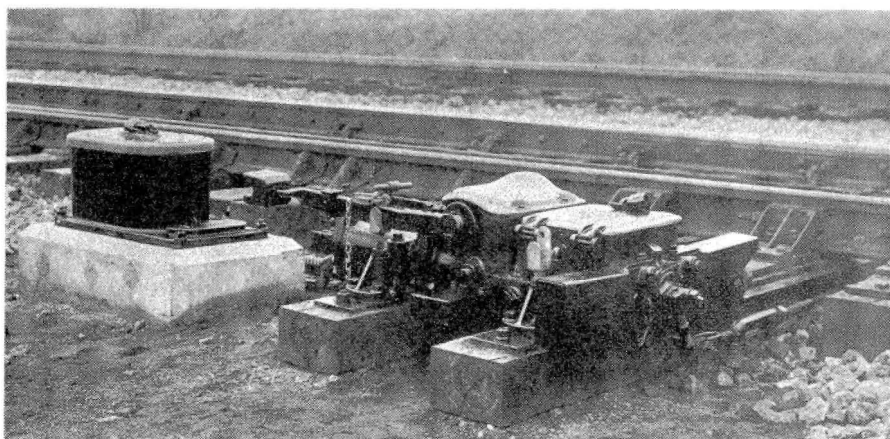
On the automatic block signals which serve also as "distant" signals in approach to home semi-automatic signals at the junctions, both the upper and the lower "arms" are

proach-Medium aspects on the distant signals is, therefore, the means of eliminating numerous unnecessary train stops.

Electro-Pneumatic Switch Machines

The power switch machines on this project are of the electro-pneumatic type with dual control levers

The power switch machines are of the electro-pneumatic type and are equipped with dual control, each switch machine being mounted on plates which are attached to the insulated gage plates.



placed switches and a train or other obstruction. In the majority of instances the train ahead clears the block or if a switch were open it is closed before the train operating under the Restricting aspect arrives; therefore, no stop is required. Thus this practice of using the Restricting aspect, rather than the Stop-and-Proceed, is the means of saving numerous unnecessary train stops which is highly important with reference to heavy freight trains.

On these intermediate automatic block signals the upper "arm" is a searchlight signal unit capable of displaying red, yellow or green. The lower "arm" is a "one-color" lamp body in which the lamp is extinguished except when the Restricting aspect is to be displayed, in which instance a yellow light in this lower "arm" under a red light in the upper

searchlight operative units. Such a signal displays the red-over-yellow Restricting aspect as explained above, and also such a signal displays the yellow-over-green, Approach Medium aspect when the home signal displays the red-over-green Medium aspect to direct a train to use a diverging route over a crossover or turnout. The use of the Approach-Medium aspect on the distant signal permits an engineman to bring his train up to and through the turnouts at the speed for which they were designed, whereas, if the ordinary Approach aspect were used, the engineman, according to rule, would be required to reduce speed at the distant signal and approach the home signal prepared to stop. The circumstances with reference to weights and lengths of trains, grades and air brake operations on the B. &

so that they can be operated by hand when special switching movements are being made. Electro-pneumatic switch machines in preference to electric machines were chosen by the B. & L. E. for this project for several reasons. The rail is either 152-lb. or 130-lb. and the switch points on the No. 16 turnouts are 33 ft. long. The electro-pneumatic machines move these heavy switch points with sufficient snap to crush ice, chunks of coal or twigs which may be fouling the points. Regardless of requests, explanations and rules to the effect that sand should not be used through power switches, under certain circumstances when accelerating heavy trains, sand must be used. Unless the sand deposit is very heavy, the electro-pneumatic machines will crush it out and position the points.

These Type A-20 U. S. & S. Co.

electro-pneumatic machines will operate a switch almost instantaneously as compared with 10 to 12 seconds for the usual low-voltage electric machine. Except for the interchange connection at OW, the power switches are at junctions so that a saving of 10 seconds, or perhaps 20 seconds if a switch and crossover are involved, will save in numerous instances enough time in changing a line-up to prevent the stopping of a heavy train.

Each switch machine has two cylinders, one each for operating the switch to the normal and the reverse position. The cylinders are 6 in. in diameter and the stroke is 11 in. The air pressure is controlled between a maximum of 85 lb. and a minimum of 70 lb. The air valve at each switch is turned down so that under normal conditions the switch goes over without banging. On the other hand, if the switch hangs or does not start easily, the pressure builds up to snap the points over.

At each single switch the compressed air is furnished by a duplicate set of air compressors each rated at 4.2 cu. ft. per minute. At layouts including a single switch and a crossover, the compressors are rated at 9.2 cu. ft. If the pressure falls to 70 lb., the No. 1 compressor is started to operate until the pressure is increased to 85 lb. If the No. 1 compressor fails to start, or if the pressure falls to 60 lb., then the No. 2 compressor cuts in and cuts out at 75 lb. In the meantime, a low-pressure indication is sent in to the C.T.C. machine in the dispatcher's office. The compressor motors operate on 220-volt a-c., each 4.2-cu. ft. compressor being operated by a 1-hp. motor, and each 9.2-cu. ft. compressor by a 2-hp. motor. In case the a-c. power is out of service, the supply of compressed air in a reservoir, starting at 70-lb. pressure, will operate a single switch a total of 40 times, which is more than the number of times that any switch would normally be operated for train service in a 24-hour period. If circumstances are such that the a-c. power cannot be restored in a 24-hour period, then a locomotive can be stopped at each power switch layout to pump up the air pressure in the reservoirs. A further standby is that the dual control lever can be used to operate each switch by hand if all other means fail.

Adjustable rail braces and insulated gage plates, $\frac{3}{4}$ in. thick and 7 in. wide, are used on three ties under each switch. On two of these ties the plates extend under and are attached to the switch machine thus preventing lost motion. A sufficient

number of anti-creepers were applied to prevent the rails from running within the limits of the switches, thereby preventing train delays which might be caused if the rail ran to the extent that the switches could not be locked by the machines.

The C.T.C. Machine

The power switch machines at the five single switches and four crossovers, as well as semi-automatic sig-



Train passing special "S" signal which is advance information for approach to southward signal at KO

nals at the various junctions for authorizing train movements, are all controlled by a C.T.C. machine in the dispatcher's office at Greenville. Within the limits between KO and Cool Spring, inclusive, the controls of power switches and semi-automatic signals are effected by coded control from the dispatcher's office, using a two-wire line circuit which also returns the indications of switch position, signal aspects and track occupancy to the C.T.C. machine.

The C.T.C. control machine at Greenville includes an automatic train graph which records the passing of trains at the OS switch detector circuits at the various switches. Each midnight this record sheet is torn off and attached to the train sheet on which a record is kept in the usual manner of train movements on other than the C.T.C. territory.

Traffic Direction Control and Locking

The direction of traffic between Greenville and OW, between OW and KO, and between KX south and KY on the southward track, is controlled entirely from the C.T.C. machines at Greenville, but the traffic direction between Cool Spring and Filer, on both lines, and between KY and XN is controlled jointly by the C.T.C. machine at Greenville and the operators at Filer and XN, respectively. Where joint traffic control is in effect, the traffic levers at each end of the block must correspond

before a signal can be cleared to enter the block.

A traffic direction lever and a set of indication lamps apply for each section of track which is signaled for train movements in either direction, as for example on the single track between OW and KO. When traffic is to be established northward for example, the traffic lever for this section is thrown to the left, which positions traffic control relays at the field stations and causes a blue lamp to be

lighted in an arrow pointing north on the diagram between the symbols representing Greenville and OW. This lamp remains lighted as long as the traffic lever remains in the left position, and, in the meantime, the southward station-leaving semi-automatic signal at OW cannot be cleared even if the dispatcher attempted to control it. After the northward station-leaving signal at Greenville has been cleared and accepted and passed by a train, a red lamp below the blue lamp is lighted to indicate that the block between Greenville and OW is occupied. This lamp remains lighted until the northbound train, as well as any following trains, have passed beyond OW. In the meantime, traffic direction cannot be reversed even though the dispatcher might attempt to do so.

When traffic direction is thus established northward, for example, and a leading train has passed the intermediate signal, the station-leaving signal at Greenville can be controlled to display a Proceed aspect for a following train, but under no circumstances can the southward station-leaving signals at OW be cleared to permit an opposing southbound train to enter the block between Greenville and OW until all northward trains in this block have passed beyond OW.

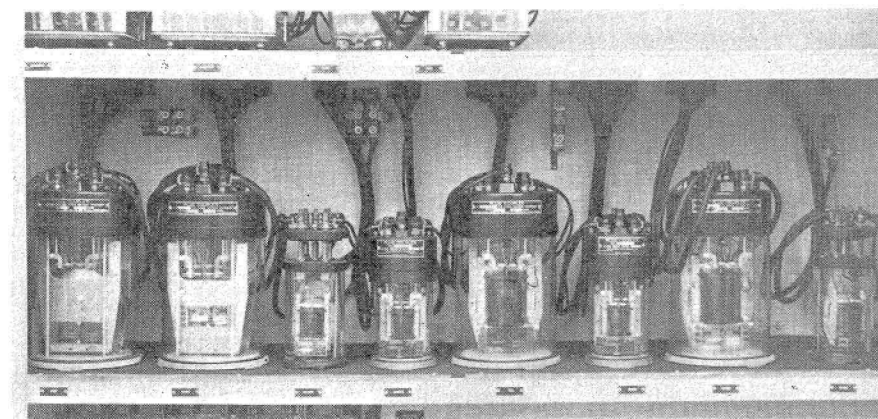
At Houston Junction, on the old main line between Cool Spring and Filer, a light-traffic single-track branch line of the Pennsylvania crosses the old main line of the B. &

L. E. between Cool Spring and Filer. This crossing is protected by signals on the B. & L. E. and by a tilting target signal at the crossing which is normally in the Stop position for the Pennsylvania. When a Pennsylvania train arrives and stops short of the crossing, the conductor removes a padlock and opens a door of a case, which causes the B. & L. E. signals to display the Stop aspect, then after a three-minute time period, the electric lock is released and the conductor clears the tilting target signal to direct his train to pass over the crossing. The signal is then restored to the normal position and locked.

The hand-throw main line switch at Mercer Junction, leading to the Mercer Branch, is equipped with an electric lock. When a train on the main line stops to use this switch, the electric lock is automatically unlocked. When a train on the branch line is to use the switch, the dispatcher sends out a control which causes track code to be sent from each direction toward the switch, thus effecting a release of the lock, no line wire circuits being involved.

Special Starting Signal

After southbound freight trains have reduced tonnage by setting out cars in the holdover yard at KO, there is no advantage of starting just to pull down to signal 14RA and then stopping again. For this reason, a special starting signal is located at the right of the southbound track near the yard switch. This signal which consists of a 10-volt, 25-watt lamp and reflector with a cover glass



Code transmitters and code following relays at a typical location

14 in. in diameter, is normally extinguished. When a Proceed aspect is displayed on signal 14RA, this special starting signal is lighted to display an illuminated white letter "S."

Telephone Communication

On each side of the control panel on the C.T.C. machine, there is a section of cabinet which includes the sending keys for the selectors of the telephone train dispatching circuit for the territories north and south of the C.T.C. territory. Thus the dispatcher has within reach all the facilities for authorizing trains on his entire territory.

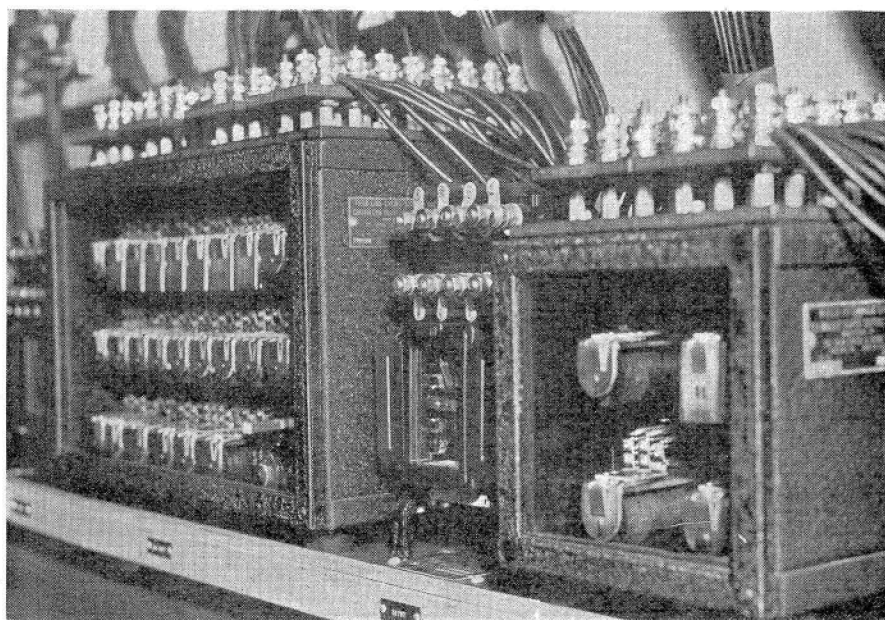
The two line wires for the C.T.C. line coding system are used also for a telephone circuit connecting telephones in the instrument houses at the various switch locations. This telephone equipment is used by the signal maintenance forces when communicating with the dispatchers or

when communication is required between two maintainers at different locations. When the dispatcher wants to call a maintainer, he sends out a control code which causes a lamp to be lighted on the track side of the instrument house or houses, and when a maintainer sees such a light, he answers the nearest telephone.

Modern Coded Track Circuits

An important feature of this Bessemer and Lake Erie project is that a modern form of d-c. coded track circuit equipment is used, by means of which the local field controls of signals are accomplished entirely by circuits in the rails, thereby obviating the need for line wire control circuits. Track circuit code at the rate of 180 per minute establishes control for the Clear aspect; 120 code for the Approach-Medium aspect and 75 code for the Approach aspect. Absence of code or improperly applied steady energy results in the display of the most restrictive aspect.

Other than on the traffic direction sections, as previously discussed, the track circuits are normally energized by code which feeds in the direction opposite to the direction of train operation. The signal lamps are normally lighted in double-track territory and are normally extinguished on single track. Approach indications in double-track territory are secured by means of reverse code which feeds in the same direction as the trains operate. The pulsations of this reverse code are spaced in the "off" periods between the pulsations of the signal control code. Time locking rather than approach locking is used so that no reverse coding or line wire circuits are required for locking purposes. The track-occupancy indications in single-track territory are controlled to indicate for a station-to-station block as a whole so that no line wires were required

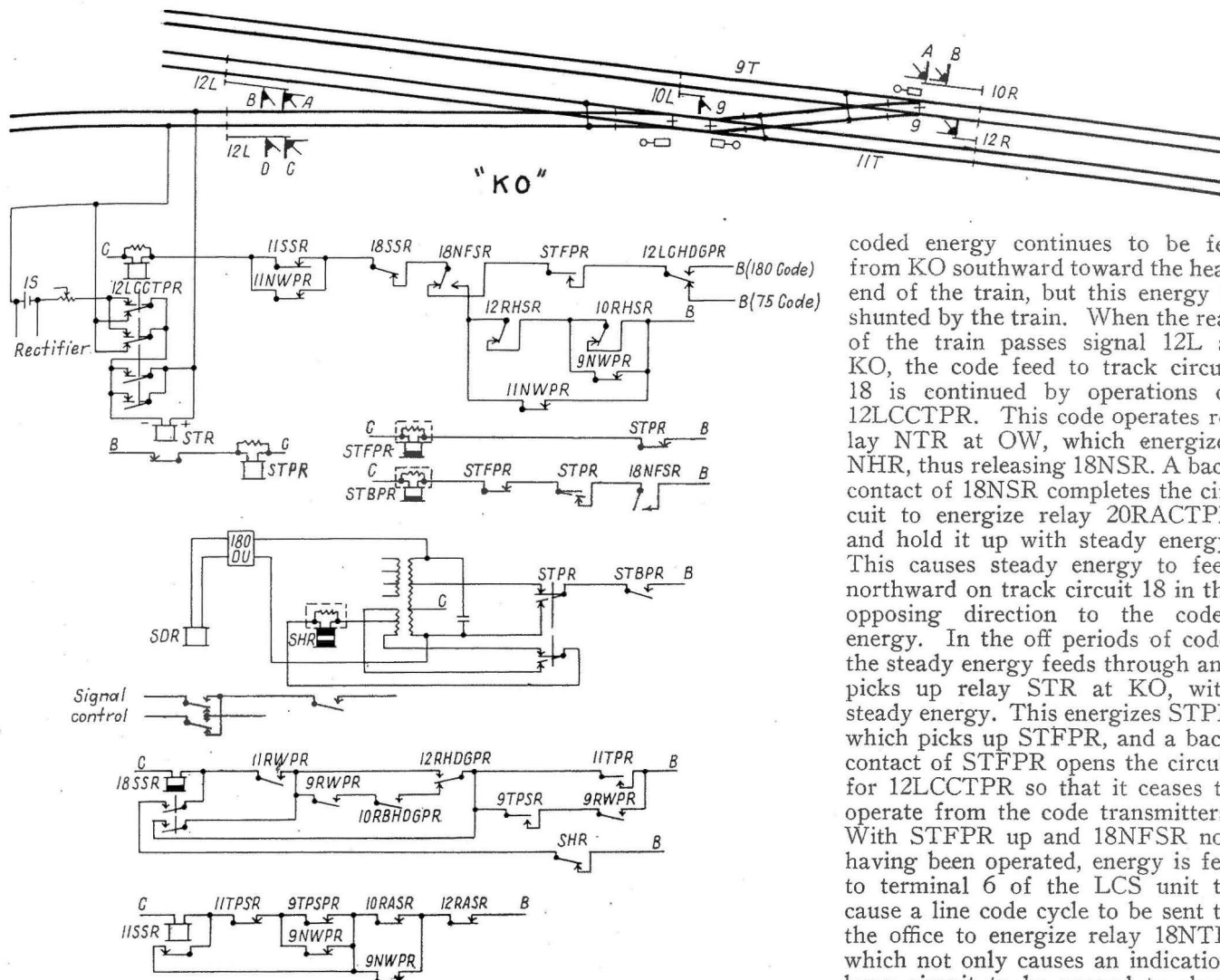


The line coding equipment is of the new Type L Form 506 including the new Style KP polar relays, thus affording flexibility in handling field storage units

station-to-station block indicator lamp circuit to be opened. It should be noted that when relay STFPR at KO is released due to the removal of

circuit for 20RACTPR is open, thus keeping this relay de-energized and preventing it from being energized steady or by pulsations from the

will de-energize relay 18STK and thus light the block indicator lamp showing that the block is occupied. As the train proceeds toward KO,



Right section of Fig. 2—Diagram of circuits

steady energy in the track circuit, an indication code will be transmitted to the office to de-energize relay 18NTK. The block lamp circuit contains back contacts in series of relays 18NTK and 18STK.

As the locomotive of the north-bound train passes signal 20LA and occupies track circuit 19T, relay 19TPSR is released, and with slow-release signal repeater relay 20LAHDGPR not as yet released, circuits are closed to pick up relay 18NSR which has two stick holding circuits, one which holds it as long as 19TPSR is down. Up to the time the locomotive passes signal 20R, relay NTR continues to follow code and relay NHR is energized. After the track circuit 18 north of 20R is shunted, relay NTR ceases to operate which releases relays NHR and NDR. The release of NHR closes the second stick holding circuit for 18NSR. While 18NSR is up, the

code transmitters, until such time as 18NSR is released. The release of relay NDR will cause an indication code to be sent to the office which

coded energy continues to be fed from KO southward toward the head end of the train, but this energy is shunted by the train. When the rear of the train passes signal 12L at KO, the code feed to track circuit 18 is continued by operations of 12LCCTPR. This code operates relay NTR at OW, which energizes NHR, thus releasing 18NSR. A back contact of 18NSR completes the circuit to energize relay 20RACTPR and hold it up with steady energy. This causes steady energy to feed northward on track circuit 18 in the opposing direction to the coded energy. In the off periods of code, the steady energy feeds through and picks up relay STR at KO, with steady energy. This energizes STPR which picks up STFPR, and a back contact of STFPR opens the circuit for 12LCCTPR so that it ceases to operate from the code transmitters. With STFPR up and 18NFSR not having been operated, energy is fed to terminal 6 of the LCS unit to cause a line code cycle to be sent to the office to energize relay 18NTK which not only causes an indication lamp circuit to be opened to show that the station-to-station block is occupied but also effects a release so that the traffic direction can be changed. The feed of steady energy northward from OW to KO is continued until a line code cycle is sent

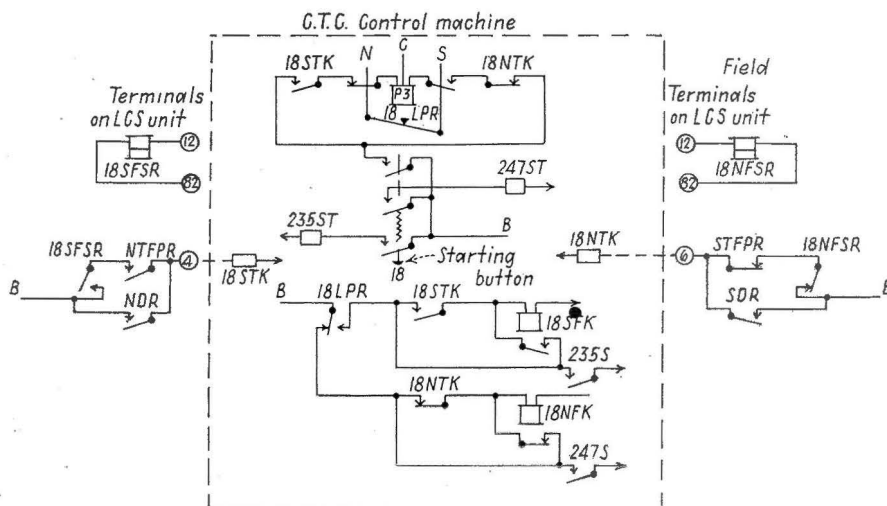


Fig. 3—Diagram of circuits in the control machine

out to clear signal 20LA again, or until cycles of line code are sent out to change the direction of traffic.

Changing the Direction

With the traffic direction established northward, and the north-bound train having cleared the block as proven by relay 18NTK in the office having been energized as pre-

the diagram, the cycle sent to OW includes impulses to reverse relay 18SFSR, while the cycle sent to KO reverses relay 18NFSR.

This causes steady energy to be sent from KO on the rails to OW which energizes NTR, NTPR and NTFPR. With contact of 18SFSR in the reverse position and NTFPR up, energy is fed to terminal 4 of the LCS unit to cause an indication

relay 737STFPR which closes a circuit to energize relay SCTP. Through front contacts of SCTP steady energy is fed to the right on track circuit 738T. A result is that, as previously explained, a relay is energized at the north end of the station-to-station block. Then when the northbound semi-automatic signal at the south end of the station-to-station block is to be cleared, the

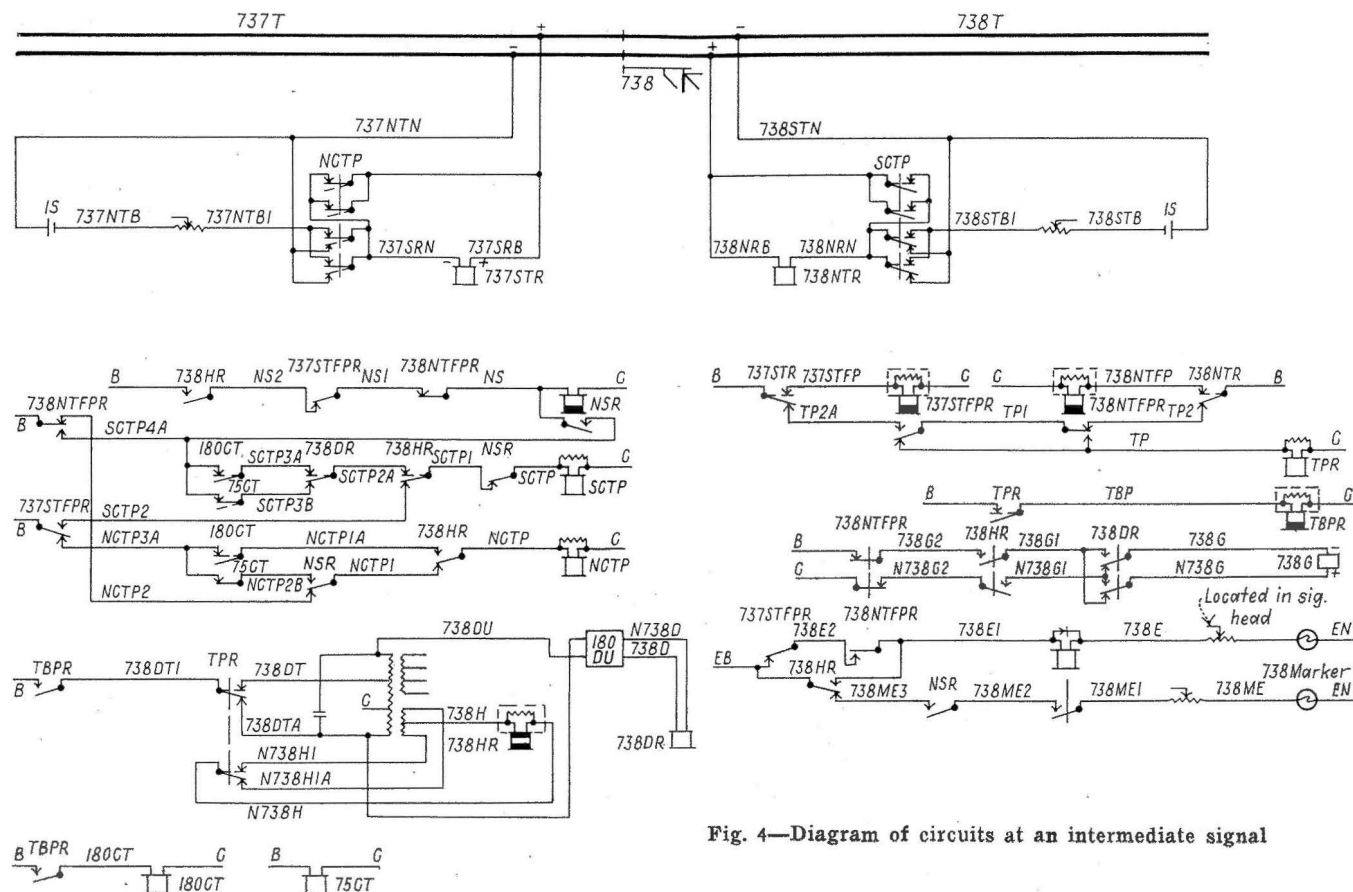


Fig. 4—Diagram of circuits at an intermediate signal

viously explained, the direction of traffic can be changed. With 18NTK energized, when the traffic lever is reversed to close contact S and the push button is operated, then energy is fed from battery to energize relay 18LPR in a direction which reverses the position of the polar contact. Relay 18LPR is of the biased polar type which will retain its polar contact in the last position of energization. Changing the position of the polar contacts of 18LPR, releases 18NFK which extinguishes the blue traffic-direction indication lamp for the northward direction. When the code starting button is pushed, code starting relays 235ST and 247ST are energized so that code cycles will be sent to OW and KO, but because of the fact that the polar contact of relay 18LPR is now in the position opposite to that shown on

to go to the office to energize 18STK which causes 18SFK to be energized, thus illuminating the blue indication lamp in the arrow pointing southward.

At An Intermediate Signal

As shown in the intermediate signal diagram, Fig. 4, traffic is established from right to left, which is southward. Steady energy is feeding to the left in track circuit 738T to hold track relay 738NTR energized. When changing the direction of traffic, this steady energy is removed, thus releasing 738NTR. Then, on account of controls previously explained, steady energy is fed from left to right, northward, in track circuit 737T to energize relay 737STR, a front contact of which closes a circuit to energize

steady energy feeding northward in track circuit 737T is cut off, and 737STR and SCTP are released to stop the flow of steady energy northward in track circuit 738T. As a result, coded track circuit energy feeds southward on track circuit 738T so that relay 738NTR follows track circuit code. A front contact of 738NTR energizes relay 738NTFPR, and because of its slow release, it stays energized as long as it receives an impulse at intervals of 75 per minute. A circuit feeds through the back contact of 738NTR, a front of 738NTFPR, a back of 737STFPR to cause TPR to follow track circuit code. A front of TPR energizes TBPR, and it stays up as long as it receives impulses. Through a front of TBPR battery feeds through front and back points of TPR, through the decoding transformer

to energize the signal control relay 738HR, to cause the yellow aspect to be displayed on signal 738 if the incoming track circuit code is 75.

A front contact of 738HR completes a circuit through a back of 737STFPR and a front of 738NTFPR to energize NSR.

Say for example that the incoming code is 75 and only 738HR is energized. A front of 738HR completes

be fed northward through track circuit 737T. This steady energy will feed through the coded energy being fed southward and will energize relay 737STR and its repeater relay 737STFPR. A back contact of 737STFPR opens the circuit for NCTP so that NCTP is not energized. A front contact of 737STFPR closes a circuit through a back contact of 738HR to a back point of

each minute which feeds 180 code southward in track circuit 737T to cause the next northward signal to display the green aspect, if the second train has not as yet accepted the yellow aspect.

At a Cut-Section

The diagram Fig. 5 shows the circuits at a track circuit cut-section, and, as drawn, traffic direction is southbound, steady energy being fed southward in track circuit 737T to hold track relay 737NTR energized. This cut section is a back contact coding cut section for northbound moves and a front contact coding cut for southbound moves. The purpose of back contact coding is to compensate for code distortion due to extreme length of track between signals. When control is sent out from the office to change the direction of traffic, the steady energy in track circuit 737T is cut off, and, after controls previously explained are effective, steady energy feeds northward on track circuit 737AT to energize relay 737ASTR, which energizes SCTP to cause steady energy to feed north on track circuit 737T.

Preparatory to clearing the northward semi-automatic signal at the south end of the station-to-station block, the steady energy feeding northward on track circuit 737AT is cut off, which releases 737ASTR which releases SCTP. When 75 code feeds southward in track circuit 737T, relay 737NTR follows code, which causes relay 737NTFPR to be energized, and it is sufficiently slow release that when the back contact of 737NTR closes, in following code, the circuit is made up to energize relay 737NTBPR, and it stays up as long as coded energy operates relay 737NTR. With relay 737NTBPR energized, relay NCTP is operated to repeat the code which is operating track relay 737NTR. Through front contacts of NCTP, track battery feeds coded energy southward on track circuit 737AT. Thus the track circuit code is regenerated at this cut section.

Signal Take-Away

After the track circuit code feed is established southward, if a control is sent out from the office to take-away the Proceed aspect of the northward semi-automatic signal at the south end of the station-to-station block before a train accepts it, then steady energy feeds northward in track circuit 737AT in opposition to the coded energy feeding southward in the same track circuit, but

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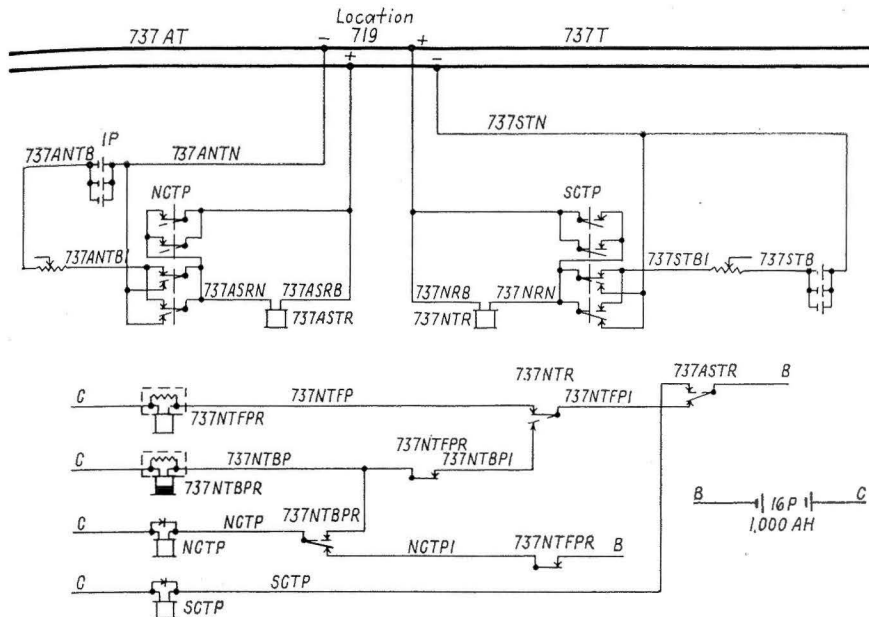


Fig. 5—Diagram of circuits at a cut section

the circuit to operate relay NCTP from the 180 code transmitter, and, through front contacts of NCTP, 180 code is fed southward on track circuit 737T, thus causing the next northward signal to display the green aspect. The 75 code transmitter operates continuously, but the 180 code transmitter operates only when relay TBPR is energized.

The pick up of the NSR relay was previously explained. When the locomotive of the northbound train passes signal 738 and shunts track circuit 738T, relays 738HR and 738NTFPR are released, but on account of the slow release of NSR, the stick holding circuit is made up through the back contact of 738NTFPR so that NSR is not released at this time. Therefore, after the rear of the train passes signal 738, the front contact of NSR is closed, and the back contact of 738HR is closed which will complete a circuit through a contact of the 75 code transmitter and a back contact of 737STFPR to cause relay NCTP to follow 75 code. Through NCTP, this 75 code is fed southward on track circuit 737T thus causing the contacts of directional stick relays at the next signal location to be released so that steady energy may

NSR, but this relay is up; therefore, relay SCTP is not picked up. As a result, no energy is fed southward on track circuit 737T.

On the other hand, if a second northbound train is to enter the station-to-station block while the leading northbound train is occupying track circuit 738T, then the steady energy feeding northward in track circuit 737 is cut off, which results in the release of 737STFPR so that with NSR up, battery feeds through a back of 737STFPR, the contacts of the 75CT, a front of NSR, a back of 738HR to operate relay NCTP 75 times each minute. Through front contacts of NCTP, track battery feeds 75 code southward on track circuit 737T to cause the yellow aspect to be displayed on the semi-automatic signal.

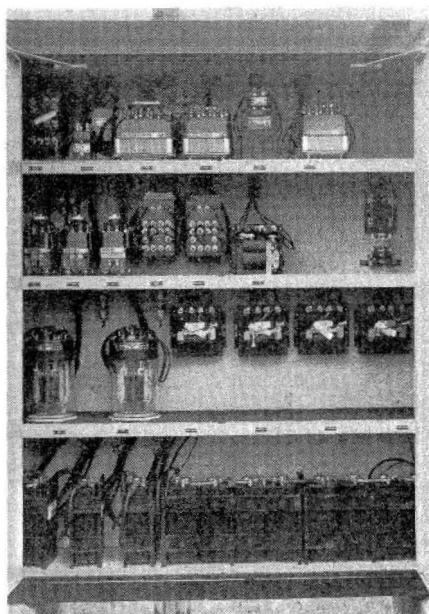
When the leading train clears track circuit 738T, the absence of steady energy feeding northward in track circuit 738T causes 75 code to be sent southward in track circuit 738T, which, as previously explained, causes the yellow aspect to be displayed on signal 738. Also, relay 738NTFPR is energized which releases NSR. Also, with 737STFPR deenergized and 738HR energized, relay NCTP is operated 180 times

C.T.C. on the B. & L. E.

(Continued from page 89)

the steady energy feeds through the code and picks up relay 737ASTR which stops the operation of NCTP instantly, thus cutting off the coded energy feeding southward on track circuit 737AT.

With 737ASTR energized by steady current, relay SCTP is likewise energized and stays up so that



Instrument case at signal location

steady energy is fed northward on track circuit 737T. Corresponding action occurs at the remaining intermediate signals as well as cut sections. Then at the north end of the station-to-station block, the incoming steady energy cuts off the outgoing track circuit code. Thus the circuit arrangement reverts to the normal condition.

Instruments and Housings

At the power switch layouts, the instruments and batteries are located in sheet metal houses. The code transmitters are the DM Type, operating on the pendulum principle. The code-following relays are the CD Type, and the various control relays are the DN-11 Type. All of the code transmitters, relays and signal mechanisms on this project are equipped with plug couplers as a means for replacing apparatus quickly without changing wire connections to terminals, and another advantage is that chances for making mistakes in connecting wires to relays is obviated.

This project includes the first installation of the latest U. S. & S. Co.

Type-L Form-506, 16-stop, 35-station time coding C.T.C. control system, including the use of the new Style-KP biased-polar line relays which have two front and two back contacts, thus permitting greater separation of circuits than is obtainable by employing relays with one front and one back contact. These Style-KP relays are used also as final sticks, the characteristic of these relays being that the polar contacts are retained in the position in which last placed. All the coding equipment is equipped with plug couplers.

Power Supply

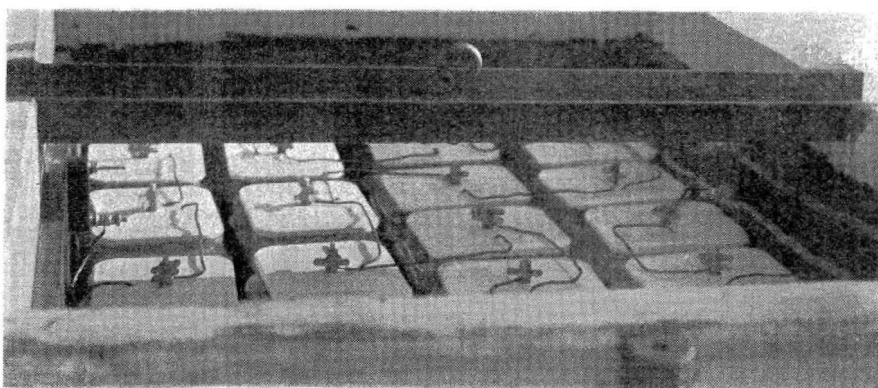
Commercial a-c. power at 220-volts was available at 13 different places on this territory so that only short power distribution line circuits were required to extend this power to all the switch layouts and to the intermediate signal locations. At each junction including line coding apparatus there is a 16-volt 12-cell set of Edison B6H storage battery on floating charge for operation of the code apparatus, and a set of 8 cells of the same type for operating the wayside equipment and to supply the operating coils of the searchlight signals. This battery also feeds the lamps in case of an a-c. power outage. At the intermediate automatic signal locations, a set of eight B6H cells feeds the code transmitters, the searchlight signal coils and acts as a stand-by for the lamps.

At locations where a-c. power is available for charging, each track circuit is fed by one cell of B4H

The rail joints are bonded with American Steel & Wire Company plug-type, mechanically-applied, rail-head bonds. The outer covering of multiple-conductor underground cables includes steel tape but no lead sheath, but the covering on the single-conductor cable for track connections includes no metal. The track connections are No. 9 except for those over 45 ft. in length which are No. 6 in order to insure proper operation of the track circuit coding. The bootleg outlets are on the gage side of the rails so as to be in a location which will not interfere when tamping under the ties.

No pole line had previously been in service along the double-track high line between KO and KY. Therefore, a new pole line was constructed in this section, using Class-3 western red cedar poles, butt treated. On the remainder of the territory the existing pole line was reconstructed as required to put it in first-class condition and to install new poles where increased clearance was required. The new code line circuit and the a-c. power distribution circuit, where required, are No. 6 hard-drawn copper wire with double-braid weatherproof covering. Also, where conventional d-c. track circuits were in service for the control of highway crossing signals, 5 and 7 conductor No. 14 aerial cables were installed to jump around the coded track circuits.

This centralized traffic control project was planned and installed under the jurisdiction of F. R. Layng, chief engineer, and under



Primary battery at intermediate track cut location

storage battery. At the track cut sections a set of 3 cells of Edison 1000-a.h. primary cells in multiple feeds the track, and a set of 4 cells of the same type in series feeds the repeater relay. At Greenville the line coding circuit is fed by a set of 21 cells of Edison N-2 storage battery.

the immediate supervision of G. R. Pflasterer, signal engineer. The major items of material as well as the detail circuit plans were furnished by the Union Switch & Signal Company which also handled the field construction with the exception of the pole line work which was done by railroad forces.