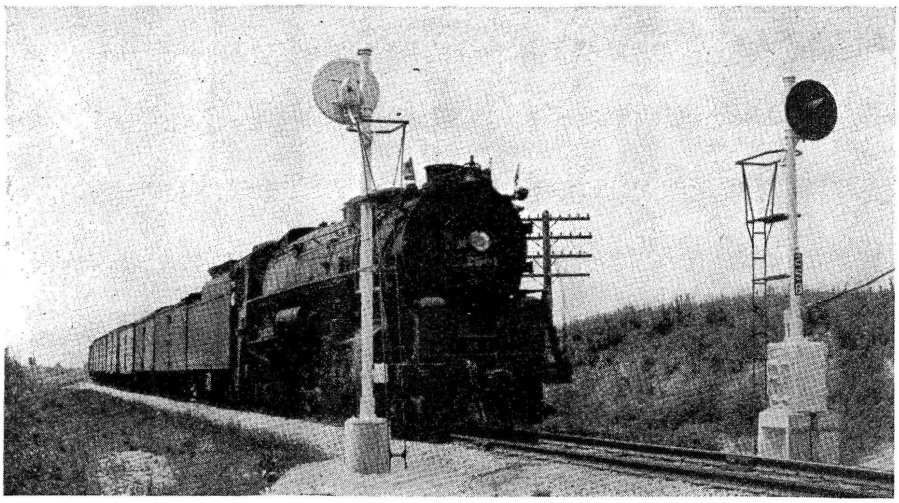


Signal Construction on the WABASH

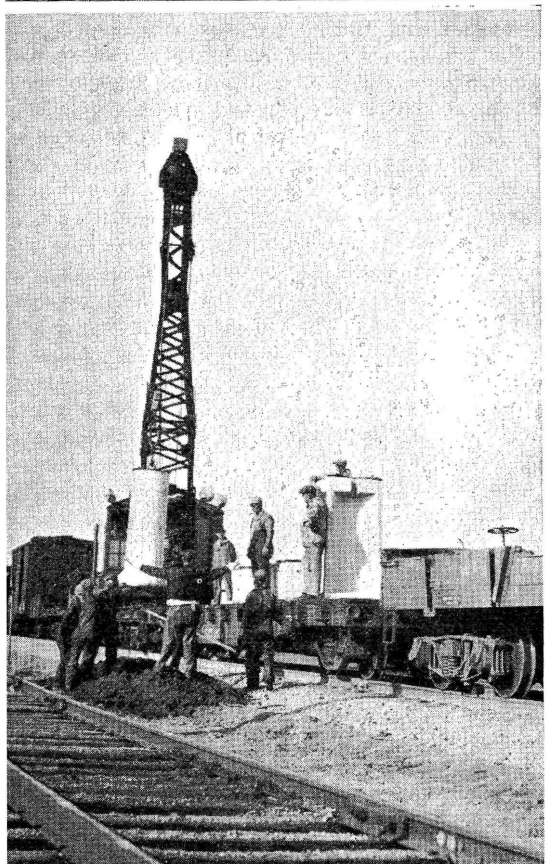
The installation of automatic signals on 116 miles of single track, which was authorized unexpectedly, is being constructed complete at the rate of one mile each working day by a force of about 45 men.

WHEN the management of the Wabash decided to equip 116 miles of single track between Orland Park, Ill., and Lodge, with automatic block signals, the reply from the signal department was " 'coming up,' will be in service in 116 work days." On the route between Chicago and St. Louis the Wabash has double track from Chicago to Orland Park, 23.2 miles, then single track to Lodge, 116.1 miles, and the remainder of the route is double track from Lodge through Decatur to St. Louis, 147.4 miles. The daily traffic on the Orland Park-Lodge territory includes 4 passenger and 5 freight trains each way, and 1 local train one way, totaling about 20 moves daily, which, with extra sections of passenger and freight trains, frequently totals about 24 trains daily.

In this territory the line, for the most part, traverses a rolling prairie country. In the vicinity of river crossings, such as the valley of the Kankakee, there are several curves and short grades. However, the majority of the line is comparatively straight and free from grades steep enough to affect tonnage ratings or the speed of passenger trains, and few of the curves are sharp enough to require speed restrictions below 60 m.p.h. The running time for the Banner Blue Limited between Orland Park and Lodge, 116.1 miles, with 1 regular stop and 1 flag stop, is 114 min., at the average speed of 61 m.p.h. Train No. 24, St. Louis to Chicago, in 4 hr. 55 min., which makes no stops in the Lodge-Orland Park section, is scheduled at 108 min., 64.5 m.p.h., in this territory. Freight trains speed is limited to a maximum of 50 m.p.h. Heretofore, train movements have been directed by time table and train orders. The automatic signaling was installed not only to reduce delays but also to improve safety in train operation. The decision to install signaling was arrived at without much advance notice, and it was highly desirable to get the signals in service as soon as possible. Instructions to prepare estimates and plans were received March 15; authority was granted April 6; material ordered April 1 to 15.

Starting on the program on such short notice, the signal department realized that no time could be allowed for pre-wiring cases or other work normally handled in advance of field construction activities, and, furthermore, the work would have to be handled on a schedule adapted to the delivery of materials. Fairly early delivery was possible for the cases, masts, ladders and searchlight signals, but delays were anticipated on shipments of relays and other instruments. This situation prevented the wiring of cases at a central point or the signal department shop.

It is the policy of the Wabash not only to handle its own construction work but also to build up its construction forces by promoting the regular forces to form a nucleus, then hiring only enough new men to complete the organization. This procedure offers training to a maximum number of men, and at the same time stimulates their interest to gain further promotion, while earning a higher hourly rate during construction periods. Based on scheduled dates for



delivery of materials, it was decided that one organization of about 45 men was about all that could be used effectively. On account of the number of train movements, it was desirable to reduce to a minimum, not only the number of work trains, but also the operation of motor cars to distribute materials and handle men.

In view of the controlling circumstances, it was decided that pre-cast signal foundations should be used, that the signals should be assembled complete with masts, ladders and bases or cases at a central point in the field, and then set, and that the terminal boards be wired complete at the shop, then placed in the cases as the relays were installed.

Type of Signaling

Signals are the Union searchlight type equipped for operation on 10 volts, d-c. Each signal is mounted on a mast to bring the center of the lens 15 ft. 3 in. above the level of the rail, so as to be in direct line with the engineman in the cab of the locomotive. The signal lamps are single-filament and are rated at 10 volts, 5 watts, or 11 volts, 11 watts where deflecting cover-glasses are used. Special efforts were made to obtain the maximum efficiency in the indication by providing deflecting cover glasses or spread lens where they would be of any benefit. In one group of 22 signals, 2 were equipped with a 30 deg. spread lens, 3 with 20 deg. and 6 with 10 deg. deflecting cover glasses. Approach-lighting control is used for all signals. Direction signal lighting control is used. Signals are lighted on approach from signal to signal, with the exception of the "A" signals or head-blocks, which are lighted when the train passes the opposing "A" signal. For receding movements, the signals are lighted for only one track circuit. The series line approach-lighting relays are the DN-22 type of the Union Switch & Signal Company, having two front and two back contacts. This relay meets the A.A.R. specification 15432, and is considered by the Wabash to be a more rugged and reliable relay than has been used for this purpose in the past.

The signaling is arranged for operation on the absolute permissive block system. The signals are controlled to three aspects by a polarized line circuit connected to the searchlight relay. The line to the rear is polarized through contacts in a 350-ohm, DN-18, d-c. slow-pickup, slow-release relay, which, in turn, is controlled by contacts in the signal to repeat yellow and green positions. The use of this slow-pickup, slow-release relay prevents "flips" of the signal aspects due to the operation of light engines at high speeds. The track relays are the DN-11 type, rated at 4 ohms.

At a total of 18 passing tracks in the territory, a set of double-signal head-blocks are located about 10 ft. from each passing track switch. Each station-leaving, head-block signal is an absolute stop signal, and is so designated by the absence of a number plate and by a marker consisting of a yellow disk 14 in. in diameter, with a raised letter painted red and outlined with red reflector buttons. This marker is mounted on the face of the mast 7 ft. below the signal unit.

Where the distance between passing tracks is a minimum, there is, in all instances, at least one set of single, staggered, intermediate signals with a minimum of 4,000 ft. stagger. However, in a number of instances, two or more sets of double intermediate locations are used, so that the block spacing averages about 1.8 miles long. A total of 106 new automatic signals were required, and 16 new two-unit and 3 dwarf searchlight signals were installed to replace semaphore signals at interlockings. The new signaling passes through a total of eight interlockings, which were modernized by installing automatic distant and semi-automatic home signals in place of wire and pipe-connected signals. This extra work at the interlockings delayed progress on the construction program.

The controls are so arranged that when a train passes an intermediate signal for the opposing direction, that signal continues to display the stop aspect until the train clears the block, although the light remains only through one track circuit. With this arrangement, if a train stops between stations, it does not have a clear signal to authorize a back-up move.

The switch circuit controllers are the U-5 type, equipped with a spring which will operate the controller if the rod becomes disconnected. The rod is equipped with a ball-and-socket joint at both ends. The line control circuits are not broken through switch circuit controllers. Switch-position protection is effected by series-opening and shunting the track circuit. As the insulated joints at head-block signals are located only 10 ft. from each passing track switch, no extra insulated joint is required to get this result. The cut sections, where possible, are located adjacent to the main line switches to eliminate the additional insulated joint.

A 220-volt, single-phase circuit feeds power over the teritory, feeds being spaced about 10 miles apart.

At each a-c. line tap, the line wires were dead-ended and the ends connected by a Kearney Connectite, so that the maintainer can sectionalize or disconnect for test between locations. The feed line is not continuous, because gaps are left the length of an automatic block between the two ends of adjacent feed sections. Thus the line is not designed to be fed through from section to section. However, all the feeds are fairly reliable and the storage battery reserve is considered adequate to carry over any ordinary a-c. outage. At each signal location the 220-volt circuit is extended directly to a 220-volt, RT-21 rectifier. The signal lamps, signals and line circuits at each location are fed directly from five cells of Gould storage battery. At the head-block locations, 60 a.h., type MPRE-307 cells are used, and at intermediate locations, 60 a.h., type HRC-7. Each track circuit is fed by three cells of Columbia high-voltage, type 572 primary battery in A.A.R. rectangular jars, connected in multiple, with a 2.5-ohm Raco limiting resistance.

Activities Start

Having placed orders for the materials, attention was turned to the preparation of plans and organization of field forces. First, a complete track and signal plan was prepared, and consideration was given to the preparation of typical circuit diagrams for different types of signal locations. However, a brief study showed that, on account of the numerous existing highway-crossing signal locations and interlockings to be passed through, the variations in circuits were so extensive that there would be so many deviations from standard that typicals would not help. Therefore, it was decided that a complete set of detailed circuit diagrams must be prepared, as past experience proved that typical plans do not facilitate the wiring to a desired extent, nor perpetuate the record for maintenance reference or future changes. Four signalmen on the Wabash, who had previously had some experience in circuit work or drafting, were called to the office for preparation of plans.

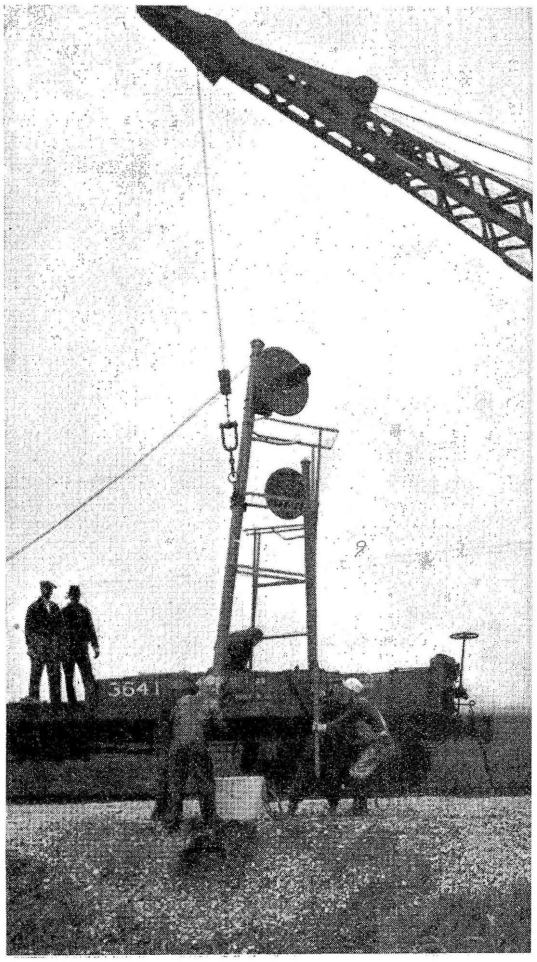
Materials for the first 43 mile section, Orland Park to Reddick, were shipped to Orland Park. A crew of about 40 men, with living cars and cook, was assembled at this place.

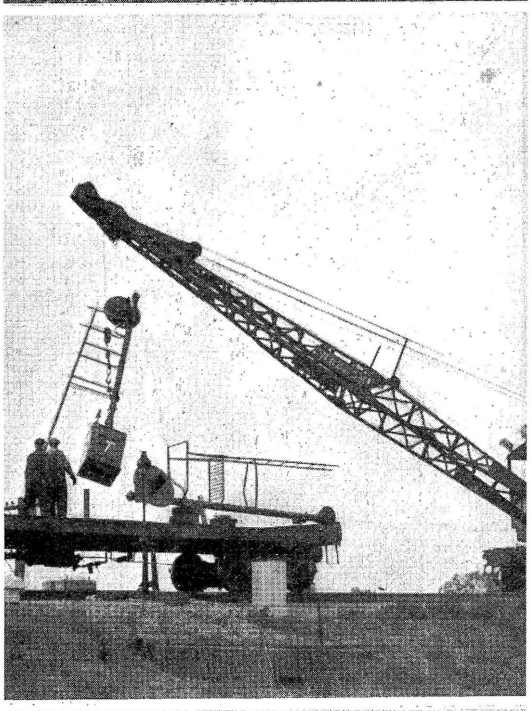
Pre-Cast Foundations Are Set

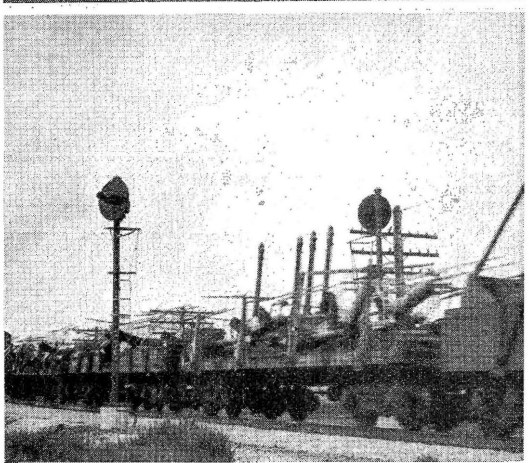
The pre-cast concrete signal foundations were furnished by the Massey Concrete Products Corp. and shipped in car lots to Orland Park. Field construction work was started with a small crew on May 10. Starting a day or two before setting the foundations, a crew of 14 men dug the holes for foundations on the 43 miles Orland Park to Reddick. On May 11, the 25 foundations were set in a total work-train time of 6 hr. 50 min.; 1 hr. was required in switching, 1 hr. 10 min. was lost in getting in the clear for other trains, so that the net time at locations and moving on the line was 4 hr. 40 min. After arrival at a location, two signal foundations could be set in five to six minutes.

This train was made up with three cars of foundations, using a power crane to lift and set the foundations. This crane, with a 50 ft. boom, and powered by a gasoline engine, is a general utility machine used any place on the Wabash to unload or load special lading, handle bridge materials, etc. A special advantage of the crane is that it can be cut-in to be self-propelled. This feature is a help in making a direct pickup of a foundation from a car, as well as making a careful "straight down" setting of a foundation or complete signal. Five men of the signal force, the crane operator and the regular train crew manned the work train.

A special plate-type clevis, designed and made by the Wabash, saved time in setting the foundations, because with this device it was not necessary to remove or replace the nuts on the anchor bolts. As shown in one of the illustrations, this clevis was made up of two steel plates 1 in. thick, of a strength which will not permit bending when lifting a concrete foundation. One plate is bent to fit over the other, and they are then welded together. A 1-in. hole is drilled and an eye bolt set through the center. In each end of each plate, a vertical slot is cut, wide enough for an anchor bolt. These slots are not cut at right angles to the edge of the plate, but are curved to correspond to a circumference of a circle with a diameter equal to the distance between diagonally opposite anchor bolts. When preparing to lift a foundation, the nuts are run up on the anchor bolts, the plate is then laid down between the bolts and is revolved so that each of the four slots fit around a bolt under the nut. A small wedge-shaped piece of flat iron is then dropped into the cross notches, thus enclosing the bolt all around, thereby preventing the plate from slipping off the bolts. After the foundation is set, the small wedges are lifted, the plate is quickly turned and released, no time being lost in taking nuts off or replacing them. Two different plates, as explained, were required,







one for the ground-signal foundations with 11 11/16-in. centers and another plate for the instrument case foundations, having 22 by 25½-in. bolt centers.

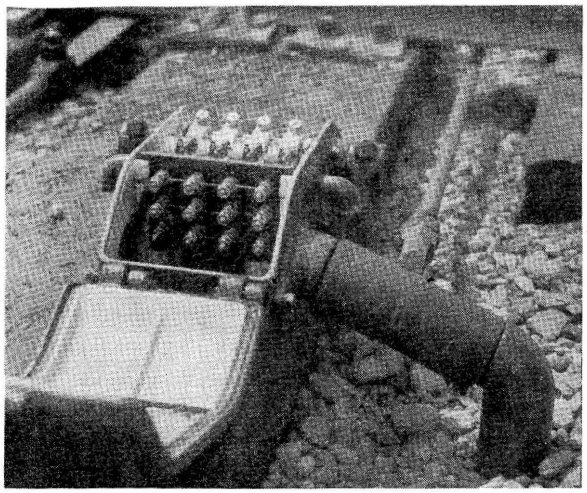
Other Work Under Way

A small track crew with a track foreman and accompanied by a signalman, went through the entire territory to handle the track work chargeable to the authority for expenditure for the signaling. This included installation of the insulated rail joints and respacing of ties to get them properly located under these joints; installation of insulated switch rods; drilling switch points for the foot for the switch circuit controller connection rods; placing new switch ties where needed; and raising crossing planks to permit the installation of bonds. The signalman instructed the track forces how to assemble the insulation in the joints, and worked along with the crew, it being his duty to install the switch circuit controllers, drill and bond joints in road crossings and throughout the switches and turnouts. By thus having one track gang do this work for the entire 116 miles, uniform results were obtained with efficiency.

Assembly of Signals

The first car of signal material arrived at Orland Park on May 10. The cars were unloaded and the masts, ladders, base-of-mast cases and searchlight signals were assembled complete. The signal-operating relays were shipped separate and were installed later. In the meantime, a part of the force was busy installing underground parkway cable, bonding the track and handling the line work.

When the signals for the first 43 miles were assembled, they were loaded on flat cars and a work train was made up including the same power crane as was used to set the foundations as explained previously. The concrete battery boxes for use at battery feed cut sections were loaded on a separate car and were unloaded by hand to save time at the locations as required. This train was operated on May 27, and was manned by eight men of the signal force and a foreman, in addition to the crane operator and regular train crew. Three men on a motor car followed the train to tighten the nuts on the anchor bolts, set the ladder foundations, etc. The time required at a double location to set one signal complete with case and the other signal with mast only, was from four to five minutes. The total elapsed period from the time the train stopped until it was moving again ranged from five to seven minutes. At locations where the train had to be cut to get proper location for lifting or setting, eight to nine minutes elapsed from the arrival to the leaving time at a location. A stop of about one minute was required to unload each of the concrete battery boxes at eight locations.

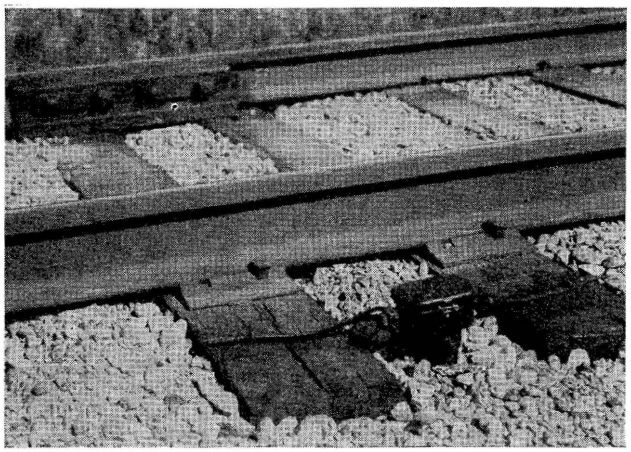


A flexible conduit extends between the box and riser

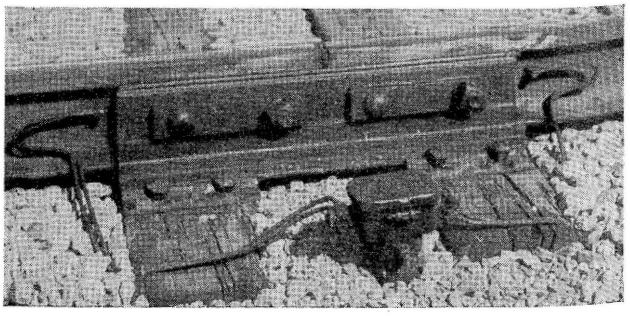
The train arrived at Orland Park at 6:30 a.m., and the work was completed at Reddick at 4:50 p.m. In addition to setting the 25 signals for the 43 miles, considerable extra work, setting foundations at the Reddick interlocking, was handled on this trip. About 2 hr. 15 min. was lost getting out of the way of other trains and taking water.

Further Progress Made

With the signals in place, the remainder of the construction work was handled by assigning different men to specialize on certain parts of the work. On the sections where the underground cable was not as yet installed, a crew of six men and a



The bootlegs for both rails are on the case side of the track with long cable connections to far rail stapled to the side of the ties



Standard length connections are used at the bootleg for the rail on the case side of the track

signalman handled this work, completing an average of five locations each day. The connections from the rail to the instrument cases are No. 9 single-conductor cable made up with 5/64-in. wall insulation, tape jute, etc., but no metallic sheath. Cast-iron bootleg outlets are used, a special

The two-spindle drilling machine

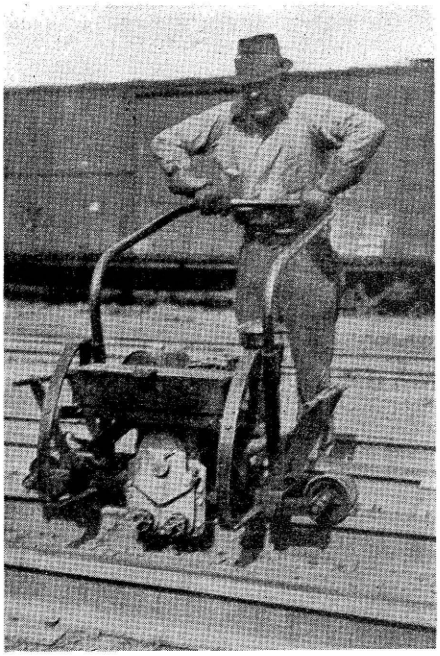
feature being that the bootlegs for both rails are located on the side of the track on which the case is located. The advantage of this is that the ballast is not disturbed when digging trenches for cable. The connections from the bootleg to the rail are stranded Copperweld bare cables with plug connections into the rail. The connections to the far rail are 9 ft. 6 in. long and are stapled to the side of the ties just above the ballast. The runs from a case under the track to a signal on the other side, are in two cables, one five-conductor No. 12 for controls, and one two-conductor, No. 9, for lamp circuit. This cable is made up with jute and non-metallic sheath.

At each switch circuit controller the cable comes up through a cast-iron riser with a flanged top. The cable entrance on the box also has a special flanged adapter. After the cables are installed, the 8-in. gap between the elbow and the box is enclosed with a section of Condor split insulation, held in place with clamps, thus forming a flexible conduit between the riser and the box to allow for vibration of the tie. This cable entrance was designed by the Union Switch & Signal Company for this installation.

The single-conductor cable was received on non-returnable reels, each reel holding a length of 500 ft. These reels were light enough to be handled readily and were hauled out on motor cars, set up on spindles, and the cable reeled off as used, thus reducing waste and preventing damage in handling bundles of short lengths.

Bonding on Schedule

The track bonding was handled by a crew of three men. The bonds are the rail-in-head, plug type, three types of bonds being used, the Raco stranded type No. 424, the Raco ribbon type No. 370, and the A. S. & W. Co. stranded type No. BA-2M. Each bond requires two 3/8-in. holes, 3/16 in. deep, in the side of the rail head. These holes were drilled with an Ohio Brass Company drilling machine with two spindles, so that both holes could be drilled simultaneously. A man operating one of these



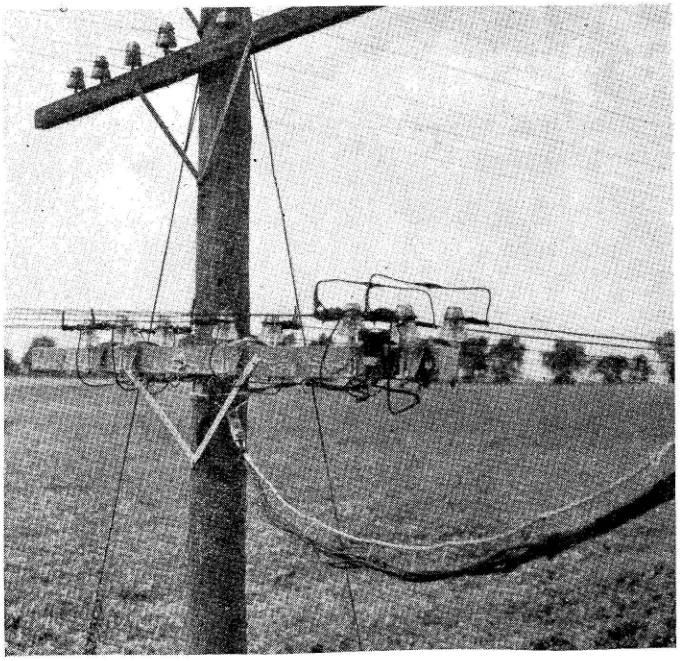
Drilling machine in operation

machines could drill about two miles of track daily. Two men applied the bonds. This crew made such fast progress that they would get ahead of the gang, and, at times, these men were put on other work.

Pole Line Work

The power distribution line wires and the line control wires were run on new crossarms applied to the existing pole line. The two wires for the 220-volt, a-c. distribution are No. 8 copper with double-braid weatherproof covering. The line control wires are No. 10 Copperweld with double-braid weatherproof covering.

The crossarms were unloaded at headquarters where the pins and braces were applied. Single arms were used at signal locations, Ohio Brass Company No. 16504 strain brackets being used. The arms were then loaded on trailer flat cars pulled by motor cars, and distributed. The insulators were applied in the field before mounting the arms. The coils of line wire were hauled out on motor cars and pulled in by hand. This line work was handled by a crew including seven to nine linemen and the same number of helpers, all signal department employees. This crew completed the line work on an average of seven



View showing cable construction and strain bracket arms

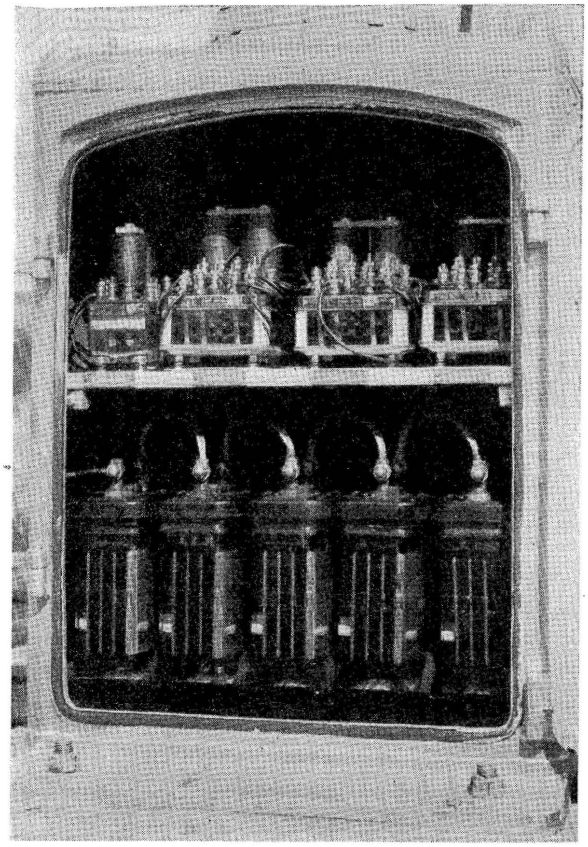
miles each week, and, in addition, when they got ahead of schedule, were used to dig holes for the signal foundations. The crew was equipped with living cars and a cook, so that they could be moved along independent of the crew handling the strictly signal work. The bonding crew lived in the same outfit cars, because the bonding was ahead of the other work.

As a part of the signaling program, a telephone in an outside booth, with connections to the dispatcher's line, was installed at each end of the passing tracks.

Line Cables

After the crossarms and line wires were in place and the signals set, one lineman and a helper, using a motor car, made up the cables from the line poles to the cases. These cables were made up with No. 14 single-conductor, with 4/64-in. insulation tape and braid, for controls, and No. 12, with 5/64-in. insulation, for a-c., and were run loose in Blackburn Copperweld cable rings on a stranded galvanized messenger. This practice not only saves time in construction, but also permits application of cable paint, changes or additions to be made readily, and, furthermore, the free circulation of air between conductors permits dampness to evaporate readily, thereby reducing deterioration of the covering and insulation.

A wireman and helper with a motor car came along next to ring out and tag the cable, make and solder the line taps, mount the Crystal Valve, 220-volt arresters on the crossarms, and install the 5/8 in. by 8 ft. Copperweld ground rods and connections. These men also ran the wires up the masts to the signal mechanisms. A crew of one signalman and two helpers used a large motor car to haul the relays and batteries from headquarters to each location, unpack the boxes and set the relays and battery in the cases. This crew also distributed the ground rods.



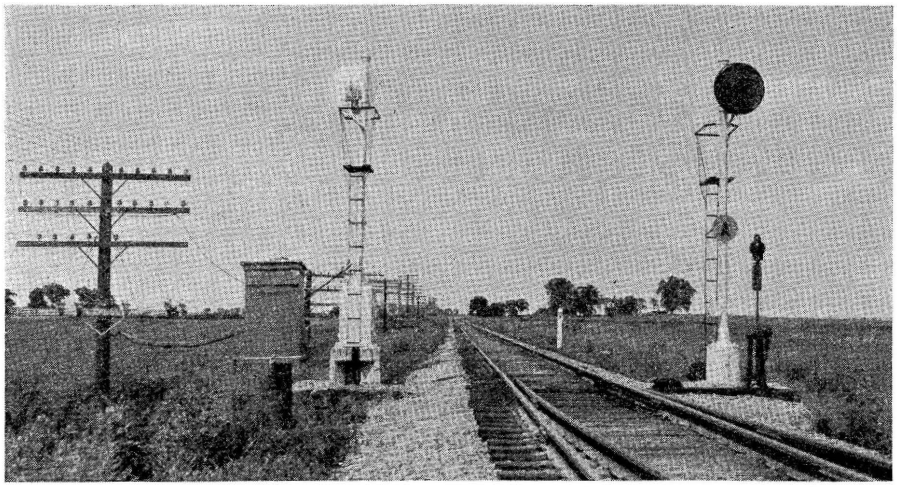
Storage cells are housed in cases

Field Wiring

The wiring was handled by three crews, each consisting of a wireman and a helper. As mentioned previously, the case linings were wired in the shop at Decatur. One wireman and a helper were employed on this work. Therefore, on arrival at a case, the wireman had his case lining complete with arresters, terminals, resistance units, jumper wires, tags, etc., all complete. The first work was to connect the underground and line cable conductors to the terminals or arresters. Then the Raco fused cutout for the 220-volt, a-c. circuit was set in place, and the rectifier installed. All 220-volt terminals were equipped with Raco insulated cover nuts to prevent accidental contact with this circuit. The relays were then set in place and the jumper wires were connected. The wires going to the searchlight signals were also connected at the signals. The cells of battery were then connected, the fuses were installed, and the charging rate adjusted. A wireman and a helper can do all this wiring work on the average of one signal each working day.

Two outfits, each consisting of an assistant wireman and helper, connected up the wires in the switch circuit controllers and battery boxes. Inside each battery box, three Bakelite-based A.A.R. terminals are mounted on a board on each side of the box, the idea being to provide separate connections and terminals for each cell connection, so that any cell can be removed or replaced without dropping the track relay. The No. 808 type Raco adjustable limiting resistance is mounted on the board at one end of the box.

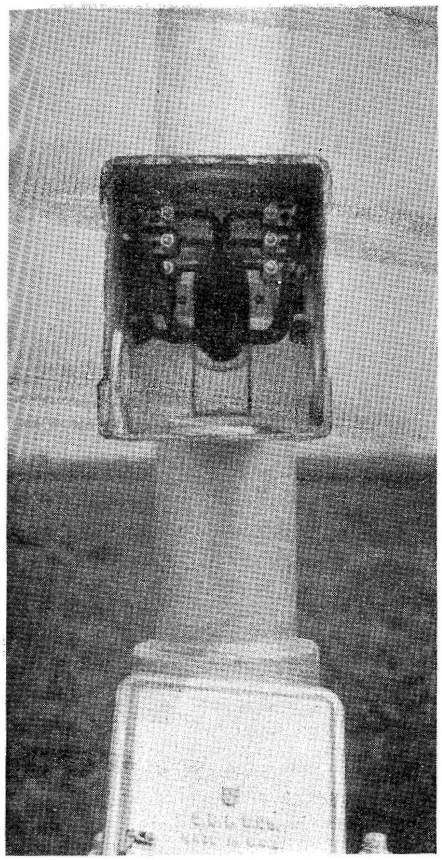
One signalman, working alone, followed the wireman, to make a careful check of the wiring, charging rates,



Each absolute signal is designated by a reflectorized "A" marker

lamp voltage, etc., and to focus the signals. A leading signalman and several men formed the cleanup gang, which did the painting and removed discarded interlocking signals, old trunking at distant signal locations, highway-crossing cut sections, etc. The leading signalman of this crew re-checked the adjustment on switch circuit controllers.

When assembling the signals in the yard at Orland Park, an extra coat of red lead paint was put on the mast at all places where ladder clamps and signal U-bolts were to be applied. After the signals were set, red lead was



The underground cable terminates in a junction box on the mast and single conductors extend up to the signal

used to touch up any spots where the paint was scratched off during handling. After the other work was completed, two coats of aluminum paint were applied to the ladders, masts and signals; the face of the backgrounds being painted two coats of dull black.

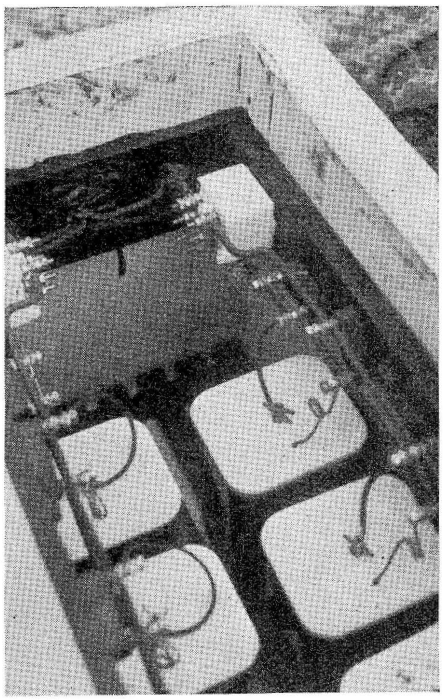
Inspection Work

The field inspection is handled by an inspector and assistant, with two signal helpers of the field force, reporting to the general inspector, independent of the construction forces. Case and wiring plans are checked by the inspector who is then ready for the field check. The case and location check includes a check of tagging and the position of all connections on relays and terminal board, followed by a check of correct size of wires in accordance with its function, line drops, clearance of guy wire, pot heads, rail connections, track insulation, switch circuit controller and connections, proper fouling clearance and the focus of lights. An electrical check includes a check of all circuits to determine current flow and proper operating voltages to the various units. Ground readings are also taken. A circuit check includes a complete operating test of each circuit by opening or closing control relays in accordance with circuit plans, and a service test is made by simulating train operation by means of track shunt wires. An observation test is made from engine cab, rear end of train, and from the ground, as trains pass.

Placed in Service

When the final approval is given by the inspectors, the signaling is cut in service in sections of 10 to 15 miles. The 43 miles from Orland Park to Reddick was all in service by July 20, and considerable work was already done on the next section. At the present rate of progress, the signaling is being completed at the average rate of about a mile per working day, and indications are that this average will be increased as the job progresses.

The entire project is being handled by signal department forces of the Wabash, the major items of material being furnished by the Union Switch & Signal Company.



Primary battery feeds track circuits

The terminal boards were wired at the shop