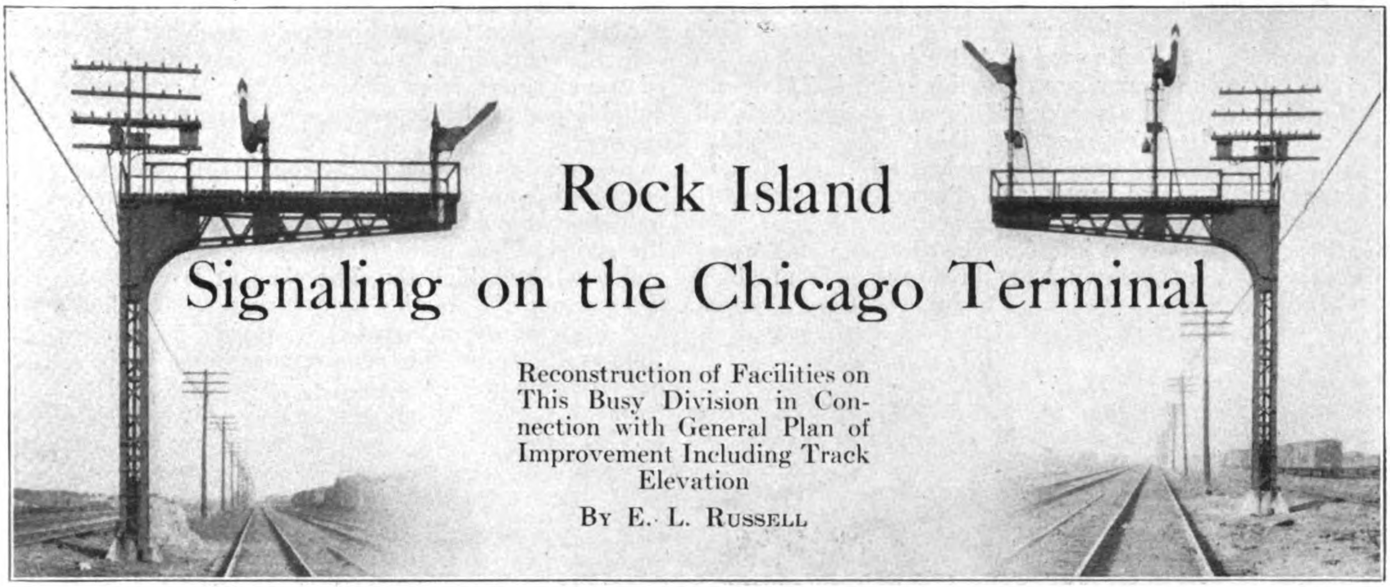


Rock Island Signaling on the Chicago Terminal

Reconstruction of Facilities on This Busy Division in Connection with General Plan of Improvement Including Track Elevation

By E. L. Russell

Two Cantilever Bridges on the South Chicago Line

As a part of the general plan of improvement on the Chicago Terminal division of the Chicago, Rock Island & Pacific, a complete rearrangement of tracks will be effected by the elevation work on approximately 20 miles of line. Up to date 3.1 miles on the main line between Seventy-second street and Eighty-third street have been permanently rearranged, and 6.7 miles of the suburban line between Beverly Hills and Rock Island Junction, South Chicago, has been arranged in a temporary way. The importance of this line may be understood when one considers that it is the only railroad reaching the heart of the city direct. All suburban as well as main line trains pass over this section of track, the week-day passenger service requiring 110 trains to and from the city.

The present arrangement of tracks between Twenty-fifth street and Seventy-second street has undergone no change, but the old layout in the zone between Seventy-second street and Eighty-third street, which consisted of a double-track main line for passenger traffic and a third for freight, has been rearranged for four main-line tracks, with provision for five ultimately, and a sixth making connection with the Belt Railway of Chicago to reach Clearing, Ill.

A mechanical interlocking at Seventy-ninth street, which was installed in 1889, with 69 working levers, has been supplanted by a grade separation between the Rock Island and the Chicago & Western Indiana tracks. Considering the increased number of train movements, greater safety and efficiency of operation are effected thereby.

The original automatics between Twenty-fifth street and Eighty-third street were disc and semaphore signals of various types. The disc signals, which were controlled and operated by gravity battery, were replaced in 1913 by top-of-mast semaphore signals operated by line-charged storage battery, the controlling track circuits being energized by similar means.

The decision to replace the d. c. track circuits with a. c. in all territory south of Sixty-third street was reached principally on account of interference from foreign current in the vicinity, occasioned by the proximity of street car lines paralleling and crossing under grade and the nearness of street car sub-stations to the main line. This territory has, however, as above noted, some d. c. signals operating from storage battery which it was not considered desirable to change to a. c. operation on account of the late change to storage battery. These signals are giving satisfaction as lately installed.

The remaining territory which will undergo a change, both in track arrangement and signaling, consists of the interlockings at Eighty-ninth street, at present a grade crossing with the B. & O., and Burnside, a grade crossing with the Illinois Central.

In order to handle safely and efficiently a heavy suburban traffic with frequent suburban stations, it is necessary to space signals close together, and this in turn necessitates double distant indications.

A. C. Power

Paramount in any railway signaling system is the continuity of service, and to guard against any great interruption due to a failure of energy supply, two automatic sub-stations have been installed, one at Eighty-ninth street and the other at Sixty-third street.

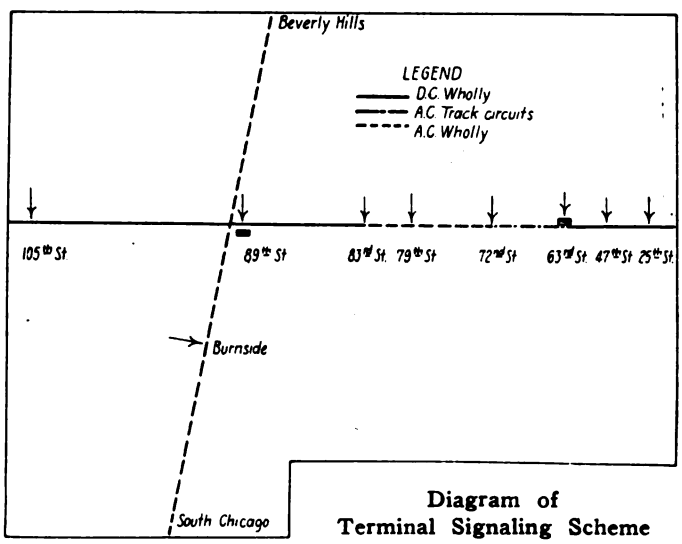


Diagram of Terminal Signaling Scheme

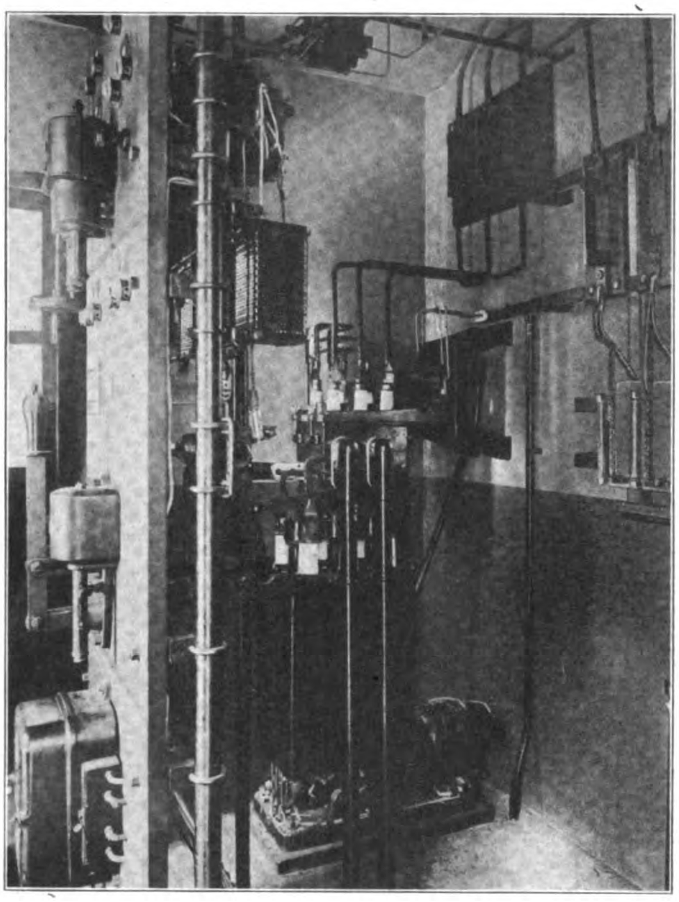
The Eighty-ninth street sub-station at present receives energy from two independent sources at 2,200 volts, three-phase, 60 cycles, and feeds all a. c. operated units from Beverly Hills to Rock Island Junction, South Chicago. This sub-station will also feed all a. c. units from Eighty-ninth street to One Hundred and Fifth street.

The Sixty-third street sub-station receives its energy from two independent sources. The preferred source is from the company's shops at Forty-seventh street. This is transmitted to Englewood at 440 volts, three-phase, 60 cycles. The emergency source at this point is 2,200-volt, 60-cycle, three-phase power. This sub-station feeds all a. c. operated units from Sixty-third street to Eighty-third street and contemplates serving all track circuits between Sixty-third street and Twenty-fifth street, if occasion demands their change to a. c.

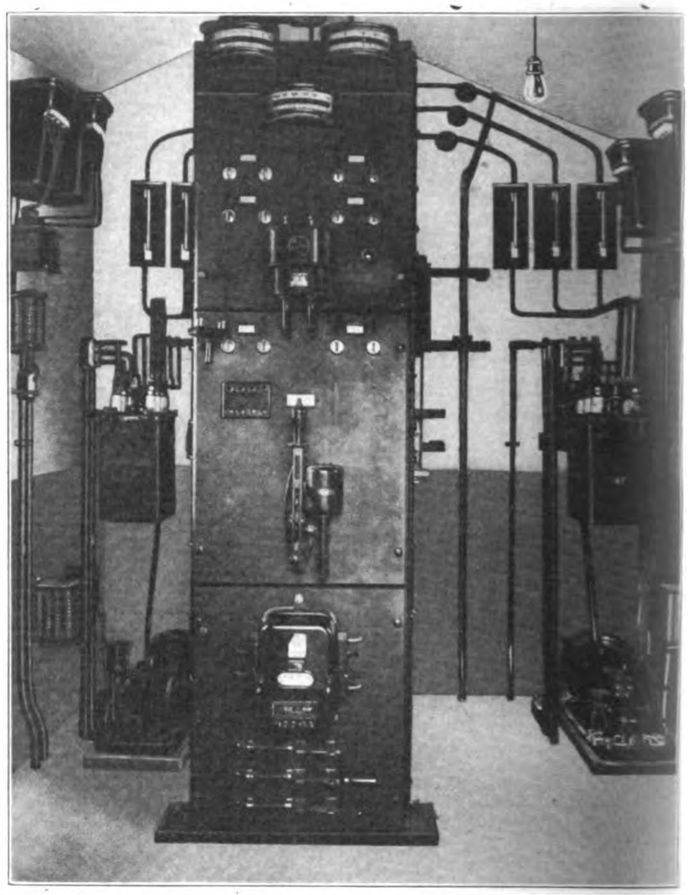
It is the purpose to interconnect the two sub-stations so that any a. c. signal will have three sources from which to draw energy. A section of territory not yet elevated prohibits the interconnection of the two stations at present.

D. C. Power

Power for operation of the d. c. signals between Twenty-fifth street and Seventy-second street as well as all track circuits from Twenty-fifth street to Sixty-third street is supplied from storage battery housed in concrete battery wells at each location. A charging line parallels the right-of-way and is energized from a motor-generator set in the interlocking tower at Forty-fifth street. Two motor-generator sets have been provided at this place, one a d. c.-a. c. set and the other a d. c.-d. c. set, so that it is possible to change if one fails. A third source, the 220-volt d. c. line from the Forty-seventh street shops, is available to float batteries indefinitely if necessary.



Front Interior View of Automatic Sub-Station



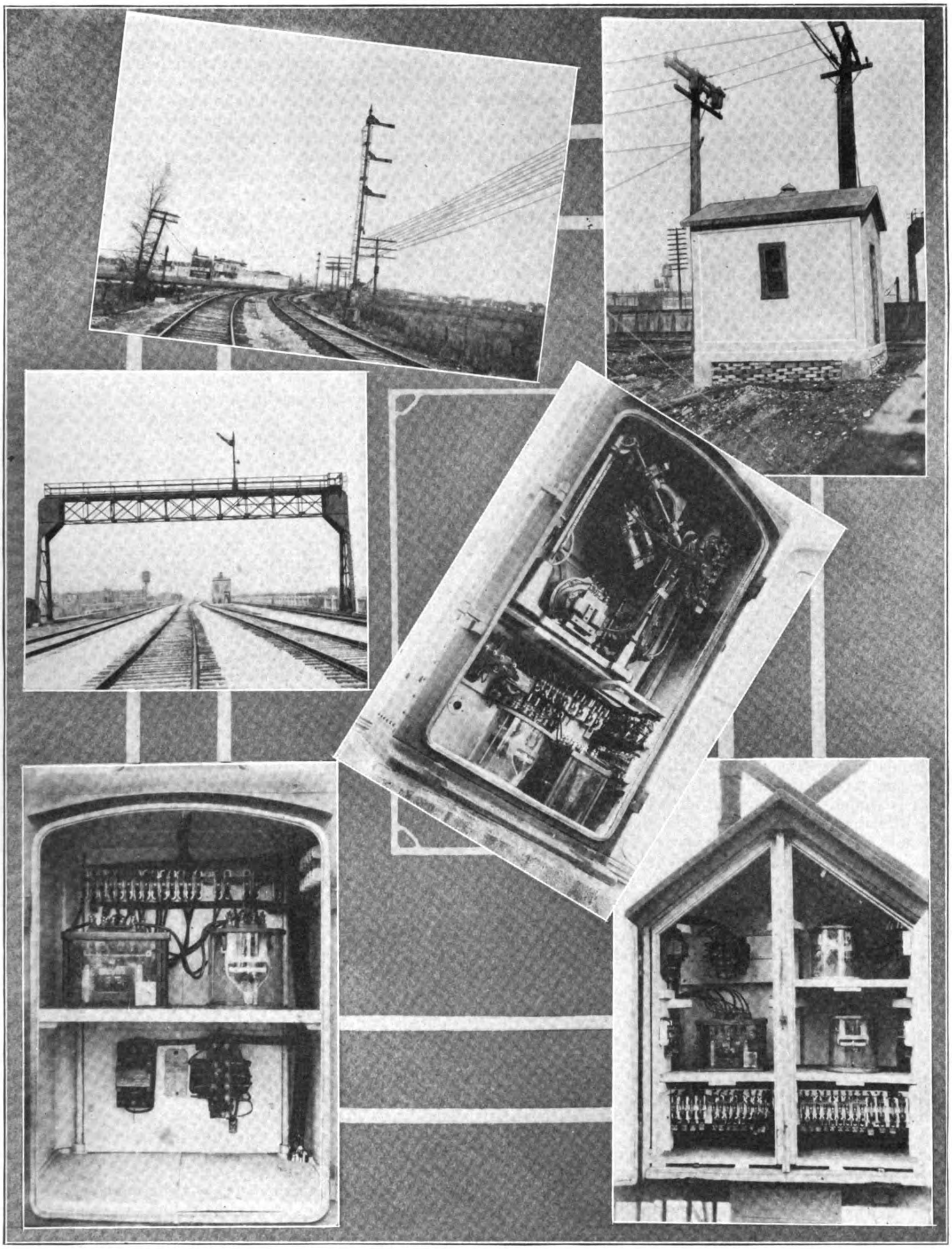
Interior of Sub-Station, Showing Rear of Switchboard

Switching Equipment

Each sub-station houses two motor-operated oil switch mechanisms which operate on exactly similar principles. The wiring plan shows these mechanisms applied to two sources of power in the sub-station at Sixty-third street. In addition to the wiring of the automatic equipment, this plan shows complete wiring of the feeders, control circuits and indicating lamp circuits. Energy is conducted through cables to the triple-pole, double-throw service switch, from which it is possible to energize either bank of transformers from either source. A voltmeter, with suitable potential receptacles, measures voltage on either service.

Essentially, the equipment consists of potential relays energized from each source, a single-phase repulsion type induction motor, low-voltage release, which trips open the switch when power fails, and a mechanical ratchet and pawl, by which the time element is varied between the starting of operation and closing of the oil switch.

A cycle of operation of the complete mechanism is as follows: Assume the signal transmission cable is feeding from the preferred source through switch 1 to transformers A and B, thence through oil switch 8 and disconnecting switch 10 to the signal cable. Also assume a failure on any phase or phases of the preferred source, relay 17 opens, de-energizes the preferential relay, relay 19 also opens, de-energizing relays 6 and 7 and the low-voltage release X, all of which receive energy from transformer J. The de-energizing of X trips oil switch 8, which closes the motor circuit for the emergency equipment, from transformer G through relay 18, back contact on the preferential relay, through relay 7 to motor, the other motor connection going through circuit closing switch on switch 8, back to transformer G. Through the medium of a ratchet and pawl mechanism operated by the motor, the oil switch 9 closes, energizing the signal cable from the emergency source, transformers I and J, which pick up relays 19, 6 and 7, breaking the motor circuit after the oil switch has been driven home. During the operation of closing the switch the low-voltage release Y is mechanically placed and held in a position for tripping 9 until its circuit has been closed, which holds



Junction of Suburban Line with Baltimore & Ohio
Bridge on the Elevated Line Near Seventy-ninth Street
Relays, Transformer, Etc., Used with Top-of-Mast
Ground Signals

The Automatic Sub-Station at Sixty-third Street
Special High Mechanism Case, Showing
Mechanism, Relays, Transformer, Etc.
Wooden Relay Cabinet on Bridge Bent

it in this position after the mechanical restoring mechanism has released. When the preferred source has assumed normal voltage again relay 17 picks up, it in turn energizing the preferential relay, which short-circuits the low-voltage release on 9, and 8 then closes.

In addition to the above equipment, a slate panel has been provided, on which has been mounted an ammeter, voltmeter, wattmeter, ammeter switch for switching the ammeter to any phase, a potential plug for measuring voltage on any phase and a manually-controlled oil switch with inverse time-limit automatic trip relay, to protect station equipment in case of short circuit on transmission line.

Cables and Wires

Cables of different characteristics have been installed to meet the various conditions imposed by the nature of the work: First, a three-conductor cable, used in permanent underground construction, transmitting energy at 1,100 volts to the respective line transformers. The wire is of one gage, No. 6 B. & S., with a standard R. S. A. insulation for 2,200 volts and provided with a jute filler with one layer of tape enclosing all three conductors. The above cable has an outer lead sheath 1/8 in. thick. Conductor splices are made with tinned copper sleeves, soldered. Second, a 15-conductor cable used in permanent underground construction and having wires of two gages, No. 6 and No. 14 B. & S. G., all of which are used for local circuits. This cable is lead-covered and meets R. S. A. specifications for 600 volts. Third, a three-conductor cable used in temporary overhead construction, transmitting 1,100 volts to line transformers. Conductors are No. 6 B. & S. G. with R. S. A. insulation for 2,200 volts, with a jute filler and tape, to make cylindrical in form, over which a 3/16-in. wall of impregnated jute is wound and having a galvanized steel outer covering of 3/32 in. wound spirally in the same direction with a 50 per cent overlap, enclosing all conductors. Fourth, a special cable, with two conductors of 14 B. & S. G., used in permanent work to supply energy to crossover circuits, switch lamps, dwarf signal lamps, etc. Each conductor is insulated for 600 volts and all are laid parallel with jute and tape to make cylindrical in form. Over this tape is wound two layers of impregnated jute in opposite directions and having a steel tape covering similar to cable No. 3. It differs, however, from that cable in that it has a 3/16-in. impregnated jute covering over the steel. Cables of this construction are buried in a trench or ditch some 12 in. below tie level.

All other aerial 110-volt circuits are No. 10 B. & S. G. weather-proof wire, and where drops are made from the pole line each circuit is protected from lightning by spark-gap arresters. Where service requires lead-covered, steel-armored cable, special grounds of 1-in. galvanized pipe 7 ft. long are installed in order to detect any serious deterioration or break-down of the insulation of the conductors.

Manholes and Duct Lines

Manhole design and construction are of importance to satisfactory underground installations and on account of the restricted space at points where one type of manhole could not be used a special manhole with only sufficient room to pull cables is employed. Arrangements are made for passing the cables up through the wall to a special splicing chamber or transformer shelter. Manholes not seated in retaining walls but placed in the embankment are of reinforced concrete, rectangular in section, sides and bottom cast in one piece at the site of the work. After sufficient setting a concrete slab covering is cast over the top with suitable openings to enter the manhole. They are each provided with pulling irons and ladder, and contain openings for ground rods and sewer connection. Each manhole is built in two compartments, one for telegraph and telephone cables and one for signal cables. Six inches of concrete separate the two classes of cables, thus providing adequate protection to telegraph cables against break-down or fires in high-voltage power cables.

The portion of the duct line between manholes which was built first has a capacity of six cables and is constructed of one two-way and one four-way vitrified clay duct, separated by six inches of concrete. The whole is made a part of the retaining wall, having a minimum of 9 in. of concrete covering the duct. No one duct houses more than one cable. Cables are placed on suitable racks arranged on side of manhole. In the more recent construction fiber duct has been used, as described more fully elsewhere in this issue.

Transmission

Transmission cables having a lead or steel armor are carried in galvanized aerial cable rings attached to steel messenger wire, which is supported at each pole with pole L clamps. Cables having an outer braid and which are placed on pole lines are supported from messenger wire by a quality of hemp not quite as good as No 3 (which is a selected long-line American hemp). and having hooks made from No. 9 galvanized steel wire. Where open work is used for transmission of energy on pole lines, No. 6 B. & S. G. hard-drawn, weather-proof copper wire is run on the side of 5,000-volt, top-groove porcelain insulators, carried on one side of an 8-pin cross-arm in triangular form, 10-in. centers. Poles for supporting all aerial circuits are 30 ft. (average) cedar poles, spaced roughly 100 ft. apart.

Line Transformers

Line transformers, installed at each signal location, are three-phase, two-phase, Scott connected, primary 1,100 volts, and delivering 110 volts on secondary to a capacity of 1 kv. a. Plug cut-outs fused with fuse wire are used throughout to protect each phase of transformers. Cartridge fuses of the proper capacity are used to protect the secondary of each phase wire of transformer, with no fuse in the neutral of the two-phase secondary. Line transformers deliver normally 110 volts, but provision is made for increasing the voltage 5 or 10 per cent. Leads (both primary and secondary) are insulated with varnished cambric and have a lead sheath 1/16 in. over each insulated wire. No lightning protection was considered necessary for transformers feeding from an underground cable.

Track Circuits

Track circuits, in the zone in which permanent construction is complete, are of the double-rail type, having 100-lb. A. R. A. rail with continuous four-bolt insulated joints. The bonding consists of two No. 6 B. & S. G. solid copper wires placed behind the angle bars. Each section receives energy from a track transformer having a capacity of .5 kv. a. and wound with double secondary, used for the purpose of giving individual secondaries for each track circuit on double track. Each secondary has voltage taps from 2 to 18 volts. The primary is energized from a 110-volt circuit and has an "auto" tap of 10 volts for lighting purposes.

Two-position galvanometer relays are connected to the entering end of the track circuits and are equipped with four front and two back contacts. Reactors are used in the transformer leads to the track and contain a reactance of from 0.7 to 3.7 ohms, with an air gap set for minimum power factor. Track wires have been installed in ½-in. galvaduct and lead from the relay box to a telescopic bootleg made of concrete with a cast-iron cap. Conduit is placed about 12 in. below the tie. Track wires used for temporary work are placed in cypress trunking, supported on oak stakes at a height of one inch below the base of the rail.

Crossovers connecting the two main lines are provided with a special crossover circuit so that maximum protection is obtained. They are fed from one secondary of the double secondary main line track transformer and energize a single-element relay of the vane type. Trap circuits are installed at locations where grade crossings are encountered. All relays connected to the track circuits have pin-point lightning arresters installed across the relay leads.

Track relays are of two-position ironless galvanometer type. Locals of these relays are wound for 110-volt excitation. Line relays are two-position of single-element vane type and wound for 110-volt excitation. Crossover relays are two-position, single-phase vane type, wound for 5-volt excitation.

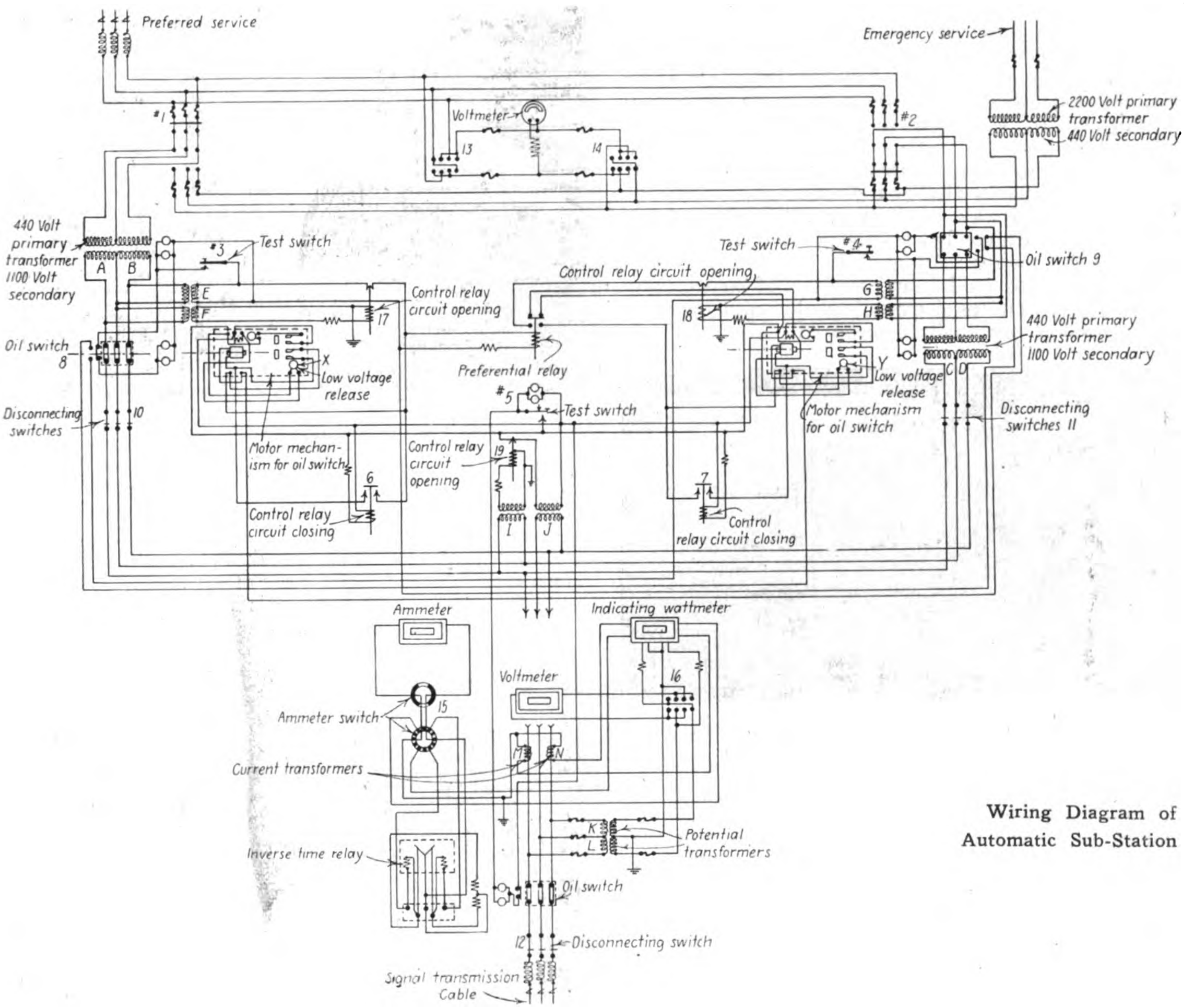
Relay cabinets are installed on single bridge bents and are of wood construction, with the completed cabinet covered with sheet metal. The shelves are arranged to give an uncrowded condition, with all terminals, track reactors and transformers arranged to face the observer.

Signals

Automatic signals are of two kinds, top and bottom post, each operating in the upper right-hand quadrant in three positions and mounted on ground posts or signal bridges, as required. In two cases, illustrated in the heading of this article, adjacent yards made it impossible to use the usual form of signal bridge. A special two-track cantilever bridge was therefore designed to meet the conditions.

The top-of-mast ground signals are equipped with battery case at the base, which provides housing for relays, transformer, etc. The motors are single-phase, 110-volt, 60-cycle, induction type, connected to the semaphore shaft by means of low-reduction gears. A clearance of .045 in. obtains between the rotor and stator, with a protecting ring at each end of the stator, preventing the insulation on stator winding from interfering with the rotor. The retaining mechanism for these signals is of recent design, to which modifications have been made. A star-wheel is connected by means of a friction clutch to the signal motor shaft, which is held in the caution or clear position by means of a lock engaging the star-wheel. The lock is actuated through a simple arrangement of levers and a U-shaped magnetic armature. When the holding coils are energized, this armatuure assumes a position in the magnetic field, such as to cause it to move upward and remain suspended free from any guiding contact in the magnetic field. When the controlling circuits release the hold-clear, gravity acts to release the locking feature.

The bottom-post signals are provided with a special



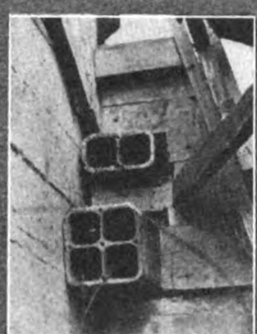
Wiring Diagram of Automatic Sub-Station

high-mechanism case housing the mechanism, relays, transformers, etc. The signals have slots of the tractive magnet type. The motors are two-phase induction and are wound for 110 volts, 60 cycles. All signal and switch lights and relay cabinets are lighted with a 2.5-watt, 12-volt lamp on a 10-volt circuit, taken from the 110-volt side of track transformers.

INSTALLATION OF CONDUITS IN RETAINING WALLS

IN 1913, the Chicago, Rock Island & Pacific entered on a ten-year program of track elevation in the city of Chicago, which includes several grade separation problems and other special types of construction. The method of installing conduits, in connection with the retaining wall construction, is an interesting feature of this work. Previous to this time, all automatic signal and telegraph wires had been carried on the pole lines in use prior to track elevation; but as the future development of the entire right of way was studied, it was deemed advisable to provide a conduit system in the retaining walls to care for these wires.

Various types of conduit and methods of construction were considered and used experimentally until the most efficient method was finally determined. Many difficul-

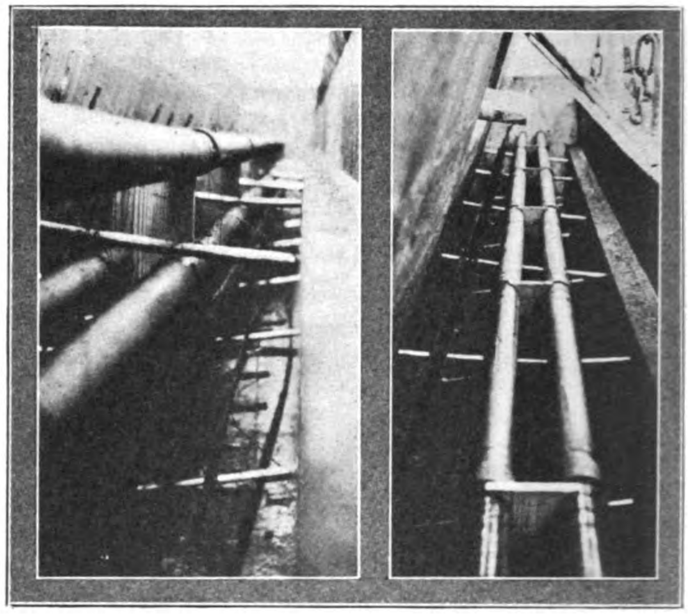


Early Installation of Clay Conduit

Section of Wall with Fiber Conduit

ties were met, as rapid progress and economy in installation costs required that the conduit be placed in the retaining wall form and encased at the same time that the retaining wall form was filled with concrete; also the high tension alternating current used for the automatic block signals required the two ducts used for the telegraph wires to be separated from the other ducts a sufficient distance to prevent induction and other dangers. The form of construction finally adopted is fiber conduit, made in five-foot lengths with an inside diameter of three inches and tapered ends over which couplings made of the same material fit snugly in order to prevent seepage during construction.

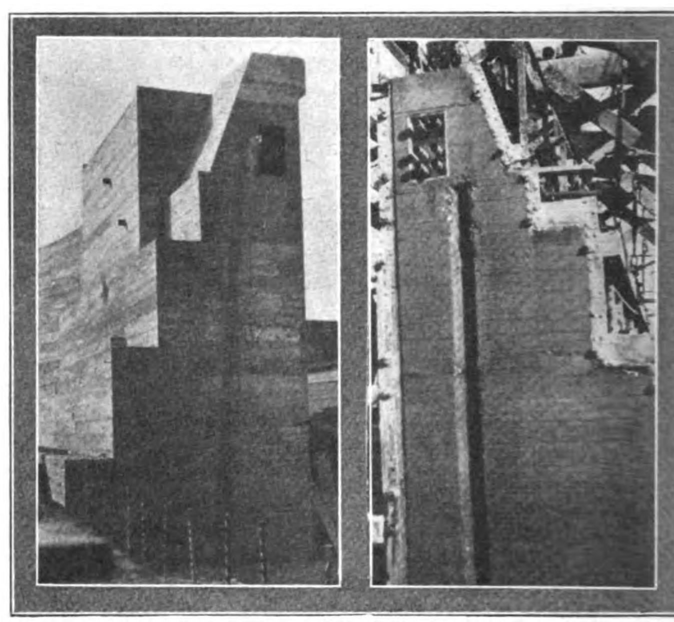
The installation consists of a six-way conduit with the upper two ducts separated six inches from the lower four ducts. The conduit was assembled in the retaining wall form, near the top, separation of the ducts being secured by means of ¾-in. wooden templates located at each joint of the five-foot lengths. The six ducts were wired firmly to the wooden template and were supported by and wired to rods extending through the retaining wall form. While no trouble was experienced in keeping these ducts in a straight line and water-tight during the pouring of the concrete, the joints were coated with a compound paint as a precautionary measure to insure water-tightness. To allow for possible settlement or lateral movement at the construction joints in the wall, the ducts were terminated four inches in from the end of one section and two inches from the end of the adjoining section, the connection through the construction joint being made with a special tin sleeve passing through



Two Views of the Method of Supporting Fiber Conduit in the Wall Forms

a pocket left around the ducts. This pocket was then filled with a pliable asphalt mixture to make the joint water-tight and to allow the ducts to adjust themselves easily to any movement without damage to the cables.

In comparison with other types of construction used in the earlier stages of the work, this method showed many improvements both as to speed and economy. The fact



Two Views of Joint and Manhole Construction

that the fiber conduit could be made water-tight and kept in good line during the pouring of the concrete wall made it more satisfactory than vitrified clay conduit embedded in the wall in the same manner. With the clay conduit, all joints were wrapped with treated burlap and mopped with hot asphalt, but it was practically impossible to prevent seepage of the concrete into the ducts, filling them up to such an extent as to prevent regulation rods being passed from manhole to manhole. This was avoided in some cases by leaving a shelf in the wall on which the conduit was installed to be encased by a second operation, using a dry concrete mixed by hand or by a small capacity mixer.

Although by nature of its construction the first cost of the fiber conduit is practically double that of clay conduit, its lightness and ease of handling effected a sufficient economy to more than offset the higher material cost and gave more satisfactory results.

The two upper ducts of the conduit system carry two cables for the telegraph wires and also the wires for the company telephone system. The four lower ducts are used in connection with the automatic block signals and provide for one cable carrying 110 volts and one carrying 1,100 volts, the two remaining ducts being reserved for future development.

The installation of this system included the construction of twin manholes at points averaging 350 ft. apart. The section used for the automatic signal circuits was constructed with inside dimensions of three by six feet; the adjoining section used in connection with the telegraph wires and company telephone circuits, was made three by four feet, both having an inside vertical clearance of 6 ft. 6 in. The manholes were so constructed that the ducts carrying the high tension automatic signal circuits were encased with six inches of concrete as they passed through the adjoining manhole. Sufficient openings were left in the manholes to provide for ground and all track circuits. Drainage was cared for by means of drain pipes leading to tile laid at the rear of all walls for the drainage of the embankment.

Organization for Signal Maintenance*

Plans for Fixing Respective Authority and Arranging Work to Produce the Best Possible Results

By James Anderson,
New York Central, Lines West

THE conditions peculiar to each railroad will, to a certain extent, determine its signal organization. Broadly speaking, there are two systems of organization, the departmental and the divisional, the principal difference between them being in the duties of the superior officers. In the departmental organization, the signal engineer has complete charge of the signal department, construction as well as maintenance forces being under his control. On all matters pertaining to signals he acts in an advisory capacity to the general manager, the general superintendent, or the chief engineer, and in many cases all of them. The signal engineer also has charge of all stock carried by the signal department, makes requisitions for necessary signal material, has charge of signaling accounts, causes investigations to be made of signal failures, reporting to and conferring with the operating department in cases where accidents have occurred involving signals. Directly under the signal engineer comes the signal supervisor, who has charge of all signal apparatus on his division, and he takes orders from and reports only to the signal engineer. In the divisional organization, the signal engineer acts in an advisory capacity to the general manager, the general superintendent or chief engineer, and is charged with the making of signal standards, making or approving plans for new installations, and contracting for and supervising new installations that are made. Each division has a signal supervisor in charge of signal work, who reports to the division superintendent. In matters pertaining to the maintenance and sometimes also the construction of signals, he acts practically as a signal engineer for the division.

Individual or Combined Organizations

Directly under the signal supervisor and his assistants come the maintenance forces which on various roads are organized in almost as many different ways as there are roads. While uniformity of practice in signal maintenance is, of course, much desired, it is very difficult to secure it and at the same time effect the maximum economy. On account of differences in traffic, climate, locality, etc., an economical and feasible practice laid down for one railroad or part of a railroad might be impractical for another. On the majority of roads, the signal maintenance forces form a part of the signal department organization which is concerned only with the maintenance of signaling apparatus. On some roads it has been found advantageous to combine the maintenance of signals with track work, while on others good results have been obtained by the combined maintenance of signals, telegraph and telephone facilities. Since in the present state of the signaling art some training or experience along electrical lines is almost universally essential, it has been shown that a combination of maintenance forces between the signal and telegraph departments is preferable to one between the signalmen and the track forces.

On roads where signaling and telegraph maintenance are combined, the signal engineer may co-operate with the superintendent of telegraph or the same officer will handle both departments. In some cases the signal maintenance forces take care of the apparatus to be maintained by both departments, and in other cases a signal supervisor and chief lineman have charge of a district, each reporting to the signal engineer and each having duties to perform, the first on signals and the latter on telegraph apparatus. The signal maintainer has helpers who are linemen and whose first duties are to look after the maintenance of telegraph apparatus, but any spare time can be spent in assisting the signal maintainer to perform his duties. Where the signal, telegraph and possibly telephone maintenance have been consolidated, the maintainer's districts have been shortend in proportion to the additional duties assigned so that the labor and hours of work have remained the same as before. There are a few roads on which the maintenance of all electrical apparatus is taken care of by the signal department, thereby eliminating the necessity for extra forces for this purpose. Under this type of organization, station platform lights, shop motors, electrically-driven coal hoists, etc., are maintained by the signal force. These combinations have proved successful because a good signal maintainer must, as a rule, be a man experienced in electrical matters.

While an extensive combination of signal and track maintenance has not proved very successful, there are places on nearly every railroad where the amount of signaling equipment is small and a combination of duties would prove practical and economical. For example, at interlockings or manual block stations, the local sec-

*The first of a comprehensive series on signal maintenance which will appear in these columns. Copyright 1917, by James Anderson.