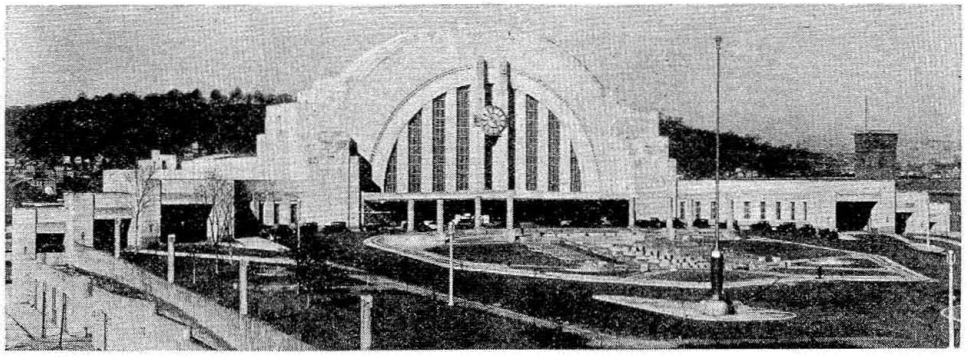
Railway Signaling

Cincinnati Terminal Interlocking

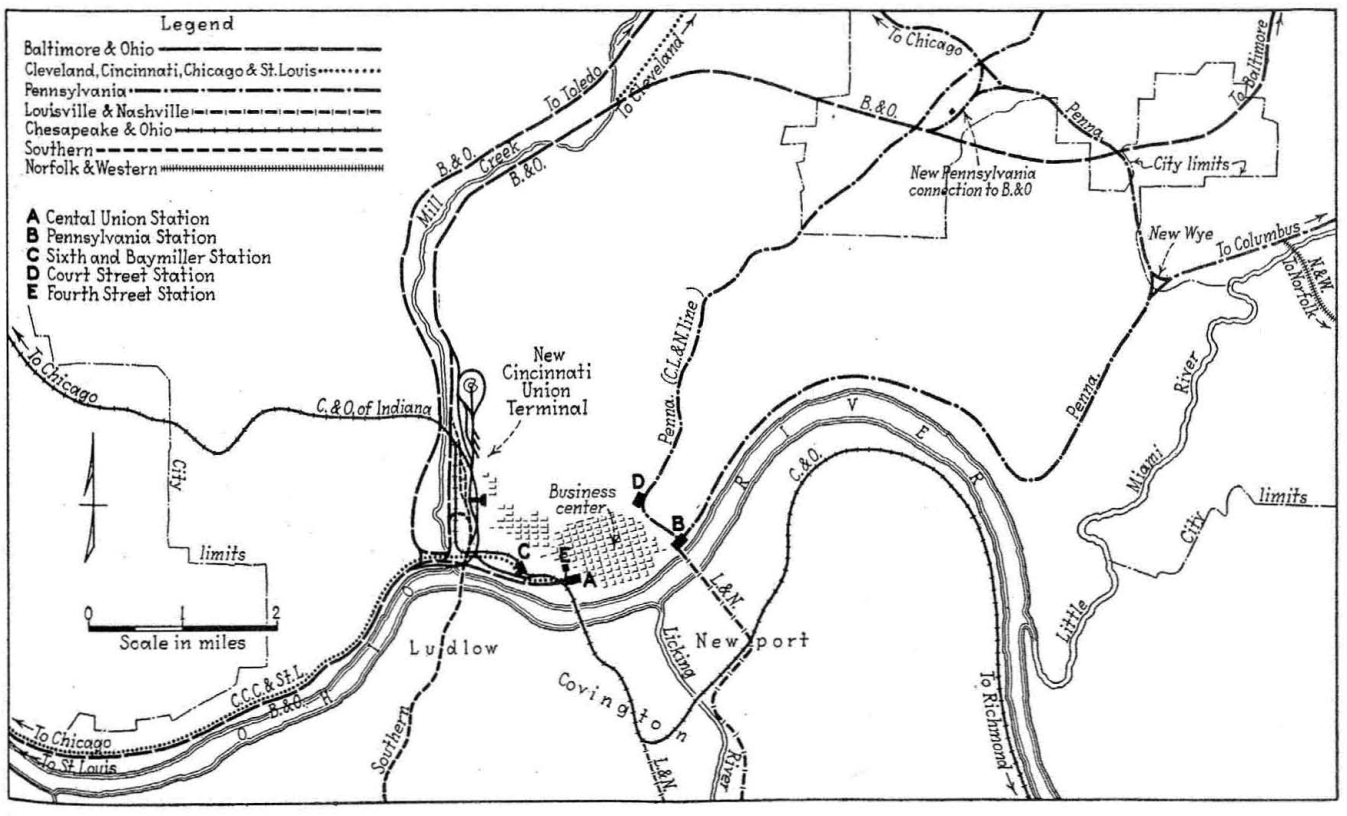


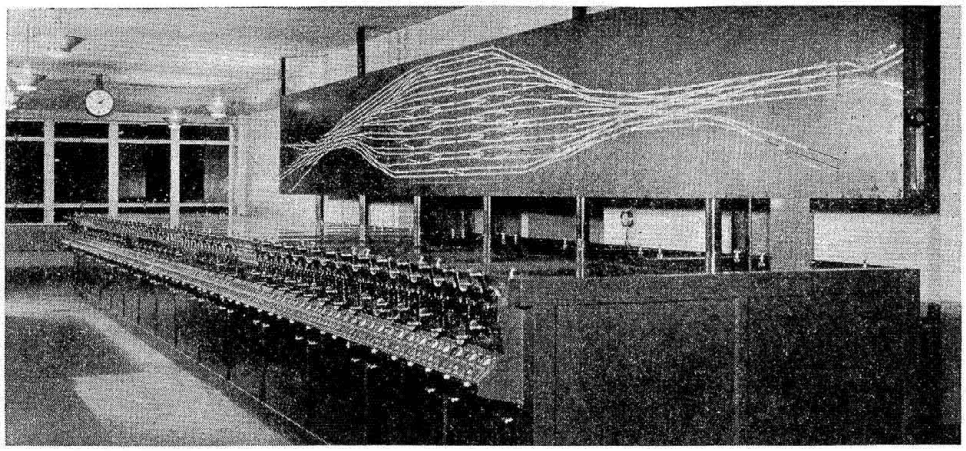
The east front of the new station

One electro-pneumatic interlocking serves entire station and throats—Machine on fifth floor of station—A-C. power supply with rectifiers for d-c. control circuits

THE NEW passenger terminal of the Cincinnati Union Terminal Company, which was placed in service on April 1, involves an entirely new track layout and station, as well as a coach yard and engine terminal. The station is located west of the business section of the city and handles all the passenger trains of the seven roads serving Cincinnati. The station is of modernistic design, the central unit of the building enclosing the main concourse having a floor area of a semi-circular shape with a radius of 90 ft. This concourse is flanked by various services such as ticket offices and restaurants, while the taxi cabs and baggage trucks operate through subways underneath, with passenger ramps leading to doorways opening on the concourse. The waiting room, 78 ft. wide and 410 ft. long, extends from the rear of the concourse out over the tracks, gateways leading to ramps descending to the various tracks. The interior of the station is artistically decorated, including mosaics illustrating the history of transportation, the growth of Cincinnati, and several of the important industries of the city.

The terminal is of the through type with a connection at the north end with the Baltimore & Ohio, which is used by the trains of that road and those of the Big Four





The electro-pneumatic interlocking machine has 231 levers and the illuminated track diagram is 42 ft. long

to the north and east, and all trains of the Pennsylvania and the Norfolk & Western. At the south end there are three separate connections, namely, one directly to the north end of the Southern's Ohio River bridge, a southwest connection with the Baltimore & Ohio and Big Four lines that follow the north bank of the Ohio river to the west, and a southeast connection to the north end of the Chesapeake & Ohio bridge for the use of the trains of that road and the Louisville & Nashville. A fifth connection, almost in the middle of the layout, is provided for the Chesapeake & Ohio of Indiana.

Interlocking Facilities

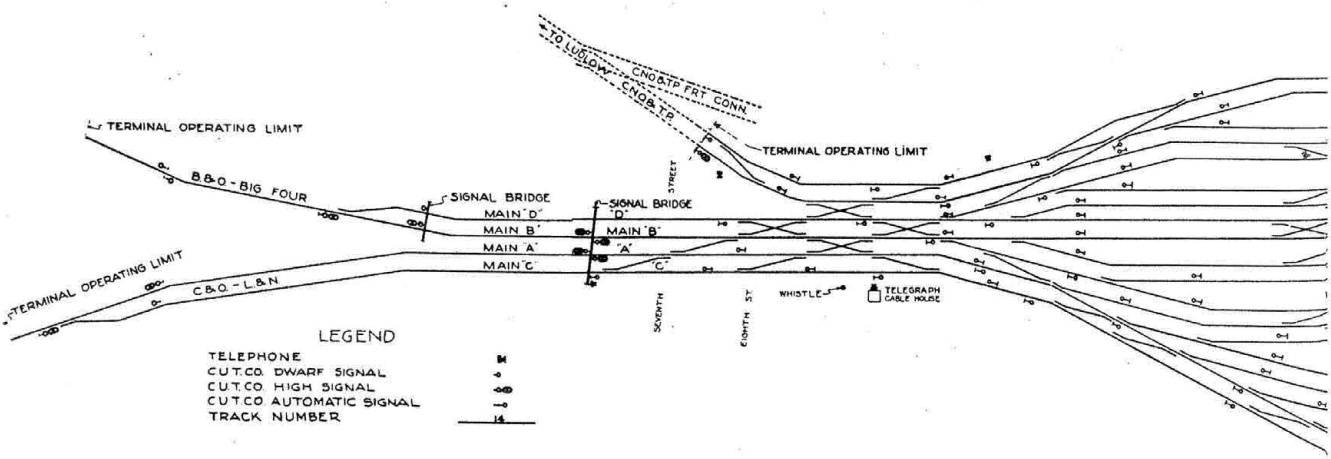
The switches and signals throughout the station tracks, as well as in both the north and south throats, are all controlled from one interlocking machine located in an operating room on the fifth floor of the station building and immediately in the rear of the dome which is over the main concourse. Windows are arranged to permit a view of the entire terminal area for over a mile both northward and southward. This room was given special treatment to reduce the interference from noise. The floor is covered with heavy cork linoleum. The ceiling, and the upper section of the walls extending about three feet from the ceiling, are covered with sound absorbing material.

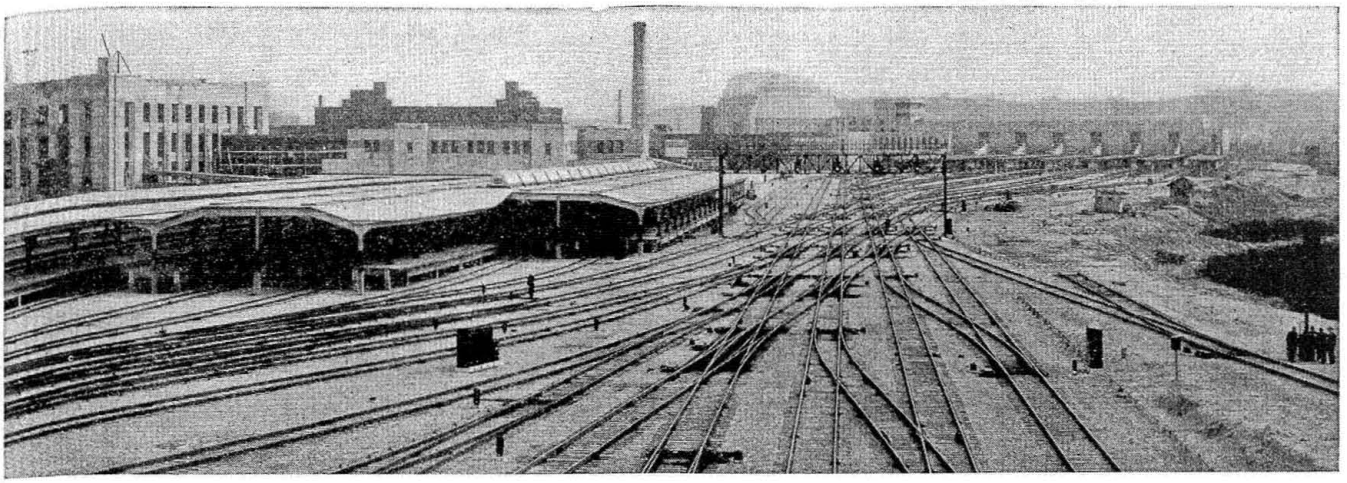
The interlocking is the Union Switch & Signal Company's electro-pneumatic type, the interlocking machine having a frame for 231 levers, using 187 working levers, is the largest of this type in service. The present arrangement of signals and interlocking equipment consists of 4 derails, 70 single switches, 37 double slip switches, 116 dwarf signals, 22 bridge signals and 11 ground high signals. Provisions have been made to add two more station tracks when traffic warrants. Nine spare levers have been provided for this purpose with the necessary mechanical locking in place.

The interlocking machine is equipped with four master clockwork time releases, each release handling about one quarter of the signal levers. An unusual feature of this installation is that these time releases are mounted inside of the interlocking machine, the operating knob extending out to the front of the machine, one of these knobs being shown in the picture of the machine.

The clockwork time releases are provided without latches and with normal intermediate and reverse contacts. Intermediate contacts are set to close in 15 sec after reverse contacts open, and remain closed. Normal contacts close after 60 sec. The 15 sec. period is used for dwarfs and the 60 sec. for high signals. The time feature in all cases is annulled by the occupied condition of the block in advance of signal, except when a call-on indication has been displayed by the operation of the stick push button.

As this interlocking machine handles the entire terminal area, there is no need for check-locking between the two ends of the terminal, all such requirement being provided for in the mechanical locking between levers. The direction in which traffic is to be moved on each through track is established by a check lever. Lever lights below the respective levers give information relative to the operation of the machine. The signal lever light, which



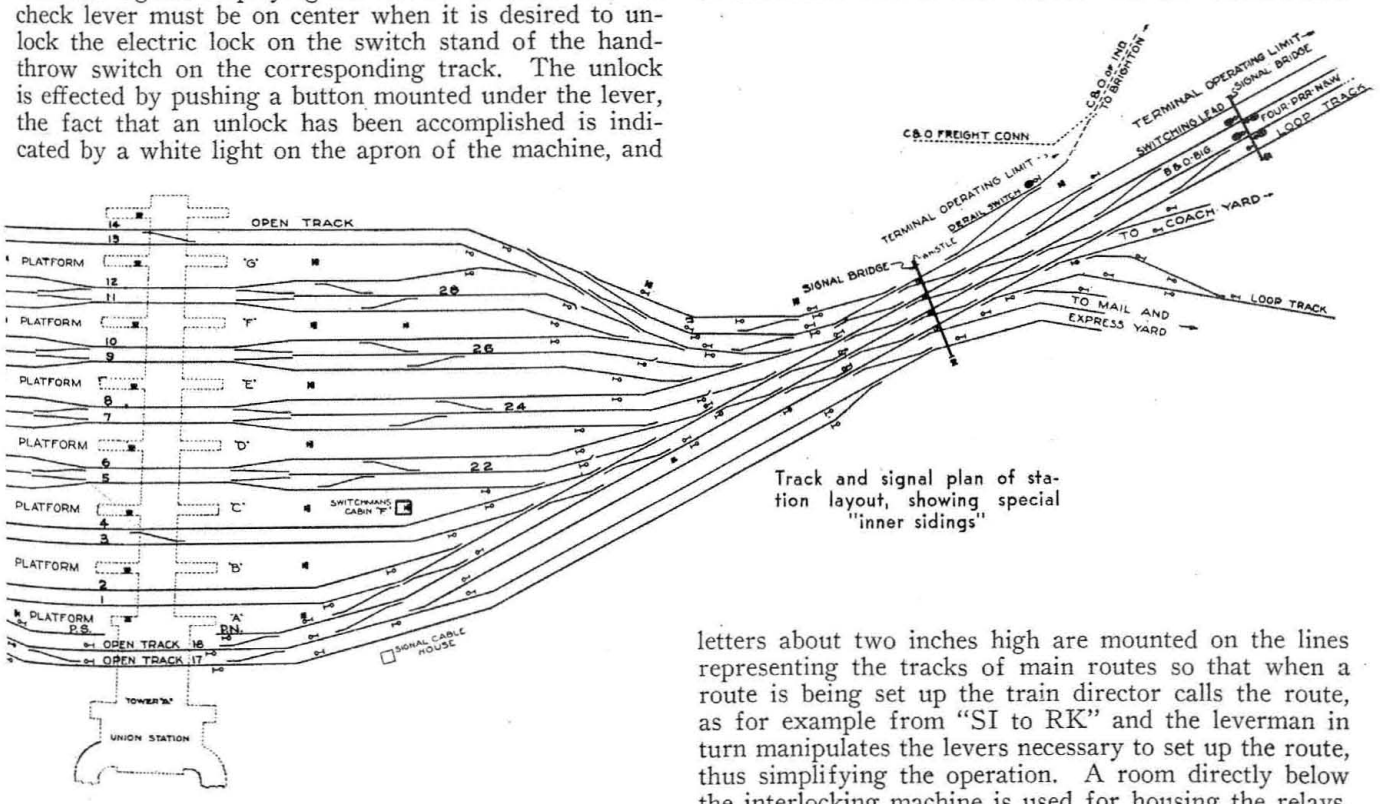


A view showing the north throat with the station in the background

is normally lit, indicates whether the first track circuit in advance of the signal is occupied. A green switch lever light, which is normally lit, indicates whether the lever is free to be thrown, i. e., when the lever is not locked by the electric lock. A red switch lever light is lit when the switch repeater relay is de-energized, i. e., only during the period of transversal of the switch points, and checks that the position of the switch and control lever coincide. The lever light for a check lever is lighted normally, but when the lever is operated to the left or right to unlock the electric locks on the hand-throw switches the lever lamp is extinguished.

There is a check lever for each of the 16 main station platform tracks and the two open tracks through the station. The normal position of a check lever is on center, and it is thrown to the left to set up northbound traffic on the corresponding track, and thrown to the right for southbound traffic. With check levers in normal or center position, opposing moves may be made with the signals displaying the restrictive indication. A check lever must be on center when it is desired to unlock the electric lock on the switch stand of the hand-throw switch on the corresponding track. The unlock is effected by pushing a button mounted under the lever, the fact that an unlock has been accomplished is indicated by a white light on the apron of the machine, and the directional lights on the track model are extinguished. When it is desired to lock up the switch again, this result is effected by moving the lever either to the left or the right.

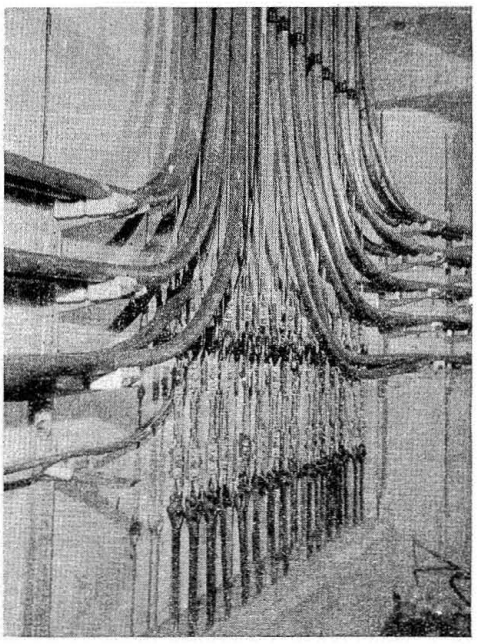
An illuminated track diagram, 5 ft. high and 42 ft. long, is mounted over the machine. The supports constitute the conduit for the necessary wires. The entire track arrangement is represented by aluminum lines on a black background, the tracks being cut into sections corresponding to the arrangement of track circuits. The lamps in this diagram are normally extinguished. Two red lamps, located in the lines representing the track, are lighted where the corresponding track circuit is occupied by a train. Two green lights, representing a signal, are lighted when the corresponding signal is cleared. Two lamps were used to reduce the chances for failures occasioned by lamp burnouts. Traffic and check levers are designated by two yellow lights on an arrow, the direction in which traffic is set up is indicated by the position of the arrow that is illuminated. On the model board letters about two inches high are mounted on the lines representing the tracks of main routes so that when a route is being set up the train director calls the route, as for example from "SI to RK" and the leverman in turn manipulates the levers necessary to set up the route, thus simplifying the operation. A room directly below the interlocking machine is used for housing the relays, as will be explained later.



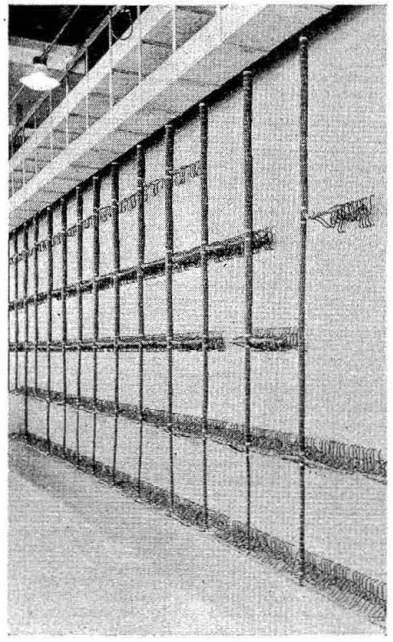
Track and signal plan of station layout, showing special "inner sidings"

of the shaft the lead cables extend through a duct system of fiber conduit in concrete, out to cable houses constructed of brick, there being one such house at each end of the station platform. More than 2,000,000 conductor feet was involved in these lead cables, which were made up according to Signal Section, A.R.A., specification No. 2120. The lead cables all terminate in one of these houses and from there 37-conductor parkway cables are extended on to the various relay cases, from which smaller parkway cable is used for the runs to junction boxes, signals, switches, etc. Parkway cable was used beyond the station platform area because it was not considered feasible to construct a concrete duct line on the new fill, which is from 10 to 40 ft. deep throughout the entire track layout.

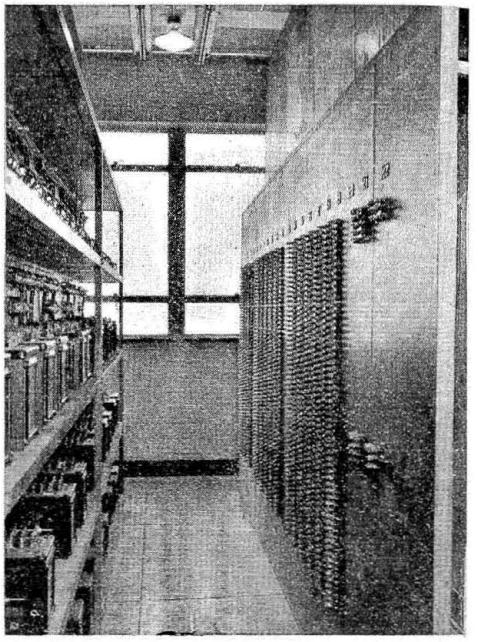
All parkway cable is buried at least 30 in. below the surface. After being covered with a layer of loam, a plank of elastite 1 in. thick, and not less than 6 in. wide, is laid over the cable so as to afford mechanical protection against picks, shovels, etc. More than 3,000,000 conductor feet were included in these parkway cables. Each cable is protected by a lead sheath and two wraps of steel tape with jute covering, made up according to Signal Section, A.R.A., Specification No. 14529. Over 330,000 conductor feet of aerial parkway cable with bronze tape without lead sheath was used on the several approaches. This cable was supported from the structure by means of $\frac{5}{16}$-in. Copperweld messenger wire and never-slip Copperweld cable rings.



View at bottom of 90-ft. vertical shaft for cables



The wires are neatly cabled on rear side of racks



One of the two main terminal boards in the tower

The Instrument Room

The wires in the various cables are No. 14 for all control circuits, No. 6 for the 2,300-volt a-c. loop circuit and No. 1 for the 12-volt d-c. loop circuit. Single-conductor No. 9 parkway with two wraps of bronze tape is used from junction boxes to the rail where it is brought up through a bootleg made of Carey elastite with a malleable iron cover. The single conductor of the cable is joined to a stranded plug cable connection which is plugged into the rail. The joint is pushed back into the bootleg which is then poured full of compound. All cables, both the lead covered and the parkway, were furnished by the Hazard Division of the Okonite Co.

As mentioned previously, the relay room is on the fourth floor directly below the interlocking machine. This relay room is 20 ft. wide and 82 ft. 8 in. long.

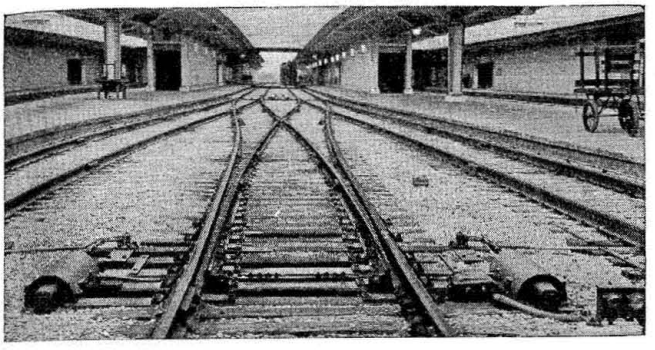
At the east side of the room on each end there is a large terminal board where the incoming cables terminate. This board is constructed of sheets of Electrostone two inches thick bolted to a framework made of angle iron. Each of the two terminal boards is 8 ft. high and 16 ft. long. The terminals are the Union Type K-10, made up in units of six pairs of terminals on a bakelite base, a movable link extending between the two posts of each set so that tests can be made without opening the circuit. The terminals for all associated wires are grouped together on the board. For example, the signal H and D wires and the lock wire are together, as are also the KR and switch control wires.

The relays are all of the shelf type and are located in open shelves, the shelves and terminal boards at the back being made of 1½ and 2 in. Electrostone, the framework being constructed of angle iron. There are approximately 960 relays, as well as the necessary rectifiers and lighting transformers, located in this room. Each of the three relay racks is 12 ft. high and 74 ft. long. Each shelf is covered with a rubber mat. Two of the racks have six shelves and the others five shelves with a large space at the top for wall-mounted devices. There are three of these racks, the one on the east side of the room faces east, the next one faces west and the third one faces east. There is an aisle 3 ft. wide in the wire space between the backs of the first two racks and a space of four feet between the next two racks. In order that the maintainer can get to the relays on the upper shelves a rolling ladder attached to a trolley above is provided in each aisle between the racks. In each aisle there are four sets of Reelite extension cords and lamps mounted on the ceiling, so that a maintainer can very quickly get a lamp to any relay.

The wires between the terminal boards and the relay racks are run in overhead chases made up of Transite boards. This wire is all single-conductor No. 16 solid with 3/64 in. Kerite insulation, over 300,000 ft. of this wire being required for the tower wiring and instrument

cases. The wires going to the relay racks are brought down back of the relay racks in laced cables and each wire extends through a hole in the board to a terminal, Union Type-K terminal units, as mentioned before, being used here also. The relays were wired in the factory with tags complete and jumpers connected from the relays to the wall terminals so that when installing the relays all that was required was to bolt the terminal strip to the board and connect up the incoming wires to the wall terminals.

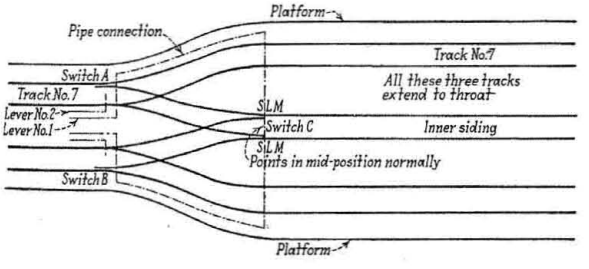
As all the track circuits are a-c., the track relays which are the Model 15, are all located in the tower. As a means of quickly checking the position of track and track repeater relays, a pilot lamp is mounted over each of these relays and is so connected through a back point that the lamp is lighted when the relay is de-ener-



Two mechanical switch and lock movements operate the special switches

gized. The KR relays are the DP-17 type, wound to 750 ohms; the DN-11-type relays are used for track repeaters, signal controls, etc. The slow-acting relays are wound to 500 ohms, the other relays using six points are 2,000 ohms, while the eight-point relays are 1,500 ohms.

The control and locking circuits employed on this plant



Plan showing pipe connections for special inner switches

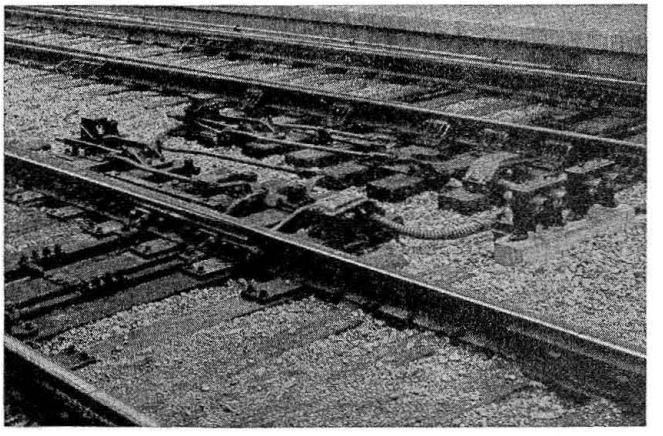
are in accordance with generally accepted practice. The SS control is used for all signals, the circuit being carried through the KR relays, each of which repeats the position of the switch involved. Each switch repeater circuit is on a separate two-wire circuit. The check-lock circuits are all two-wire and the signal control circuits have a separate return except that one return wire is used for all signals on a mast controlled by one position of a lever.

Relay Cases in Field

At signal bridges and at central points over the plant, instrument cases, located at the edge of the track layout, are used for housing relays, track transformers, etc. These cases are made of copper-bearing rust-resisting sheet steel and are set on concrete foundations. These cases are provided with a ½-in. Transite partition to which the terminal blocks, track resistors, and transformers are bolted. The rear of the case is removable in sections, and there is a space six inches deep for incoming cables which are brought up through holes in the foundation. The cables are pot-headed and the wires brought up in lacings and each wire is pushed through a hole to its proper terminal. Union Type-K terminals, the same as used in the tower, were also used in these cases, and the cases were wired completely at the factory. The bottom shelf is used for terminating the cables with the instruments located on the two shelves above. More than 700 relays and necessary rectifiers and transformers are housed in the outside instrument cases.

Special Switching Arrangement

Cincinnati is one of the important gateways for traffic moving between the East and West and the North and South. As a result there is a large volume of interchange of sleeping cars and express cars at this point between the trains of the various roads. The station tracks were, therefore, laid out so that cars can be taken off one train and set on to another by use



The hand-throw switch stands are equipped with electric locks

of so-called inner sidings, thus obviating the necessity of switching all the way back over the main throats which would interfere with main-line movements. As these switching movements are to be handled by trainmen and yardmen familiar with the moves to be made, it was decided that such operation would be carried out satisfactorily by using hand-throw switches for these inner sidings, rather than connecting them with the interlocking machine.

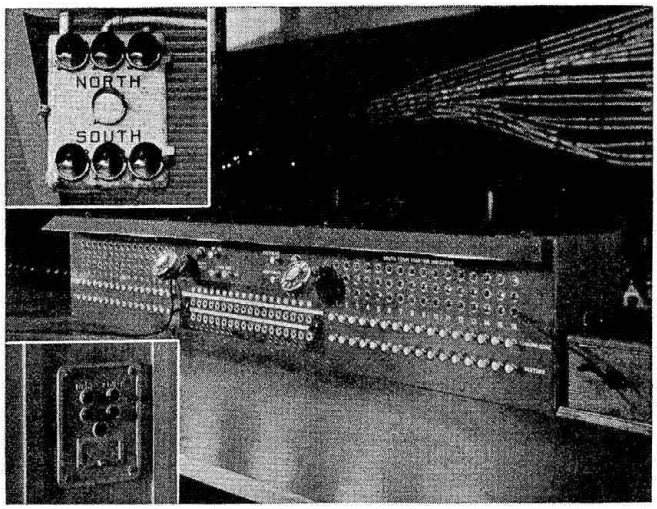
The accompanying sketch shows the arrangement of connections for operating these switches. At switch No. A, as well as at switch No. B, there is a two-lever hand-throw switch stand. The two levers are equipped with lugs so arranged that lever No. 1 must be thrown over first before lever No. 2 can be operated. Lever No. 1 is pipe connected to a mechanical switch and lock movement at switch C. Switch C is normally in mid-position, thus forming a derail, for the wheels of a car trailing over the points would drop on the ties. There are two switch adjusters on the head rod on switch C with an extra long thimble on the operating rods permitting 2¾ in. lost motion. The operating rod connected to the switch and lock movement connected to switch stand A will push switch C over to the left position, there being enough lost motion on the other adjuster to permit this much movement. When it is desired to line up the crossover from track No. 12 to the inner siding, the switchman telephones the towerman and if conditions are such as to permit such a move, the towerman places the check lever normal and

operates a release button, which unlocks the electric lock on the switch stand. The switchman then throws lever No. 1, which throws switch C from the mid-position to the left. He then throws lever No. 2, which reverses switch A, thus completing the lineup from track No. 12 to the inner siding.

Adjacent to each hand-throw switch there is a two-indication color-light Union ES 20 electric switch lamp. For the switches on the station track these targets show green for normal and yellow when reversed. The targets for the switches on the inner sidings show purple normally when the switch is on center, and yellow when lined either way.

Train Starting System

A complete train starting system, also furnished by the Union Switch & Signal Company, was installed as



Upper left—One of the train starting signals
Lower left—A set of push buttons at a gate
Right—Train-starting control machine in tower

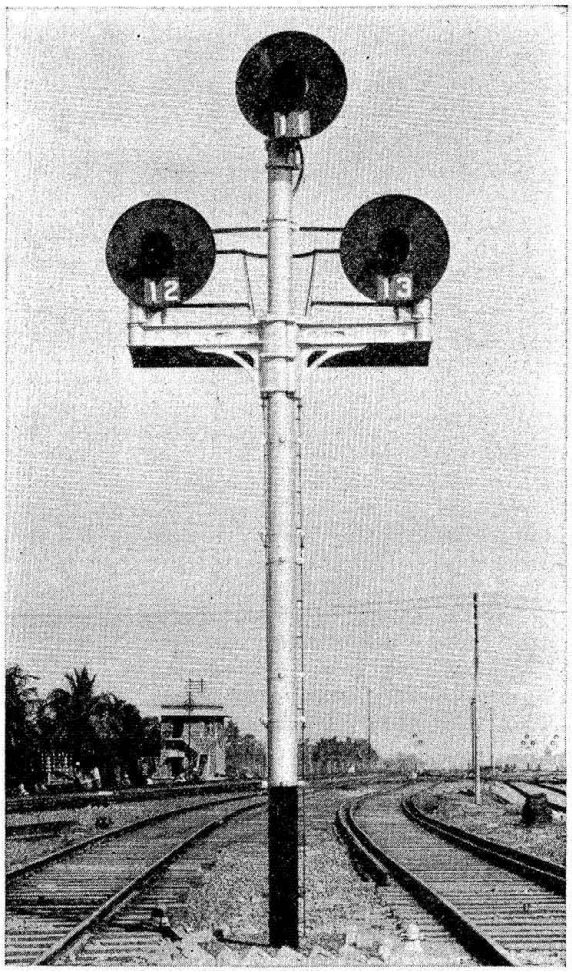
a part of the signaling system. The train starting signals are two-faced so as to display indications in both directions. The horizontal row of lights at the top of the signal govern northward train movements and the bottom row, southward movements, the two rows being separated by a lunar white light. The platforms are 1,600 ft. long and, with the train starting signal located midway, the train starting signal indication can be displayed for a train to leave from either end of the platform for either direction. The conductor unit is provided with four push-buttons with six units on each of the eight platforms. Two gateman indicators have been provided for each track; one is located on each side of the concourse.

On the train director's table, which is approximately 15 ft. in front of the interlocking machine, is located the train starting control cabinet. In addition to directing the movement of trains the train director supervises the departure of all trains. About two minutes before the train is due to depart, the conductor presses a button on the platform, which registers a red light in the train-starting signal on the platform, in the tower and at the gate. The train director acknowledges the conductor's signal by pressing the Acknowledgment button which registers a yellow light in the tower and on the platform, putting out the red light in the tower. When the train is due to leave and at the closing of the gate, the gateman presses a button registering a green light at the gate, in the tower and in the signal on the platform, putting out the red and yellow lights in the signal, the red light at the gate and the yellow light in the tower. After the train has departed, the train director presses the restore button, putting out all lights.

Some conception of the amount of engineering that is represented by the design of circuits and preparation of construction plans which are involved for such an installation, can be gained from the fact that approximately 4,000 engineering-man-days were involved and 2,500 drafting man-days. The installation in the field required approximately one year with an average construction force of about 100 men, or roughly 25,000 man-days of construction work. Sixty-three carloads of material were involved.

Organization

The responsibility for determination of the type of interlocking, arrangements for contract and co-ordination of interlocking facility with all of the other features of the Cincinnati Union Terminal project was vested in the construction organization represented by the engineering staff headed by Col. H. M. Waite. The interlocking was grouped with the general electrical features of the project and came directly under charge of A. H. Sullivan, electrical engineer of the staff. E. K. Post, signal engineer on the staff of the chief signal engineer of the Pennsylvania Railroad System was retained as consulting signal engineer. The complete interlocking was installed under contract by the Union Switch & Signal Construction Company.



A treble bracket signal on the Eastern Bengal Railway in India