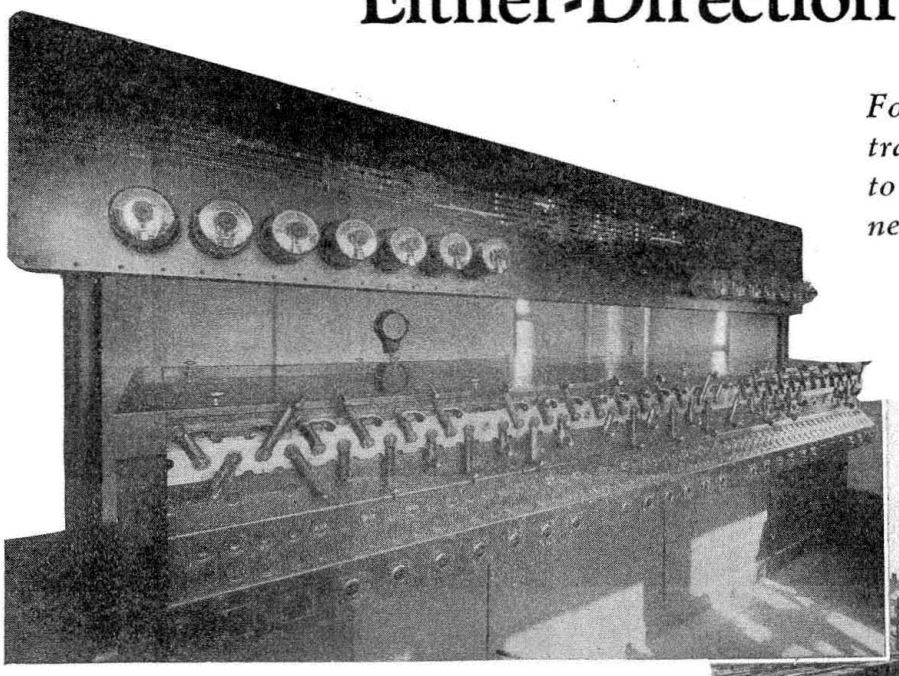
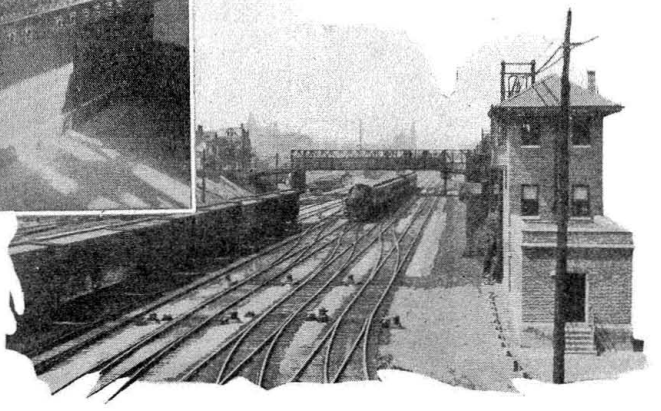
C. & O. Installs New Interlocking and Either-Direction Signaling

Four-mile section of multiple-track road from Newport, Ky., to Cincinnati, Ohio, includes a new bridge and extensive track elevation

By C. A. Taylor
Superintendent of Telegraph and Signals, Chesapeake & Ohio



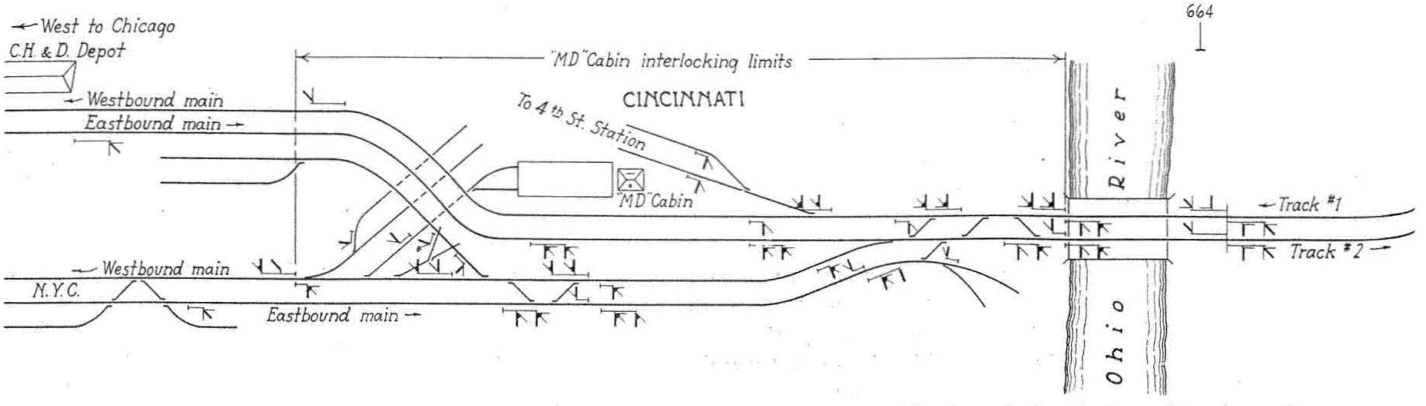


Above—Interlocking machine at "KC"
Right—View looking west through the "KC" layout

TRAINS are now directed in either direction by signal indications, without written train orders, on a four-mile section of double-track railroad on the Chesapeake & Ohio between Cincinnati, Ohio, and Covington, Ky. To permit this, three new electro-pneumatic interlockers were built and one mechanical interlocker was converted to electro-mechanical, in this district, which embraces a new double-track bridge across the Ohio River and an extensive four-track elevation project through Covington which lies on the south bank of the Ohio River across from Cincinnati.

The old bridge was built in 1886-1888 and is owned by a subsidiary of the Chesapeake & Ohio, which not only owns the bridge and its approaches, including the approach tracks on the Kentucky side to Saratoga Alley in Covington, a distance of about 3,600 ft. east of the river bank, but serves also as a terminal ownership company from Cincinnati to "KC" Junction where the Chesapeake & Ohio is joined by a line of the Louisville & Nashville. This route is used daily by about 23 passenger and express trains of the Chesapeake & Ohio and the Louisville & Nashville, all of which move across the bridge twice, because the engine terminals and coach yards of both roads are on the Kentucky side. Freight traffic is handled in transfer trains which vary in number with the traffic.

The old bridge was inadequate to carry locomotives weighing over 92 tons, which prevented the use of regular road engines over the bridge. As a result, freight transfers were sent over the bridge



Track and signal plan of territory from

with small locomotives handling only about 30 to 35 cars each. During heavy traffic seasons, there were so many of these transfer trains that the track facilities were taxed to capacity and at times congested, thus causing serious delays. As the tracks were at grade, the delays to street traffic in Covington, Ky., were serious.

As a part of the new construction program involving the new bridge, the tracks were elevated through Covington and two additional tracks were added to the double track line, from the east end of the east approach to the new bridge, eastward to "KC" Junction, where the L. & N. tracks join those of the C. & O. The double-track line beyond "KC" Junction to Newport, Ky., was also reconstructed and grade crossings eliminated and additional crossovers installed. The main tracks through the entire territory were constructed of 100-lb. rail, and for the restricted-speed routes, No. 14 turnouts and crossovers were used.

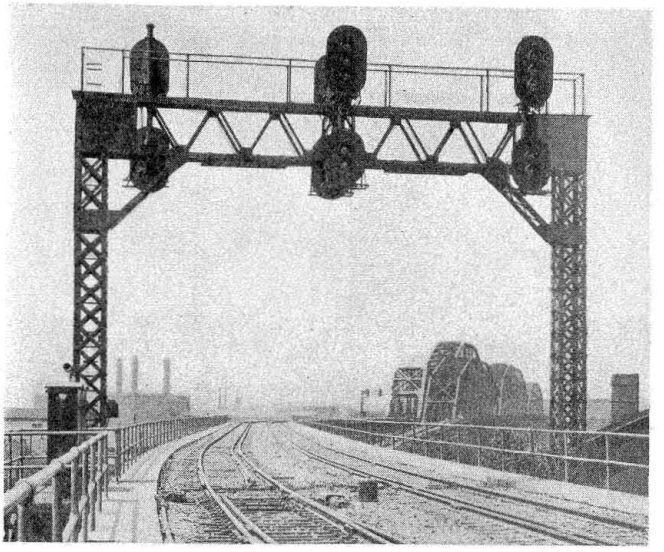
Interlocking Plants

At Newport, "NX" Cabin, a single-track line of the L. & N. crosses the C. & O. double-track line at grade. The existing interlocking machine at this plant was converted from mechanical to electro-mechanical by adding Union Type-S-8 electric levers to the mechanical machine. The final layout consists of a 20-lever mechanical frame with 15 operating levers and 5 spare spaces, and 10 Type-S-8 electric levers. Three main-track crossovers, not formerly interlocked, two of which are located at the water column just east of Licking River about 3,000 ft. west of "NX" Cabin, are now interlocked and controlled from the interlocking machine and are operated by Union Style-M low-voltage d-c. switch machines.

At "KC" Junction, which is the junction point of the L. & N. and C. & O. double-track lines, a new electro-pneumatic interlocking was installed consisting of a 59-lever machine with 50 operating levers, 2 spare levers and 7 spare spaces. This machine was installed on the third floor of a new three-story brick building, the lower floor of which is used as a yard office.

Another new 23-lever electro-pneumatic interlocking machine was installed in a new two-story brick tower known as "OB" Cabin, located at the west end of the new four-track line near Sixth Street, Covington, to handle the crossovers and switches in this vicinity. The interlocking machine is a 23-lever frame with 18 operating levers and 5 spare spaces.

On the Cincinnati side of the river an obsolete 110-volt d-c. electric interlocking plant was replaced by a new electro-pneumatic plant consisting of a 51-lever machine with 30 operating levers. This new two-story brick tower known as "MD" Cabin, is located at Rose Street, Cincinnati, alongside of the double-track line of the Cincinnati Inter-Terminal and the tower proper is supported by a three-story

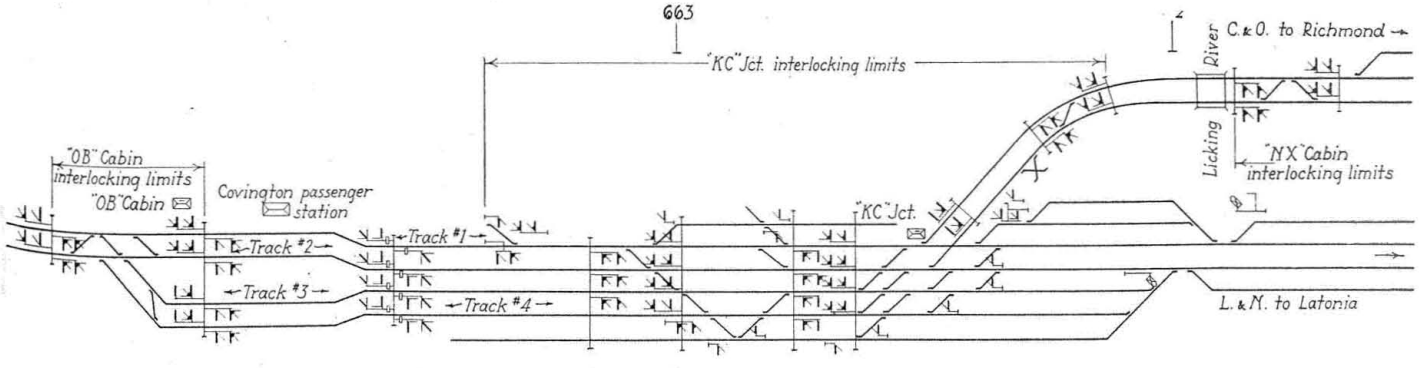


The Fourth street signal bridge in Covington, with Ohio river bridge in background

substructure of reinforced concrete, which was required in order to place the tower at the proper elevation with respect to the location of the main tracks on the new Inter-Terminal bridge structure. This plant handles the switches for tracks leading to the Union Station, the C. & O. Fourth Street Station, the Big Four yards and also to the Chicago division of the C. & O., along which are located the yard tracks used by the C. & O., the B. & O. and various interchange connections and industries in Cincinnati. One of the many interesting features of this plant is that all but 8 of the 19 interlocked switches are located on an elevated steel structure, which is in some places over 50 ft. above the ground level.

Through Movements by Signal Indication

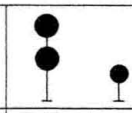
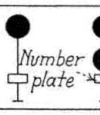
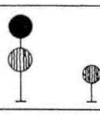
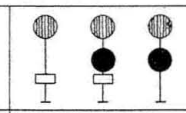
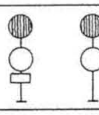
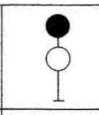
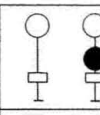
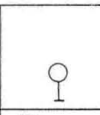
The new track layout as shown in the diagram includes crossovers to permit parallel movements within the limits of the interlocking plants, and thus provides maximum flexibility for handling crossover movements when diverting trains from one track to another in the entire territory between "NX" Cabin, Newport, and "MD" Cabin, Cincinnati. The signal-



Cincinnati, to "NX" Cabin, Newport, Ky.

ing between towers is controlled by traffic locking, signal indications being provided for directing train movements in either direction on all tracks. The bulletin covering the signal installation specifies that traffic on all main tracks between interlocking limits is reversible and that the current of traffic will be authorized by interlocking signals and that signal indications will supersede time-table superiority. All train movements in this area are under the direction of the general yard master at Covington who outlines how the movements shall be handled through the entire district, in order that delays may be reduced to a minimum.

With the new bridge in service, large locomotives capable of handling as many as 125 cars are used for the freight transfer trains in either direction. This reduces the number of trains, but increases the necessity for preventing stops, which requirement has been adequately met by the new facilities. The changing of motive power on inbound and outbound passenger trains, which was formerly necessary at Stevens Yard, 10 miles east of Newport, has also been eliminated and passenger train schedules were shortened accordingly.

								
NAME	Stop signal	Stop and proceed signal	Slow speed signal	Approach signal		Approach restricting signal	Clear restricting signal	Clear signal	Clear slow speed signal
INDICATION	Stop	Stop then proceed	Proceed at slow speed prepared to stop	Approach next signal prepared to stop		Approach next signal at restricted speed	Proceed at restricted speed	Proceed	Proceed at slow speed
RULE	601-A	501-AA	601-G	501-B	601-B	501-E 601-E	601-F	501-C 601-C	601-H

Green Yellow Red

Chart of aspects and indications of signals

Signals and Signal Aspects

The high signals are Style R-2 color-light type with 8⅜-in. doublet lens. The interlocking signals are of the two-unit type, except the dwarf signals, which are of the one-unit type, Style-N, with 5½-in. doublet lens. The automatic signals are of the one or two-unit type, the two-unit type being used only for distant indications governing the approch of trains to home interlocking signals, where a restricted-speed indication is displayed for crossover movements.

Eight signal aspects are given by the color-light signals in this installation. The signal indications, based upon the standard code of the A.R.A., are few in number, easy to understand, and have been of great help to the trainmen in handling heavy traffic. Even with the more extensive track layout, the number of indications with the new system of signaling is no greater than with the old semaphore signaling previously in service.

Traffic Locking

The Chesapeake & Ohio has developed an adequate traffic locking scheme for train operation in either direction by signal indication. A 28-volt d-c. circuit requiring only two wires for separate control and return between towers for each track provides the following facilities:

(1) An audible and visual indication that an unlock is desired.
(2) A visual indication that conditions are such as to make it proper to reverse traffic.
(3) A locking circuit guarding against changing traffic except when, all track sections between towers are unoccupied, opposing signals in the stop position, and levers mechanically locked.

Features of Interlockings

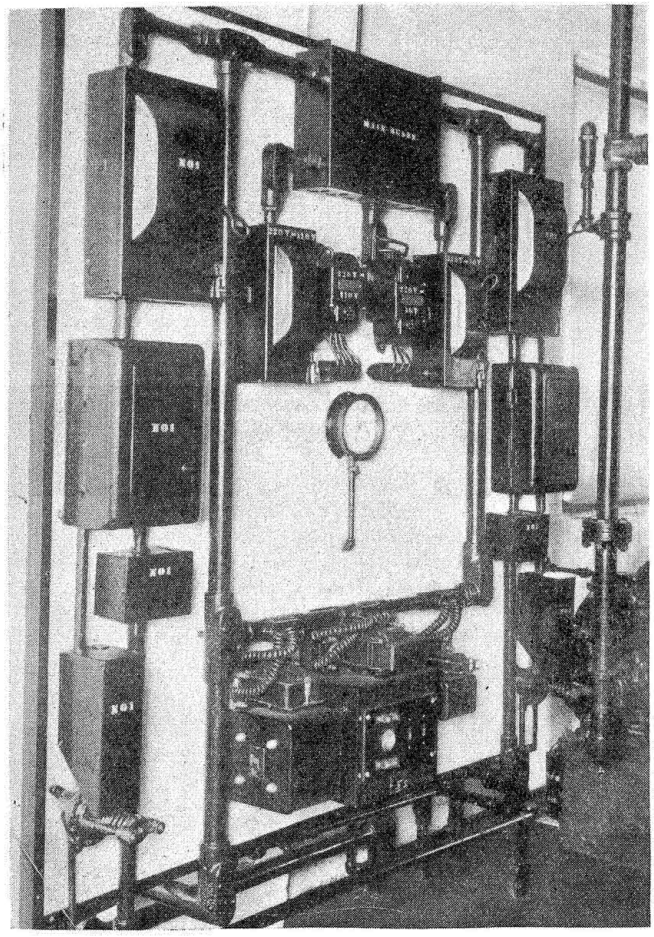
The interlockings throughout the entire district are provided with modern safety features, including complete approach locking for all high and restricted-speed signals, time locking for all low-speed and dwarf signals, and route and detector locking. "Call-on" signals are provided for directing the movement of trains into occupied blocks for following movement only. The color-light signals are normally illuminated from commercial a-c. power supply with a floating storage battery system for stand-by service. Track circuits are operated by storage battery, and emergency engine taps are provided in the main air line, thus entirely eliminating train delays which might otherwise occur owing to interruption of the a-c. power supply.

The power interlockings are of the electro-pneumatic type using the Union Model-14 interlocking machine and the Style A-1 switch layout with Style-C independently mounted switch valve. Illuminated track models are mounted over the interlocking machines, with white lamps in each track circuit burning when the track is clear, and with red approach and green traffic direction lights. Lever lights are also provided and are mounted in lamp cases on the machine below the levers, white lights being used on signal levers indicating when the block is unoccupied, green lights on switch levers for detector lock indication and white lights on traffic levers indicating when conditions are proper for reversing traffic. An additional feature which has been standard practice on the Chesapeake & Ohio for several years is used in the form of signal repeater lights which are mounted in the third row below the signal levers. These lights flash red when the levers are operated to display proceed signal indications, and will remain red if the signal does not respond to the lever movement. When the signal resumes its most restrictive indication, following a train movement, the red light is illuminated and will continue to burn until the lever has been returned to the normal position, thus providing an indication of considerable value to the leverman in guarding against failure properly to restore signal levers after train movements have been completed.

On removing the covers at the rear of the interlocking machine it can be noted that the lever numbers are lettered with white enamel on the ends of the lever shafts, on the bearings of the circuit controllers, and on the hard rubber rollers just below the center bearing. This practice provides information

which is of decided assistance to the wiremen when wiring the machine and the maintainer when making adjustments and conducting tests during routine maintenance. The single-conductor No. 16 flexible wires, used between the relay case on the floor below and the machine, are brought up through large openings in the concrete floor and are neatly cabled together with lacing twine and fanned out for distribution throughout the length of the machine, passing up between the rows of terminal posts on the spring combination board. The vertical strain caused by the weight of the cable is taken up by small horses or frames made of ¼-in. by 1-in. strap-iron which is wrapped with insulating tape and covered with P. & B. compound, to which the cable is tied with marlin.

Annunciator bells, for audible indication of traffic signaling between operators and for announcing the approach of trains, are of the single-stroke type and are located inside the model board. The clockwork time releases are normally the latched-up manual-re-

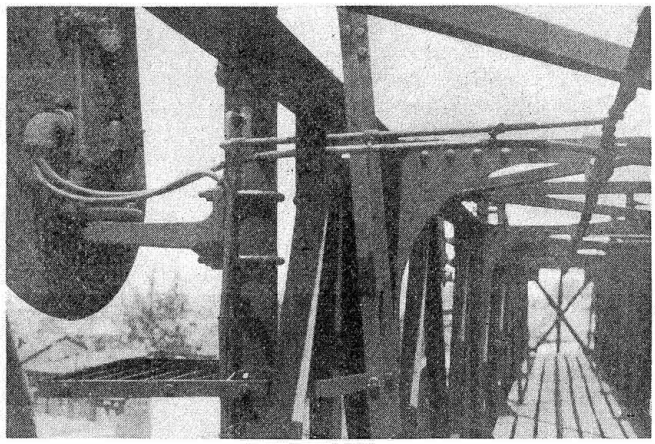


Power board at "KC," showing transformers, air gages and control equipment mounted on asbestos panel

storing type and are mounted on the face plate of the model board below the track diagram, a feature being that the time limit, for which the release is adjusted to operate, is stamped on a fibre tag attached to the metal frame of the release by two small machine screws and located under the glass cover so as to be readily visible for the information of the maintainer and inspector in conducting tests of approach and time locking.

First Floor

The relay cabinet, the power switchboard, the batteries and the air compressors are located on the first floor of each tower. The relay cabinet is the sectional sheet steel type with glass doors, chase ways being provided between sections with removable panels so as to make all wiring readily accessible. From four to six relays are located in each section and the wires are brought up from the rear of the cabinet through ½-in. holes in the panel boards to terminals, from which jumpers extend to the relays. All wires run-



Aerial cables on signal bridges are supported by iron rods spot welded to bridge members

ning from the relay case to the machine are carried from the top of the relay case to the openings in the concrete floor under the machine in metal chases. Wires running between the relay case, the power switch board, batteries and air compressors are run in metal conduit which was laid in the concrete floor when it was poured.

There are three batteries located in each tower, a 6-cell main battery used for the operation of relays, switch valve magnets, etc., a 5-cell emergency battery arranged in two portable trays for emergency use at any location throughout the plant, and a 14-cell traffic-locking battery. All of these storage cells are located on a rack, the frame of which is constructed of 1½-in. angle-iron, gas welded and braced to provide a rugged structure. The top of the rack is made of a single sheet of ¾-in. asbestos board, at a height of about 3 ft. above the floor, on which the cells are set and arranged for accessibility and convenience in inspection.

The power switchboard, as shown in one of the illustrations, is likewise constructed of a framework of 1½-in. angle-iron and T-iron on which are mounted sheets of ¾-in. asbestos board. The transformers, rectifiers, air gage, and control switches are mounted on this asbestos board and the wiring between units is run in metal conduit provided with suitable condulet outlets at each unit. The power board at "KC" tower, as shown in the illustration, is about 7 ft. high and 5 ft. wide.

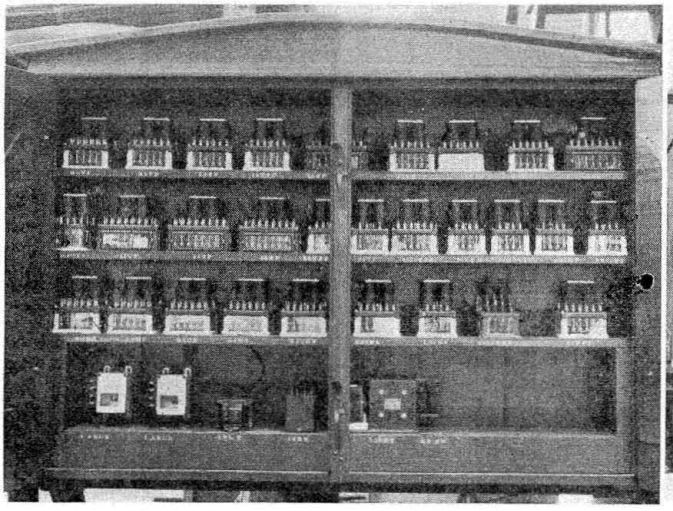
Compressor Equipment

Duplicate sets of automatically-controlled, 220-volt, 3-phase motor-driven air compressors are in service at each plant. The compressors at "OB" Tower have a capacity of 12.5 cu. ft. per min. each, while those at "KC" Junction and "MD" Towers have a capacity of 20 cu. ft. per min. each. Each compressor is controlled by an electro-pneumatic switch so adjusted that when the pressure in the main reservoir drops to 50 lb., the compressor automatically cuts in, and after the pressure has been built up to 65 lb. it cuts out. The motor operating circuit for each compressor is controlled over a 3-pole

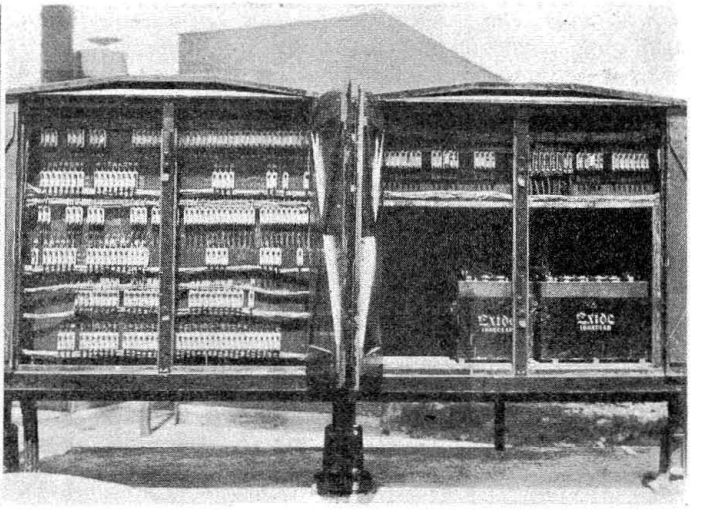
single-throw Square D fused knife-switch located on the power panel, and by opening or closing this switch, as required, the compressors are alternated in service every other day.

As shown at the right in the view of the power board, the main pipe from the compressor runs up vertically and is attached to the compressor with a "T," the bottom of which is equipped with a plug and small pet cock. This arrangement is provided to permit blowing off any moisture that accumulates at this point on one compressor while the other compressor is in operation, and the test is always made before cutting each compressor into service.

In the 2-in. vertical pipe leading from each compressor, a pop valve is located which will operate at a pressure of about 90 lb., so as to protect against starting the compressors against a closed valve. In the main lead pipe between the piping arrangement in the tower and the atmospheric after-cooler, which is suspended on the back wall of the tower, a check valve is used which serves the double purpose of preventing moisture from backing up and back pressure accumulating against the compressors, if for any reason the compressors are not operating and air is being furnished from some other source.



Relay cases are wood; wires terminate on A. R. A. terminals in back of case



Rear side of case and battery at location on elevated structure

Air Line and Connections

The air for the operation of switches at each plant is distributed in main runs of 2-in. extra heavy galvanized iron pipe placed on small concrete piers with the pipe line about level with the base of rail. In some locations it was necessary, on account of close clearances, to bury the main pipe line underground; in other places, it is supported on stakes made of 3-in. angle-iron which are set in concrete and on which the pipe is supported by a strap-iron hook which is welded to the stake at the proper height. At the plant in Cincinnati the main pipe line serving the switches on the elevated structure is carried on suitable angle-iron supports attached to the bridge girders under the deck between tracks.

Cross runs are of ¾-in. extra heavy galvanized iron pipe, buried about 18 in. below the ties and connections to the main line, are made from the top of the 2-in. pipe so as to reduce to a minimum the accumulation of moisture in the cross runs. By the use of two ¾-in. street ells, hinge joints are provided so as to eliminate any chance of breakage at cross run connections due to expansion and contraction in the main pipe line. Expansion joints are located every 500 ft. in the main pipe line. All pipe fittings are extra-heavy double galvanized; flange unions have brass seats, and gate valves are of the best quality and tested for 150 lb. pressure.

Ample reservoir capacity has been provided by installing two main reservoirs at each tower, as well as auxiliary reservoirs at the ends of the main pipe line and at other points throughout the plant, as was considered necessary. Emergency engine taps have been provided for each plant and at "KC" Junction an additional source of air supply has been made available by arranging the piping so that the maintainer can readily make connection to the shop line near the Covington engine house. If the power supply for the operation of the compressors is interrupted, or for any other reason the compressors fail to function properly, air supply is thus available for emergency operation of the plant.

Power Distribution

Power is obtained from the local distribution lines of the Ohio and Kentucky Light Heat & Power Company, and is separately metered at each location. At each tower double-service connections are provided, one consisting of 60-cycle, 220-volt, 3-phase supply for operation of the compressors, from one phase of which power is obtained for the model board and machine indication lights and battery rectifiers; the other consisting of 60-cycle, 110-volt, single-phase supply for tower lighting. At each signal bridge and at several of the ground mast signal locations in Cincinnati, 110-volt, single-phase, 60-cycle power is obtained for the operation of signal lights and charging the storage batteries.

While the battery capacity at all signal locations is generally sufficient to provide stand-by service of at least 12 hr., an additional safeguard against delay to traffic owing to future possible interruptions of the local a-c. power supply, has been provided. This was accomplished by installing a system of emergency sectionalizing circuits consisting of two No. 9 A.W.G. insulated wires between each signal location which are connected on fused knife-switches so as to provide for properly inter-connecting the 110-volt buses and opening the switches controlling the normal supply when such action becomes necessary. By

this means, anticipated transformer burnouts may be handled without having to exhaust stand-by batteries in the operation of signal lights, and thus conserve the stand-by battery power for other possible emergencies in which sectionalizing will not meet the requirements.

At the Cincinnati plant, where several ground signals are fed from one source of power, a similar arrangement of 110-volt power circuits is in service for local distribution.

Main Wire Distribution

In the section between Newport and "KC" Junction, one crossarm carrying 10 No. 9 A.W.G. bare copper wires on the T. & T. pole line were used for approach, signal indication lock, and signal control circuits. Multiple-conductor aerial cables were run on the same pole line and were supported by a ⅜-in. Copperweld messenger attached to the poles below the signal crossarm. In the section between "KC" Junction and Cincinnati, multiple-conductor aerial cables were used exclusively for main distribution. Between "KC" Junction and 4th street, Covington, the cables were carried on the pole line of the Western Union Telegraph Company, and between 4th street, Covington, and Cincinnati, they were carried on 2-in. angle-iron supports attached to the Ohio River Bridge, its approaches and the elevated steel structure in Cincinnati.

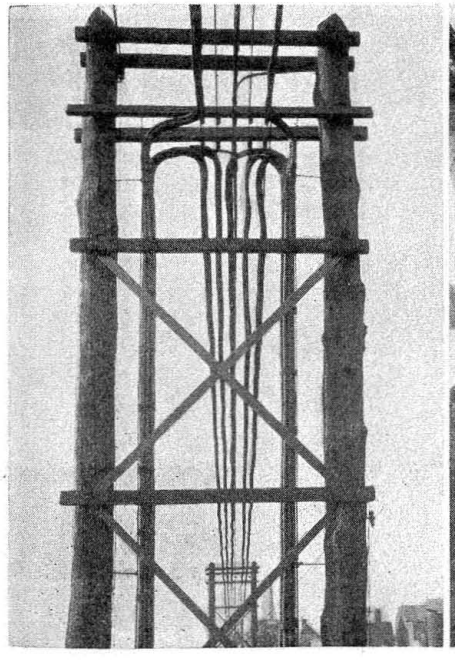
Aerial cables ranging in size from 3 to 37 No. 14 A.W.G. solid copper conductors, were used and were bunched according to destination, each bunch being carried in 2- and 3-in. galvanized cable rings fastened to the ⅜-in. Copperweld messenger wire. On account of vibration on the bridge and elevated structure, insulated cable conductors were used for tying in the cables instead of cable rings. All aerial cables were terminated on porcelain based terminals in a terminal box near each tower and at destination. From these terminals steel-taped cables ranging in size from 3 to 27, No. 14 solid copper conductors were used for connections to the terminals in the bottom of the steel relay cases on the first floor of the towers and for distribution to the switches and dwarf signals. Aerial cables were used for local signal lighting circuits on signal bridges and are supported by round iron rods spot welded to the bridge members, the cables being tied to the rods with insulated cable conductors as illustrated in one of the views. This arrangement provides secure fastening and easy inspection of the cables, as well as a neat appearance.

Parkway cables to switch machines are terminated in concrete junction boxes located about 18 in. from the switch machine, where they are spliced to No. 12 flexible insulated wires, which run through flexible armored duct between the junction box and the machine. Junction boxes are filled with sand up to a point near where the wires are spliced and the surface sealed with a layer of Chatterton compound. Removable junction box covers are provided so as to make splices readily accessible for inspection. Wires between interlocking machine and tower relay and terminal cases, between terminals and relays, and for inter-connecting between terminals in both tower and outside relay cases, are No. 16 flexible insulated, equipped with soldered eyelets. Track circuit connections are No. 9 steel-taped cables and switch fouling circuits consist of four No. 9 flexible wires in wood trunking, two wires being run to each rail.

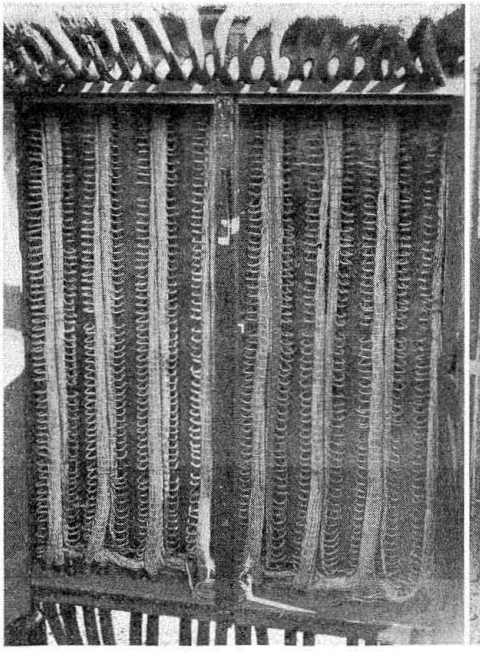
Circuits and Batteries

The controls for all apparatus except approach relays and signal indication locks are two wire, and battery indication is used in connection with switches and signals. Track circuits are fed from one cell of 125-a.h. capacity lead-type storage battery with a limiting resistance adjustable between 5½ ohms and 11½ ohms. The track relays are 2 and 4 ohms, the latter being used on circuits of 1,000 ft. or less in length.

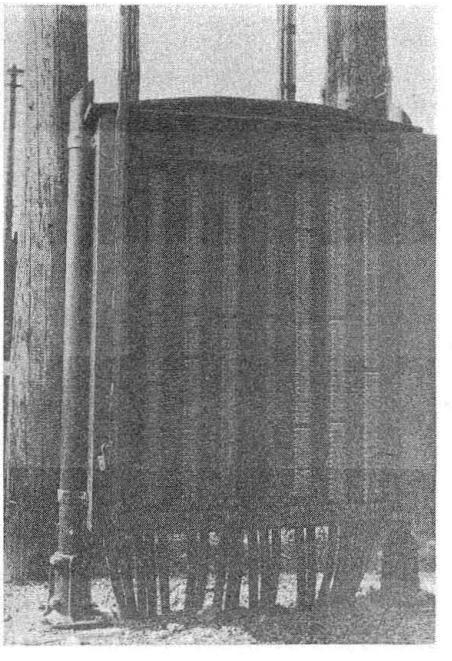
The main and emergency batteries at each tower consist of 6 and 5 cells respectively of Ironclad 315-a.h. capacity. At each signal bridge a 5-cell battery of the same type and size is used for emergency standby service for signal lighting, as well as for the operation of various track repeater and signal re-



Heavy runs of aerial cable are supported by "H" fixtures

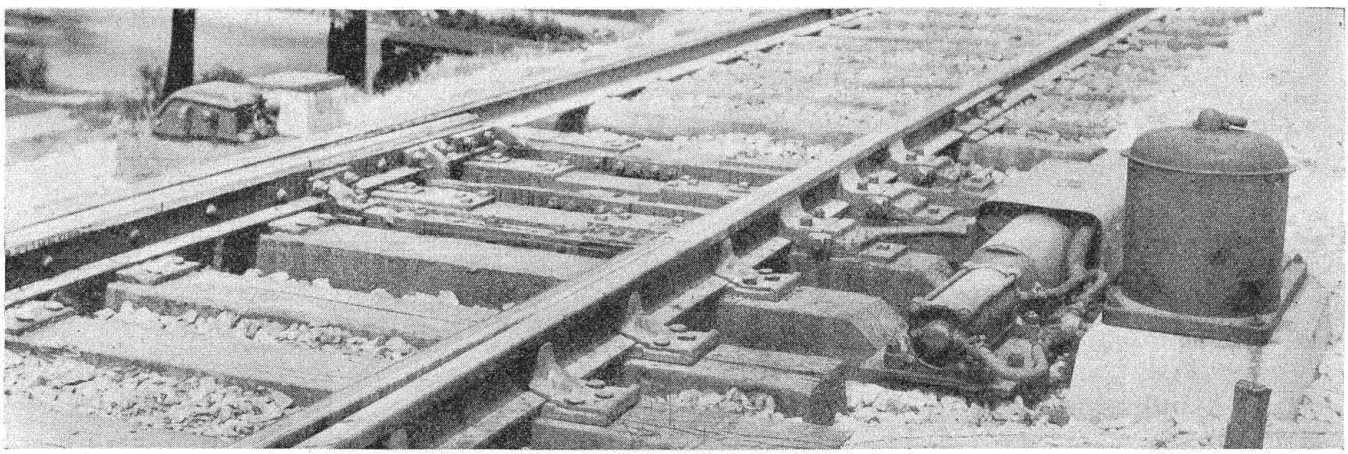


Line side of cable terminal case showing incoming line cables



Reverse side showing terminals and parkway cable running to ground

lays. At ground signal locations, where only a few signal lights are involved, a battery consisting of 5 cells of 125-a.h. capacity is used. Switch operating batteries for electric switch movements and traffic locking batteries consist of 12 and 14 cells, respectively, of lead type, 125-a.h. capacity. Copper-oxide rectifiers are used for charging the storage batteries. The batteries at all outside locations are housed in concrete battery boxes, except at locations on the elevated structure, where they are housed in the lower compartment of the wooden relay boxes. This arrangement is such as to provide ample room for inspection and test.



An electro-pneumatic switch machine layout

All of the d-c. relays are of the Model-12 and Model-13 types, self mounted so as to be readily moved about for inspection. The a-c. power-transfer relays are Model-ANL-20 and are mounted on special brackets of strap-iron equipped with rivets on which the relays are suspended and from which they can be readily removed and moved about for inspection.

Switch Layouts

As shown in one of the views, the switch machines are mounted on oak timbers properly framed and treated with carbolineum. The switch points are well braced with Type-C, adjustable rail braces on each of the first three ties and Stiles head and front rods are used for connecting the switch operating and lock rods to the switches. At the "OB" and "KC" plants the switch control valve units are mounted on concrete bases, but at the "MD" plant in Cincinnati, these units are placed on steel plates bolted to the elevated steel structure. A separate polarized switch circuit controller is used on each interlocked switch as a point detector, and the circuit controlling the polarized switch-repeating relay is operated in series over the contacts of this switch circuit controller and the contacts in the indication circuit controller on the switch mechanism.

The signal bridges were designed in the office of the chief engineer at Richmond, Va., and were erected by the bridge forces who had charge of the other structural steel work on this installation. As a means of protecting the bridge structure and signals from the direct blast of smoke from locomotives, a blast plate of ½-in. boiler plate is mounted horizontally over the center line of each track. This plate is 5 ft. wide and long enough to extend about 10 in. beyond the edge of the bridge structure.

The new towers at "KC" Junction, "OB" and "MD" interlocking plants are of reinforced concrete and brick construction. All window and door frames are of steel construction and very little wood or other combustible material was used in the construction. A special composition floor covering known as "American Lit-O-Silo-O" was used over the concrete on the first and second floors which has proven effective in protecting the interlocking machine and other tower apparatus against concrete dust. Heating is accomplished by means of a Gasteam heating system and toilet facilities are provided on the second floor and in the basement.

Construction

All plans and specifications were developed in the office of the superintendent of telegraph and signals and the construction work was performed by C. & O. railway forces, with the exception of the construction of the towers, which work was contracted. The signal and interlocking project was executed under the immediate supervision of D. K. Roll, supervisor of signal construction, reporting direct to the superintendent of telegraph and signals.

Slag ballasted track on the Denver & Rio Grande Western main line between Tennessee Pass, Colo., and Keeldar