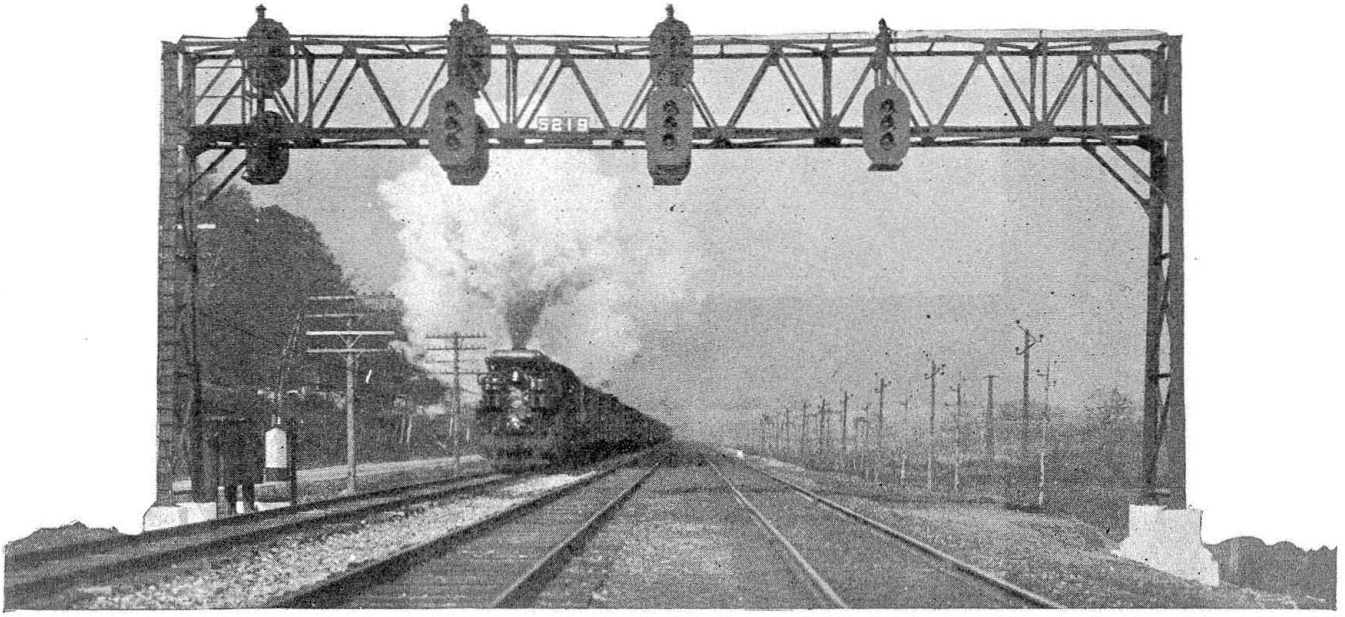
C. & O. Completes Three-Track, Color-Light, Either-Direction Signaling

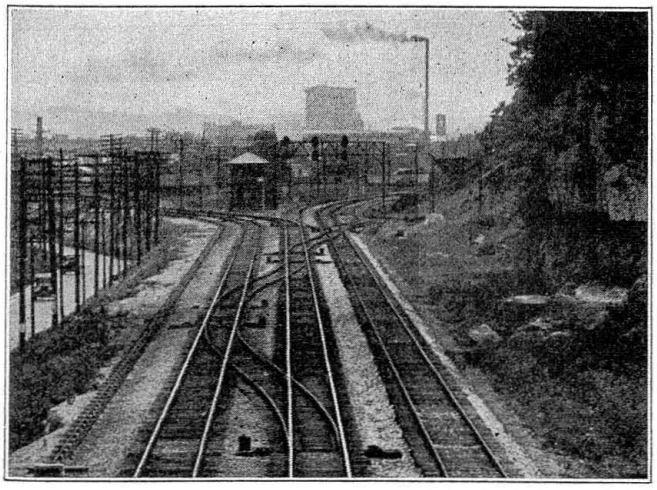


Eastbound train approaching bridge 6 at NC cabin

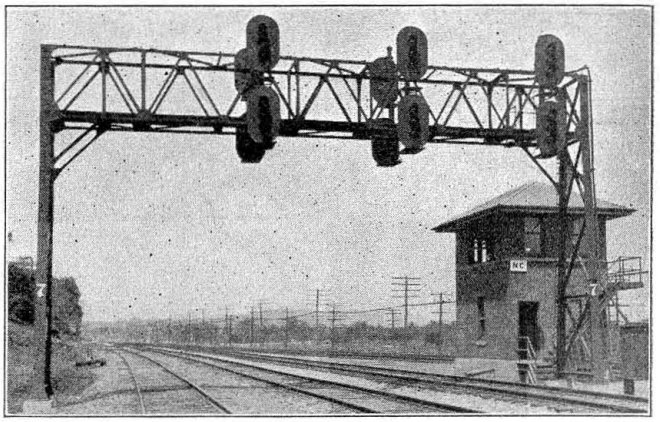
Simplified scheme of indications with traffic locking and five new interlockers eliminates written train orders, increasing safety and speed of operation

By Burt T. Anderson
Superintendent of Signals, Chesapeake & Ohio

THE Chesapeake & Ohio has completed an interesting signal installation on a 10-mile section of three and four-track railroad between Russell, Ky., and Ashland, in connection with the rearrangement of tracks and yards and a new passenger station at Ashland. Formerly a double-track line handled all the freight and passenger traffic through the city of Ashland, but due to the congestion at the old station it was often necessary for the freight trains to block some of the 20 street crossings in the city and seriously delay the highway and railway traffic. This portion of the Chesapeake & Ohio is one of the busiest sections on the system as it handles not only the regular Cincinnati division traffic but also all the coal movement to the Columbus territory. A typical day's traffic is as follows: 70 freight trains, 18 passenger trains and in addition light engines, switch engines and extras.



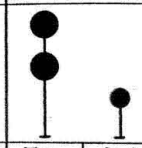
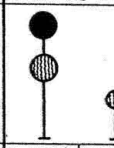
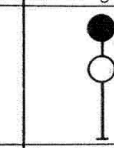
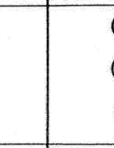
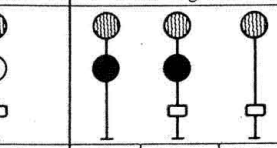
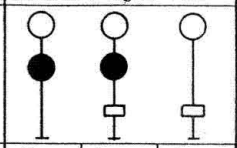
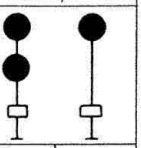
View from bridge 6, looking east toward NC cabin



View of NC tower and bridge 7 looking west toward the junction

Before the new signaling was placed in service three-position automatic semaphore signals were used throughout the entire territory. Switches and cross-

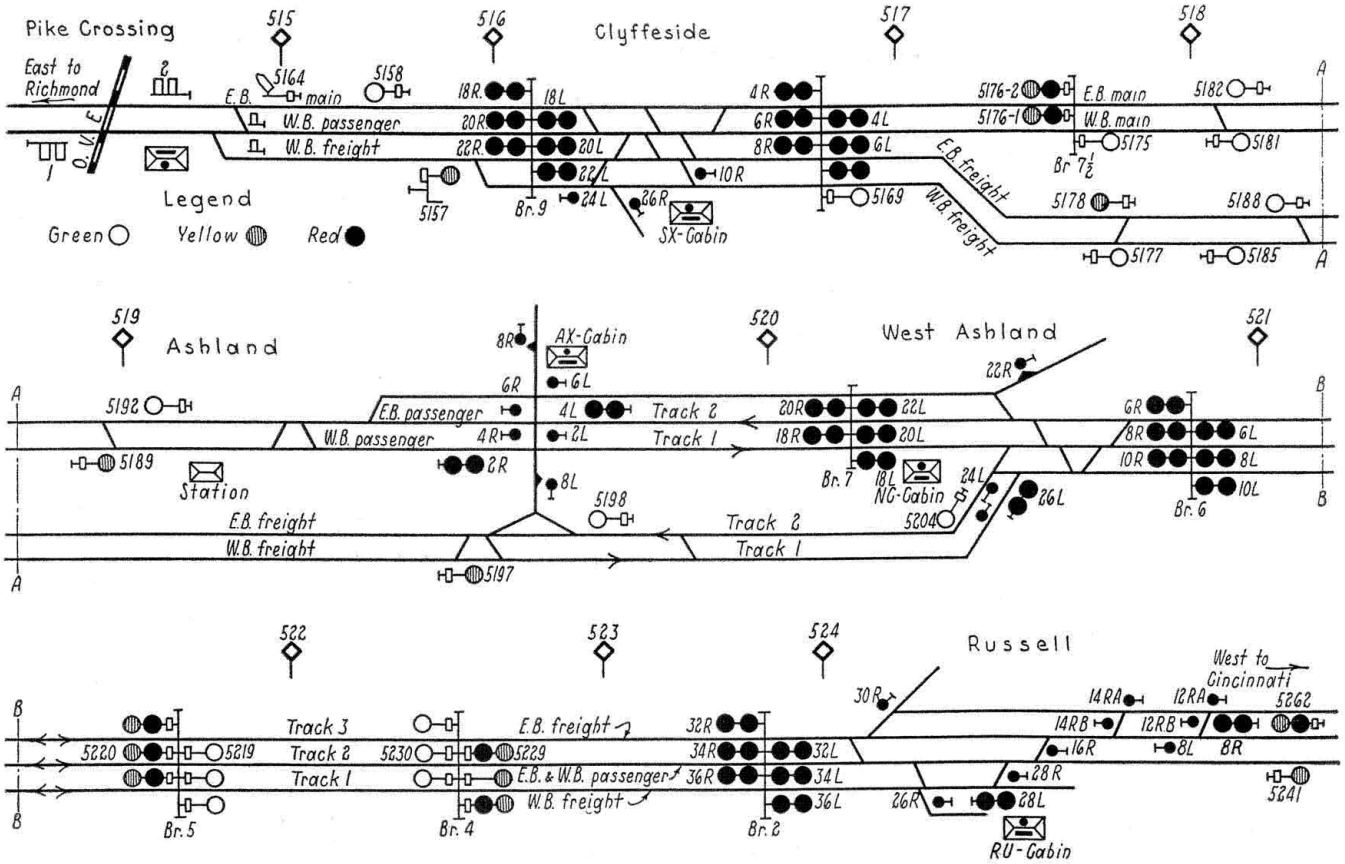
overs at Russell, NC Cabin and Clyffeside were hand-operated, protected by semaphore electric signals. A small mechanical plant AX was in service at A. C. & I. crossing. Trains were moved against traffic by train orders, 150 such movements being made per month, with only the usual train order signal protection for such operation. The old semaphore automatic signals were spaced about 7,500 ft. apart. The use of these long blocks and hand-operated switches at Russell, West Ashland and Clyffeside with the movement of heavy traffic naturally caused some delay to trains and did not provide the most flexible facilities for efficient train operation.

Fig	1		2		3	4	5			6			7	
Aspect														
Given by	Two red lights	Red light	Red light over yellow light	Yellow light	Red light over green light	Yellow light over green light and number plate	Yellow light over red light	Yellow light over red light and number plate	Yellow light	Green light over red light	Green light over red light and number plate	Green light	Two red lights and number plate	Red light
Name	Stop signal		Slow speed Signal		Clear restricting signal	Approach restricting signal	Approach signal			Clear signal			Stop and proceed signal	
Indication	Stop		Proceed at slow speed prepared to stop		Proceed at restricted speed	Approach next signal at restricted speed	Approach next signal prepared to stop			Proceed			Stop then proceed	
Rule	601-A		601-G		601-F	501-E	601-B and 501-B			601-C and 501-C			501-AA	

Legend:- Green ○ Yellow ◍ Red ●

Chart of simplified signal aspects for color-light signals on C. & O.

double-track layouts throughout the city of Ashland. Passenger traffic is now handled on the old double track main line while freight trains operate over a new double-track freight line and yard built to the north along the Ohio river. This track and operating arrangement kept the freight trains away from the busy section of town and the new passenger station. The new track begins just west of Pike Crossing, east of Ashland, with three running tracks. Westbound slow freight trains usually take Track I at Pike Crossing, Tracks 2 and 3 being reserved for high-speed traffic. At Clyffeside the three tracks join two double-track lines, one for freight trains along the Ohio river and the other, the old main line, being reserved for passenger traffic. At NC Cabin, west of Ashland, the two double-track lines again meet and become three tracks to Russell, from which two main tracks are used to MS Cabin, about two



Track and signal plan of section from Pike crossing to RU cabin

Special Color-Light Signaling Equipment on New Track Arrangement

In 1924 a new track arrangement as shown in the diagram was placed in service which provided two

miles away. Five interlocking plants are required to handle the signaling on this layout as follows:

1. Pike Crossing: Street car and state highway crossing. Also control switch leading into Track 1.
2. Clyffeside: Three and four-track junction.
3. A. C. & I. Crossing: Crossing with old A. C. & I. line (now owned by C. & O.) and main passenger line.
4. NC Cabin: Three and four-track junction.
5. RU Cabin: Three and two-track junction. Also controls signals and switches to eastbound and westbound yards.

The entire signal installation comprised about 10 road-miles, 29 track-miles and 85 color-light type signals, distributed as follows:

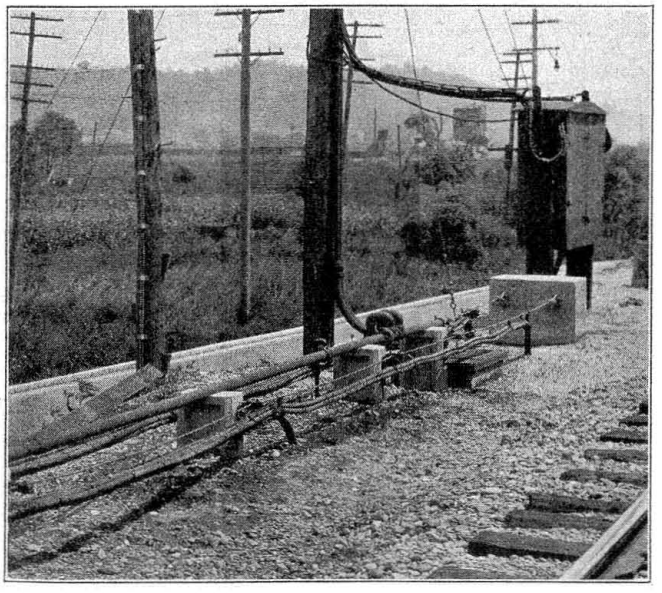
Details	Clyffeside	A. C. & I.	NC	Russell	Automatics
Switches and derails	17	2	14	14	
One-arm signals	1	0	1	0	20
Two-arm signals	12	2	12	8	8
Dwarf signals	3	6	3	9	
Size of machine	31	12	31	43	
Type of plant	EP	EM	EP	EP	

Either-Direction Operation in Three-Track Section by Signal Indication Without Written Train Orders

With the installation of the new signal facilities all trains were operated between RU and NC Cabins on any of the three tracks in either direction by signal indication without train orders. The tracks are normally operated as follows:

Track 1—Westbound slow freight.
Track 2—Eastbound and westbound passenger trains.
Track 3—Eastbound slow freight.

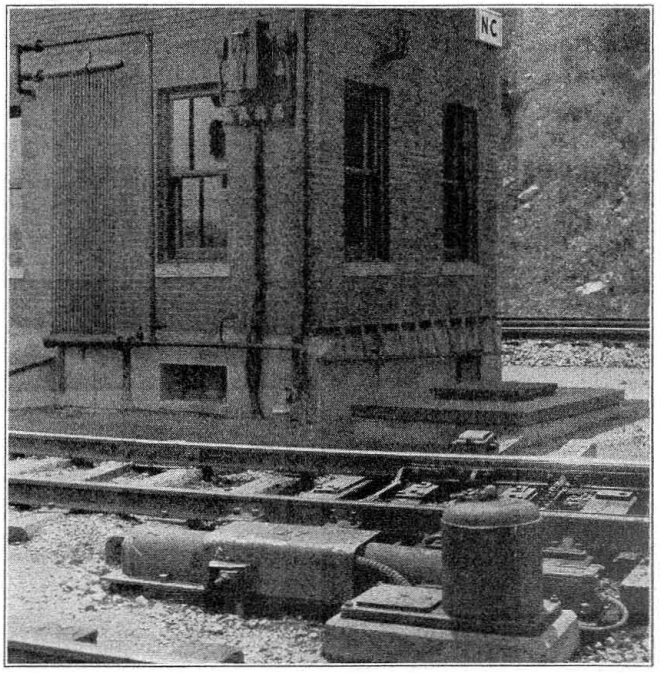
East of NC Cabin the passenger trains operate with traffic over the two passenger main tracks and the freight trains operate with traffic on the double



Main air line and cables are supported by foundations to facilitate inspection

freight tracks along the river. On account of providing four tracks between NC and Clyffeside Cabins, trains are not regularly operated against traffic between these cabins. If such movements are necessary, train orders and signals are used. This method of freight and passenger operation causes many crossover movements at Clyffeside, NC and RU Cabins. Some idea of the traffic since the new signals have been placed in service can be obtained from a check at Russell which recorded 88 engines crossing over from the west yard to the east yard and over 900 train movements at the plant in 24 hr.

The signal cabins are of brick and fire-proof construction and equipped with steam heat and electric



View of NC tower showing electro-pneumatic switch machine in foreground

lights. The heating plant and maintainer's workshop are in the basement. The first floor is used as a relay and battery room while the second floor contains the interlocking machine.

Simplified Signal Aspects

There are seven signal aspects given by the color-light signals in this installation. The signal indications are 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 the largest traffic in the history of the railroad. The number of indications is less with the new system of signaling even with its more extensive track layout than with the old semaphore signaling previously in service. It will be noted that all interlocking signals are of the two-unit type except for the one-unit dwarf signals. Automatic signals are of the one or two-unit types, the two-unit type only being used for a distant indication when trains are diverged at one of the cabins over a high-speed turnout.

The Chesapeake & Ohio has developed an adequate traffic locking scheme for train operation in either direction by signaling. On a previous installation this road installed a special hand operated a-c. generator for supplying high voltage a-c., current for operation of traffic locking apparatus. In this installation a similar scheme was developed except that 30-volt direct current was used for traffic lever operation. A circuit was designed which required two wires for a separate control and common for each of the three tracks which provided the following facilities: (1) An audible indication that an unlock was desired. (2) A visual indication that it was proper to reverse traffic. (3) A lock-up circuit guard-

ing against reversing traffic except in the proper direction.

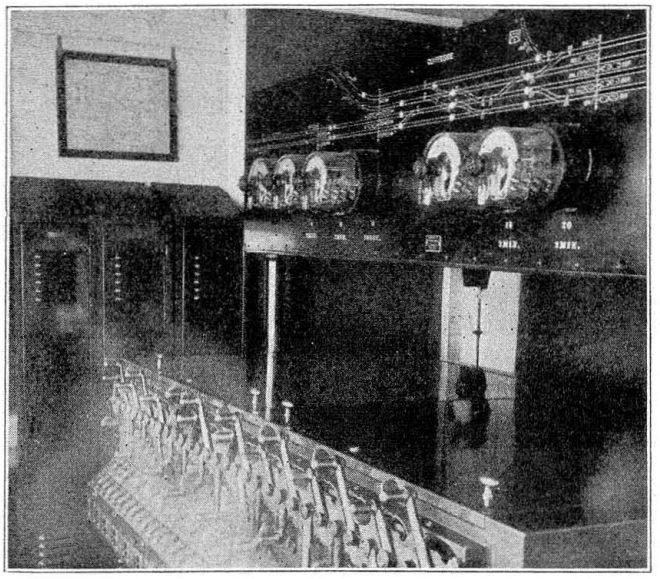
In August, 1926, a total of 210 trains were run against traffic on Track 2 between RU and NC Cabins by signals without train orders. These movements would have been made by train orders if the traffic locking and signals were not in service. In April, 1925, prior to the installation of the new signaling 182 train orders were issued for running six passenger trains between NS and RU Cabins against traffic, trains being diverted 148 times in the month. This comparison shows over 40 per cent increase in the number of trains operated by traffic locking and signals without orders after proper facilities were installed. This scheme of operation has many advantages; such as, safety, quickness and facility of operation, low first cost and freedom from failures as compared with some of the other schemes in more general use.

Parkway Cable Used Exclusively

Several new methods of signal construction were followed in this installation. The underground runs were made with steel-taped cable, not a foot of trunking being used on the entire installation. The main cable runs to the switches were supported in cable hangers attached to a ⅜-in. messenger wire bolted on the side of the air line foundations. At a point opposite each switch, the cable was dropped from the messenger line into the ground and then underground to the switch layout. Track wires and cables to the relay boxes near the cabins were installed in a similar manner. In this way only a small portion of the steel-taped cable was placed underground. When carried above the ground, proper visual inspection can be given at all times. This method of construction is less expensive than installing conduits of fibre, concrete or wood and after several years' service has proven very satisfactory.

Instead of running the 2-in. air mains in the ground or in conduit, as is sometimes the practice, they were supported on concrete foundations. The ¾-in. taps off the 2-in. main line are taken off opposite the switch locations and underground to the switch cylinders and valves. It will be noted that the 2-in. air main is simply set on top of the foundation and is not clamped to the air line foundation in any manner. The air line foundation was designed especially for this work and was provided with the proper recess in the top for the 2-in. air line and the necessary holes in the side for holding the bolts that support the messenger clamps. Either end of the concrete foundation can be used for the air line and messenger wire supports. The same foundation can also be used on the usual interlocking pipe lines. Means are provided at the end of the air line for anchoring the 2-in. air main as well as the ⅜-in. messenger runs. Suitable expansion joints are used in the 2-in. main to provide for expansion and contraction due to temperature changes. This type of construction is economical in first cost and provides means for ready inspection of the main runs at all times.

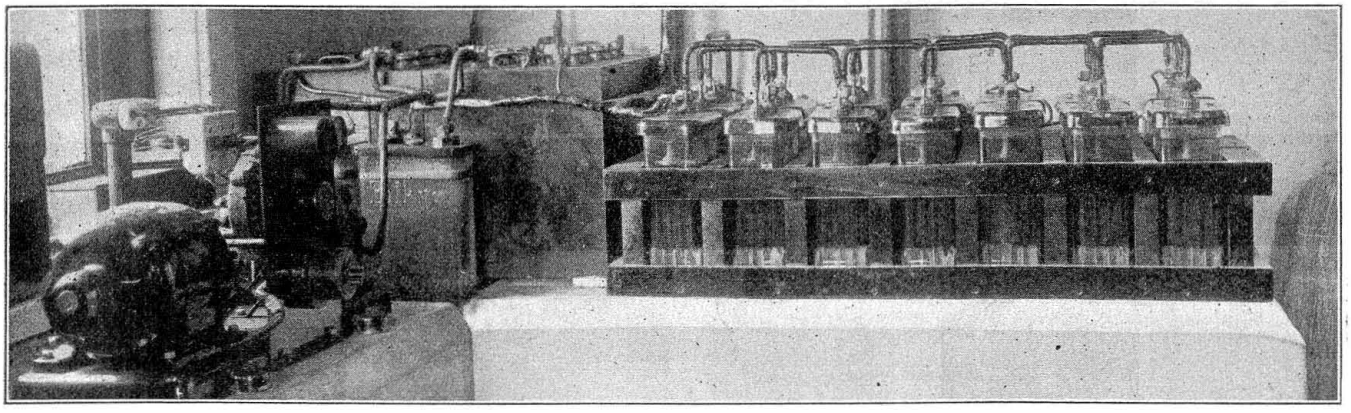
Aerial cables and wires are attached to a messenger wire supported on the bridge structure. At each signal the wires leave the messenger support and drop off to the signal light unit. With this scheme of construction no iron or wood conduit of any type is used on the bridge and a very simple and economical layout is obtained providing a very easy method of inspection.



Interior of electro-pneumatic interlocking cabin

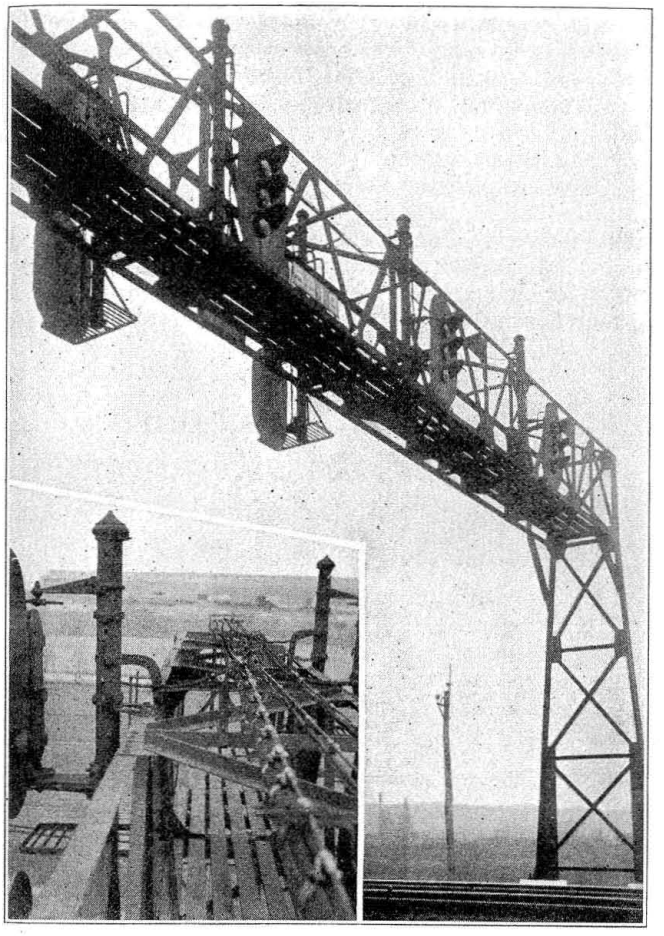
440-Volt Power Line and Associated Apparatus Not Brought Into Relay Boxes

Power at 110 or 220 volts, a-c., 60 cycles, was supplied by the local power company at Clyffeside and NC Cabins, while at RU Cabin it was obtained from the division shops. At Clyffeside and NC Cabins the 220-volt supply was used for operating duplicate sets of 12 cu. ft. air compressors; for supplying the tower and signal circuits and for feeding the 440-volt, a-c. power line running east and west from each cabin. Air being available at Russell, air compressors were



Storage batteries with motor-generator and Balkite rectifier for charging

not necessary at that point. The same type of power circuits were used at the other cabins. The 440-volt single phase transmission line was carried on two No. 4 AL wires on the signal cross-arm. The usual enclosed type of switches and panel boxes were used at each cabin for controlling the power apparatus. The wires were run in conduit and approved by the wire inspection bureaus of the different cities before service was connected. At the different signal bridges, the 440-volt line was carried in a two-con-



Close-up of signal bridge with insert showing cable construction on bridge

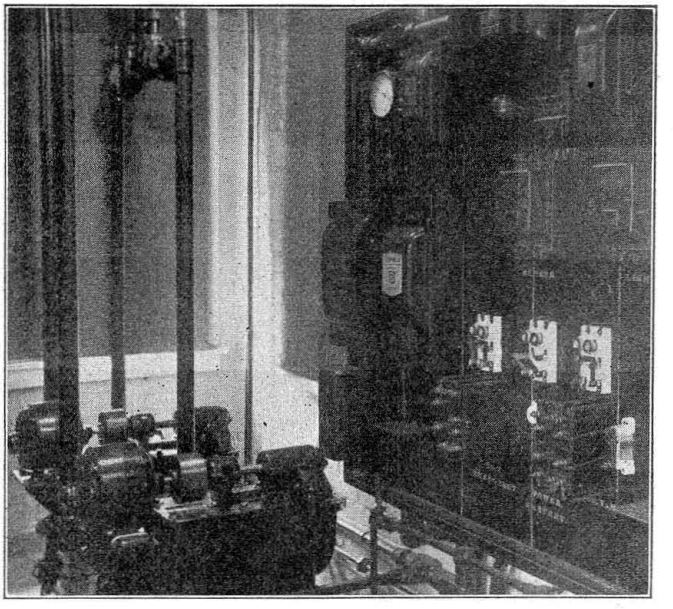
ductor cable to a separate two-way relay box, which housed the 440-volt plug cut-outs, the lightning arresters and transformer. The 440-volt wires were not taken in the main relay boxes. This practice greatly reduced the possibility of hazard at the relay locations besides providing a water-proof housing for the 440-volt apparatus, insuring a short ground connection for the lightning arresters and being accessible for inspection and operation. As the power supply sources are close to each other and the load is light, practically no drop has been found in the transmission lines. The power line circuits are designed so that the signal load at the different cabins can be fed from either Clyffeside, Ashland or Russell. In the two years, since the signaling has been installed, there has never been a power failure on this installation causing a train delay.

The air compressors are of 12 cu. ft. capacity and operated by a 1.9 hp., three-phase motor. They are located in one corner of the relay room on the first floor of the cabin, and operate alternately, automatically cutting in service when the air pressure drops below 45 lb. and cutting out automatically at 60 lb. pressure. A compressor operates about once every three hours indicating a very low leakage in the air lines and a small air consumption.

Aerial cables supported on the Western Union pole line are used for controlling the signal units some distance from the cabin. One 10-pin cross-arm was used with open wire construction to carry the 440-volt transmission line and the signal telephone line. Four additoinal DBWP wires were used for some of the circuits but all other wires (in a few instances numbering nearly 80) were in multiple-conductor aerial cables. These cables are supported by 3/8-in. messenger wires on cable rings spaced 12 in. apart. The number of circuits involved in three and four-track signaling made it necessary to run some aerial cable in addition to the one 10-pin cross-arm, through the entire length of the 10-mile installation. It was necessary to rebuild the W. U. pole line in this territory to permit of the heavier signal loading.

Track Circuits Are Primary Battery Fed

The track circuits on this installation are operated by five cells of primary battery located in concrete battery boxes. The heavy d-c. load, nearly 20 amp. when a-c. service fails at some of the signal bridges required an extra large type of storage battery having a capacity of 312 a-h. This battery is housed in a concrete battery well and charged by a rectifier. The same type of battery is used for tower circuits. The signals in some cases are near enough to the cabin to obtain reserve battery from the tower set. The storage batteries supply the relay load normally but in emergency also carry the signal lights as long as the normal a-c. service is interrupted. The first power interruption occurred as the plants were being placed in service, but due to the design of the power system trains were not delayed as d-c. power service



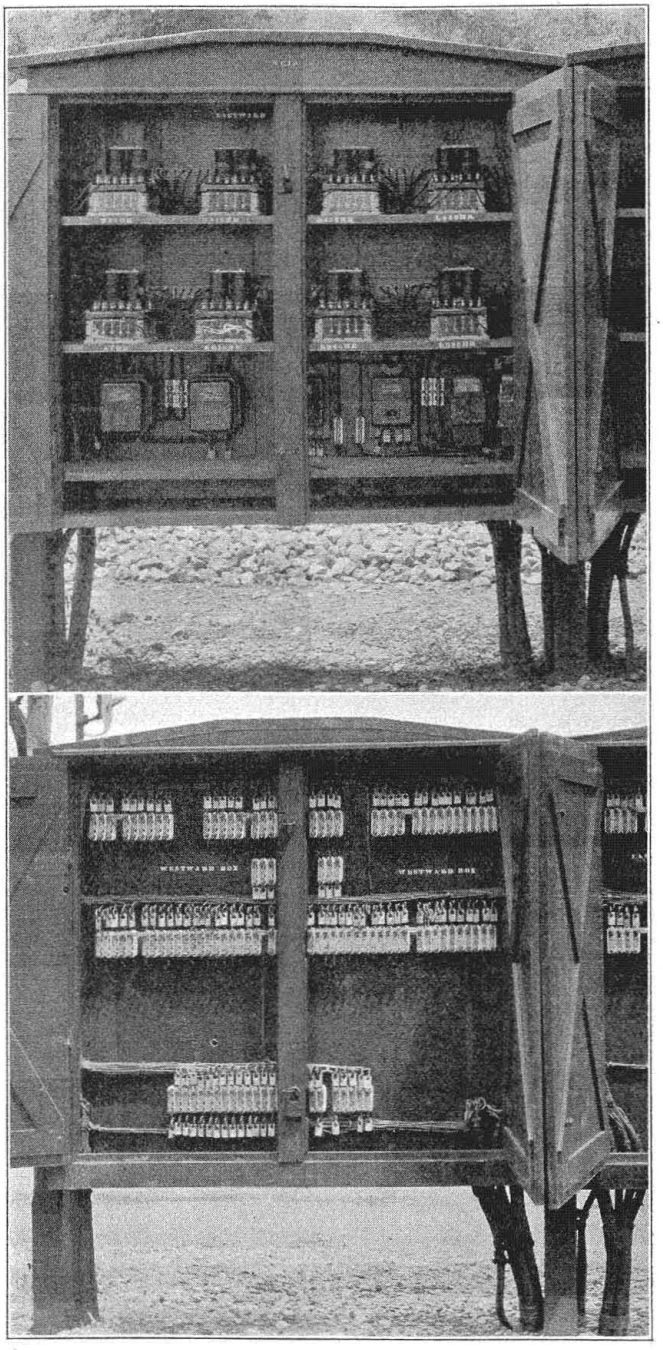
Interior of tower showing switchboard and air compressors

is continuous. The batteries have given reliable service on this installation since the plants were placed in operation.

Excellent Operating Results Obtained

The track arrangement described in the foregoing was completed about a year before the new signaling was placed in operaiton. By making an actual com-

parison of the train sheets before and after the signals were placed in service, the improved operating conditions due to the signal system could be ascertained. It is the unanimous opinion of the signal and operating officers that the improved signal facilities have speeded up train operation, reduced the number of train orders, increased the safety of train operation, reduced the liability of accidents and provided



Interior of typical relay and terminal cases, showing parkway cable entering the boxes

an up-to-date signal system of the latest type at a minimum of expense for first cost as well as for maintenance and operation. The saving in time per freight train has averaged six minutes while considerable saving in time and safety of operation was increased by eliminating the hand operation of switches at RU, NC and SX Cabins. At RU Cabin before the interlocking plant was installed, engines crossing over from the westbound to the eastbound yard were sometimes delayed as much as 20 or 30 min. getting over the crossover by hand signals in front of approaching trains. Foggy weather always slowed up train movements and increased the hazard of train operation. After the interlocking plant was in service it was estimated that at least five minutes was saved on each engine movement operation being continued in foggy weather as expeditiously as under better weather conditions.

The entire signal installation was designed and installed by the railroad forces, the cost of the work being approximately $300,000. The Russell-Ashland installation will always remain of interest due to the fact that on it were developed the first three-track, either direction, color-light signaling; the first improved type of direct current 30-volt traffic locking system; the first a-c. power system with storage battery and primary track reserve system and the first use of a simplified scheme of color-light signal indications all of which have proved satisfactory in actual service. The installation, operation and maintenance of power switches, color-light signals, and traffic locking at Russell-Ashland has been so satisfactory that additional mileage of this type of signaling is contemplated in the future.

Southern Train Stop Four Times I. C. C. Requirement

THE Southern has advised the Interstate Commerce Commission of plans for the installation of automatic train control which, with the mileage already installed or in service, will amount to over four times the 638 miles covered by the two orders issued by the commission affecting its system, or a total of 2,555 miles. Authorizations for much of this mileage have been reported in recent issues of *Railway Signaling* but authorizations for 1,187 miles additional have been included in the 1927 budget for the Southern system. The device to be installed is the intermittent inductive system of the General Railway Signal Company.

As soon as the Southern found a type of train control apparatus in which it had confidence it adopted a policy of progressive installation on those of its lines on which high-class passenger service is operated, giving preference to single-track mileage in the belief that the device may be expected to justify itself most on such lines. When the installations are completed the following principal routes will be operated under automatic train control; Cincinnati to Jacksonville, Cincinnati to New Orleans, Chattanooga to Memphis, and Spencer to Atlanta.

The mileage coveraged by the commission's two orders, 638 miles, includes the lines from Cincinnati, O., to Chattanooga, Tenn., and from Spencer, N. C., to Howell, Ga., near Atlanta. The 1926 budget included the line of the Southern from Chattanooga, via Atlanta, to Macon, Ga., 240 miles, and from Salisbury, N. C., to Morristown, Tenn., 228 miles; and the line of the Georgia, Southern and Florida from Macon to Jacksonville, Fla., 262 miles.

The 1927 budget includes the following, for which contracts for material have been let:

Southern—Biltmore, N. C., to Hayne, S. C., 66 miles.
Southern—Charlotte, N. C., to Columbia, S. C., 108 miles.
Southern—Bristol, Tenn., to Chattanooga, 241 miles.
Southern—Stevenson, Ala., to Memphis, Tenn., 275 miles.
Alabama Great Southern—Chattanooga, Tenn., to Meridian, Miss., 295 miles.
New Orleans & Northeastern—Meridian, Miss., to New Orleans, La., 202 miles.