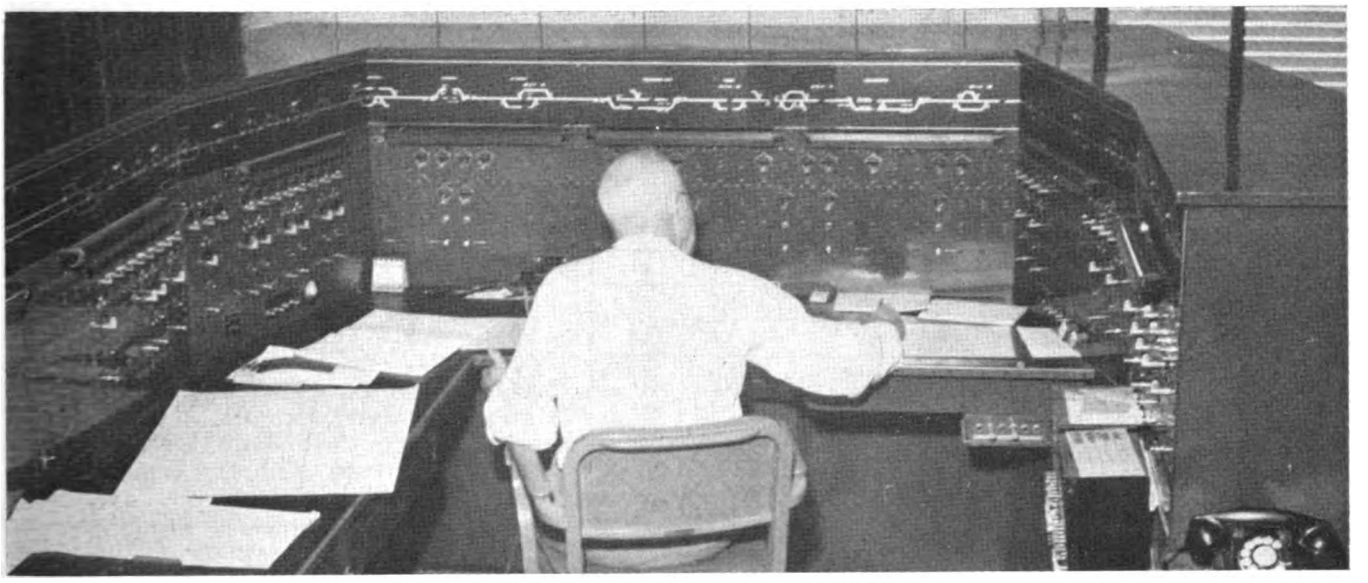
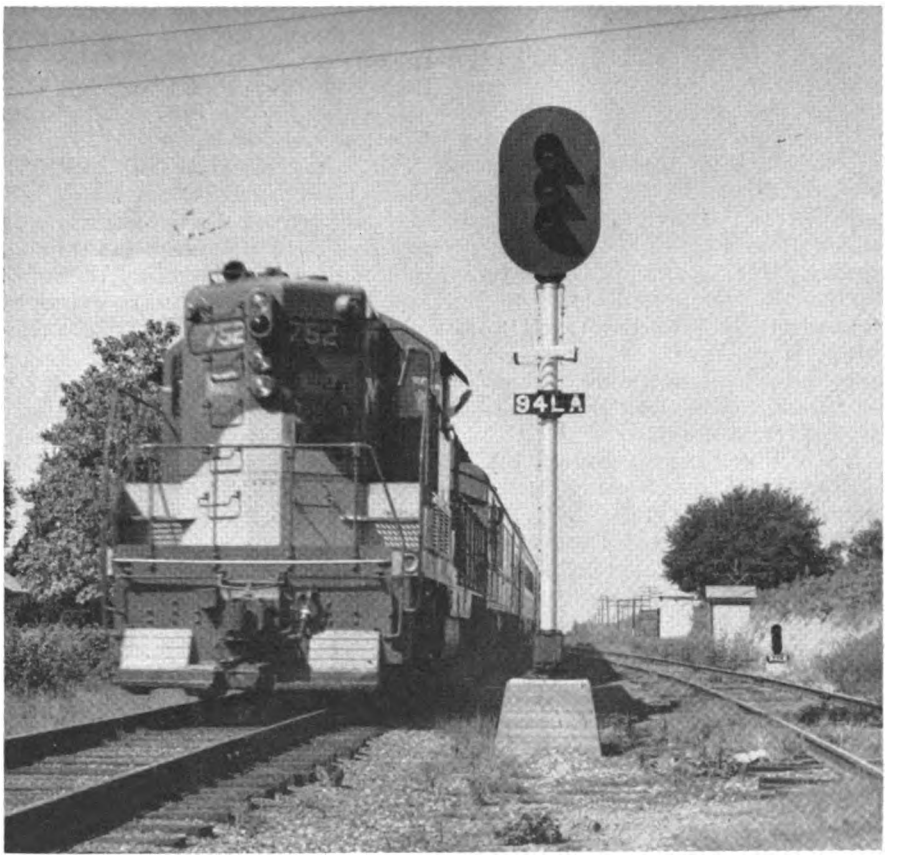
Railway Signaling and Communications



What CTC Did for the Dixie Line

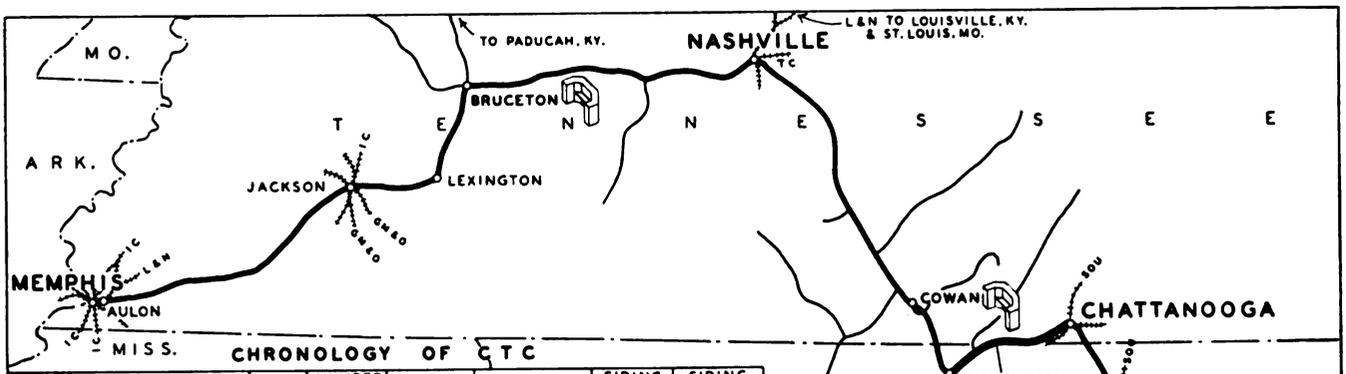
- **Reduced operating expenses**
- **Increased existing track capacity**
- **Obviated laying of second main track**
- **Expedited train movements**

THE NASHVILLE, CHATTANOOGA & ST. LOUIS has completed the installation of centralized traffic control on 466 miles of single-track main line between Atlanta, Ga. and Memphis, Tenn. The last "gap" was closed when CTC was installed between Bruceton, Tenn. and Memphis last August. Now all single track main line is CTC controlled with the remainder being double track with automatic block signaling. Double track sections are through the Nashville terminal area (4 miles) and between Stevenson, Ala. and Chattanooga, Tenn. (39 miles). Automatic block signaling was in service between Atlanta and Nashville, Tenn., but no signaling was in service west of Nashville. Train movements were formerly authorized by time tables and train orders.



Wartime Traffic Taxes Existing Line

The preponderance of traffic is from Nashville east and south to Atlanta. The railroad is a north-south bridge route from Chicago to Atlanta, and further south to Florida. For example, two daily Chicago-Florida passenger trains operate over the NC&STL between Nashville and Atlanta. During the war,



CHRONOLOGY OF CTC

DATE	LOCATION	MILES	NUMBER OF TRAINS	SIDINGS REMOVED	SIDINGS LENGTHENED	SIDING SPACING MILES	SIDING CAR CAPACITY
1943	ATLANTA, GA. - JUNTA	43	65	8	—	4.8	68
1944	STEVENSON, ALA. - NASHVILLE, TENN.	113	55	1	2	6.3	91
1945	NASHVILLE, TENN - BRUCETON	93	45	7	7	5.8	82
1947	JUNTA, GA. - CHATTANOOGA, TENN.	90	28	2	1	6.5	84
1948	ATLANTA, GA. - JUNTA			2	1	5.4	84
TO	JUNTA, GA. - CHATTANOOGA, TENN.			2	2	8.2	98
	STEVENSON, ALA. - NASHVILLE, TENN.			2	2	6.7	96
1953	NASHVILLE, TENN. - BRUCETON			6	2	7.8	101
1954	BRUCETON, TENN. - MEMPHIS	135	21	12	8	15	147

this was a route important for freight and war material from the north and middle west destined for the seaport of Savannah, Ga. By 1942, the increase in traffic due to the war effort had on some parts of the Dixie line reached the point of creating bottlenecks. Such a section was the 43 miles of single track between Atlanta and Junta, Ga., used also by the Louisville & Nashville, which handled upwards of 65 trains daily. Rolling grades and many curves (175) kept speeds down to a maximum of 45 m.p.h. for passenger trains and 40 m.p.h. for freight trains. As a means of relieving this situation, the NC&STL management decided to install centralized traffic control in 1943. Laying a second main track would have increased track capacity, but train movements would still have to be authorized by time table and train order. However, by installing CTC, train movements were authorized by signal indication with the resultant expedition of trains.

To further expedite trains east of Nashville, CTC was installed on the heavy mountain grade and curve territory between Nashville and Stevenson, Ala. (113 miles) in 1944. The remainder of the Nashville-Atlanta single-track main line was equipped with CTC in 1947 on 86 miles between Chattanooga and Junta.

Dieselization Affects Signaling

The NC&STL began their dieselization program in 1948, and by 1951 all main line trains were being handled by diesel-electric locomotives. The use of diesels on freight trains materially affected the CTC systems then in service. Longer freight trains were operated. The tonnage rating for freight trains on many divisions was increased from 1,500-2,000 tons to 5,000-7,500 tons. Longer trains meant longer passing tracks, with the result that some sidings had to be lengthened. Also some sidings could be removed because the diesel freights made better over-the-road time than the steam freights, because the diesels did not have to stop for fuel and water.

Therefore, between 1948 and 1953, the NC&STL carried out a program of passing track changes to provide more efficient operation in conjunction with diesel operation of trains. Some passing tracks were removed and others lengthened in traffic control territory, resulting in longer passing tracks spaced further apart.

Concurrently track and roadway impovements were undertaken, with particular emphasis on a reduction in curves and grades. Ninety-three curves have been eliminated and 137 curves have been reduced to two degrees or less. New heavier rail was laid: 132 lb. east of Nashville and 115 lb. west.

Consolidation of CTC Control Machines

The CTC control machine at Hills Park yard (Atlanta) controlling the 43-mile Atlanta-Junta line was moved 90 miles north to Dalton for consolidation with the Junta-Chattanooga machine in February, 1953. During the move, a CTC test set was operated by a signal department employee, who translated the dispatcher's moves into codes and steps to operate the switches and signals at the desired station. The machine move was made on a Sunday when no local freight trains were operating and when traffic was light. Several non-stop meets were made by test set control. The machine was taken out of service at 8:00 a.m. and put back in service at 11:30 p.m. the same day. It was crated and handled in a special train. To eliminate the necessity of changing the code numbers for controls and indications, two carrier lines were installed so that the d.c. control and indication codes fed in the same direction before and after the machine move.

When CTC was installed on most sections of the railroad, traffic was heavy. Much of the density was due to the wartime conditions. Fewer trains are now being operated, but freight trains are now twice as long as they were before, 80 cars and up as compared with 39.

Three Dispatchers Handle Train Movements

Three dispatchers now handle all train movements on the NC&STL. This has been made possible by the CTC installations, enabling them to control switches and signals in traffic control territory from three control machines: Atlanta-Chattanooga (133 miles); Stevenson-Nashville

DUAL-CONTROL, low-voltage switch machines are mounted on two dapped ties

(113 miles); and Nashville-Memphis (228 miles). These dispatchers also handle branch line trains which operate under time table and train order authority. All train operation is directed by three sets of dispatchers each including: one chief dispatcher, one assistant chief dispatcher, three trick dispatchers and two relief dispatchers.

With the introduction of the 40-hr. week in 1948, 4.2 operators are now needed where three formerly were required. Under these conditions the smaller number of men needed to operate the railroad with centralized traffic control on the main line, was an important factor in management's decision to continue the signal modernization program. Eight dispatchers and 58 operators have either retired or have transferred to other departments as a result of the CTC installations. With the 40-hr. week these 66 men would be equivalent to 92.4 men. A considerable operating expense in salaries alone has been saved.

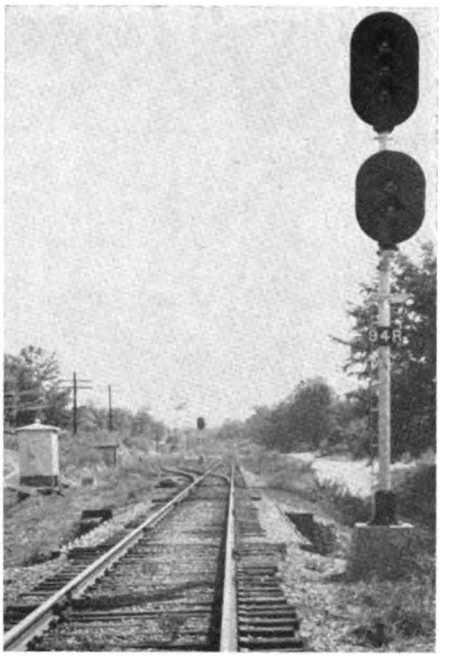
CTC Expedites Trains

Another feature of the CTC has been the reduction of over-the-road time, thereby cutting down the amount of overtime of train crews, which results in lower operating expenses. For example, in the first year of CTC operation on the Chattanooga division, overtime charges were reduced by $84,000. Studies of time savings by through freight trains revealed that 4 hr. 35 min. were saved in a run from Bruceton to Atlanta. Now a through freight train from Memphis to Atlanta is estimated to save at least 5 hr. This reduction in over-the-road time has enabled symbol freight trains to consistently make connections with other railroads, thus providing improved freight service. Cars can make earlier connections than were previously made with time table and train order operation.

Local freight train service has improved because these trains can leave a town when ready. They had no preference prior to CTC, and generally were allowed to leave a town when "everything else had gone." The local train crews are paid on a time basis, resulting in overtime being a major factor in their operating expense. This overtime has been drastically reduced since the installation of CTC.

Hold-Out Signals Facilitate Switching Operations

At towns having numerous house tracks, industry spurs, etc., dispatcher-controlled absolute signals are located at the limits of the switching area. For example, hold-out signals at Lexington are 104R, 104L, 108R, 108L. Normally, absolute signals would not be installed here because Lexington has no passing track. But with the absolute signals, the dispatcher can set 104R and 108L to Stop, give the "unlock" to switches 105, allowing the local to work in the switching area. With a train at Timberlake, the dispatcher can clear signals 114LA or 114LB allowing the train to leave. Meantime, the local can get in the clear

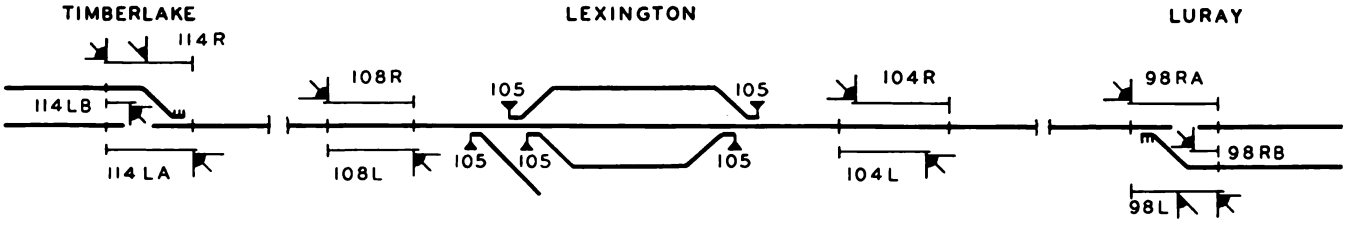


RED-OVER-LUNAR is take-siding aspect

HOLD-OUT SIGNAL west of Jackson, Tenn.

at Lexington. With all switches closed and locked, and the local off the main line, the dispatcher can clear 108L allowing the other train to pass through. Without hold-out signals at Lexington, the dispatcher would have to hold the through freight at Timberlake until the local was in the clear. The use of these special signals allows for closer spac-

(*Continued on page 70*)



C.T.C. on the Dixie

(*Continued from page 25*)

ing of trains, in effect increasing track capacity. It also allows the local more time for switching.

Only four aspects are required to direct train movements on the NC&STL: red, yellow, green and lunar, indicating Stop, Approach, Clear and Restricting respectively. All signals are the color-light type capable of displaying three aspects, except the station-entering signals which have two "arms." When the dispatcher reverses a siding switch for a move into the siding, and clears the home signal, it will display red-over-lunar. The signal in approach will display yellow. When a train is to leave a siding, the dispatcher clears the leave-siding dwarf which displays either yellow or green depending upon track occupancy ahead. Absolute signals have horizontal number plates, and permissive signals have vertical number plates. Grade signals are identified by a black "G" on a yellow circle mounted below the signal head.

All main line hand-throw switches are equipped with electric locks, the "unlock" being controlled from the CTC machine in the dispatcher's office. All main line hand-throw switches are equipped with electric lights, being a.c. lighted. The derail stands are also equipped with a.c. electric lights.

Completion of Main Line Signaling in 1954

The installation of centralized traffic control on 135 miles of single-track main line between Memphis and Bruceton completed the signaling program begun approximately 10 years before. This line had no previous signaling, train movements being authorized by time table and train orders. On this P&M division project, 12 sidings were taken out of service as passing tracks. New Century hand-throw switch stands with electric lights and SL6A electric locks were installed, as well as Hayes pipe-connected derails equipped with electric lights on the derail stands. The switch and derail lamps have a two-candle-power bulb which is continuously lighted from 110-volts a.c. Two-conductor No. 14 cable runs from the lamp receptacle to a WRRS bootleg, the line drop being two-conductor, No. 14 cable. Where a bank or ditch is adjacent to the electric lock location, the line drop is aerial cable to a cable post with a WRRS junction box, then underground cable is run to the lock, switch and derail.

In addition, eight sidings were lengthened for use as passing tracks to hold 147 cars with two exceptions; Luray and Jackson which hold 107 and 106 cars, respectively. Each end of a passing track was equipped with an M22B dual-control, low-voltage switch machine which is mounted on two dapped ties. Wiring to the junction box at the switch machine is five-conductor No. 9 and seven-conductor No. 12 Kerite underground cable. Flexible wire (No. 10) with Flamenol insulation is used between the junction box and the switch machine. Turnouts are No. 12 with 22 ft. switch points. One end of each siding is thrown over to a 18 ft. 5 in. center with the main track to provide clearance for the main track station-leaving signal.

All signals are normally lighted from the a.c., absolute signals being continuously lighted and intermediate signals being approach lighted. The signal lamps are the double-filament type rated at 10 volts, 18 watts plus 3.5 watts. A power-off relay is used to put battery on the lighting circuit if the a.c. fails. Insulated wire and cable was furnished by the Kerite Co.

A. C. Signal Power

This 110-volt, 60 cycle, a.c. power is available at each intermediate and absolute signal location, and at each electric lock location, from the secondary of the 440-volt signal power line transformers. A 100-watt transformer is used at each electric lock and intermediate signal and a 500-watt transformer at controlled signal locations, both types being pole-mounted with their associated fuse cutouts and protective devices, all furnished by General Electric. The 440-volt signal power on No. 6 copper is furnished at 11 power taps from commercial sources. Electric lighting (110-volt a.c. bulbs) was installed in each instrument case and housing.

As part of this CTC project, a new arm was added to the communications pole line to carry the 440-volt signal power, the CTC code line, and the local signal control wires. The code line is No. 8 Copperweld transposed for 30 kc. The code lines at Jackson carrier location and Lexington carrier repeater station are joined together by voice pass filters which pass voice frequency only (about 1,500 cps). Each instrument house at controlled locations is equipped with code line taps which are of great benefit to the signal employees who hook on a handset to talk to each other when they are checking out trouble, or doing routine maintenance and inspection. This is the only voice calling done on the code line.

Phone booths located at all absolute signal and electric lock locations are equipped with an Automatic Electric handset, fuse block and arresters and are used by train crews to communicate with station operators and the dispatcher. Line drops from the message and dispatcher's circuit are brought into each telephone booth into a double-pole, double-throw switch. During the day, when most stations are open, the maintenance-of-way crews use the message circuit to obtain train information from the operator. The train crews use the dispatcher's circuit to contact the dispatcher.

Carrier Handles West End D.C. Codes

Carrier terminals were installed at Bruceton and Jackson, 56 miles apart with a standby repeater at Lexington, about half-way between the terminals. Controls are sent at 13.0 kc (Bruceton-Jackson) and indications are transmitted at 20.4 kc (Jackson-Bruceton). These controls and indications are handled as d.c codes between Jackson and Aulon (Memphis). Direct current codes handle controls and indications between Bruceton and Jackson. Sola constant-voltage transformers were installed at Bruceton, Lexington and Jackson to provide a constant 115 volts a.c. for the carrier, regardless of fluctuations in the commercial power. The code system is the 506A. At Bruceton, 60 cells of Exide 3CME5, 16-a.h. storage battery feed the code line toward Jackson. At the ends of the passing track, 16 cells of 120-a.h. storage battery feed the local code equpiment, and 10 cells of 120-a.h. storage battery feed the local relays. These same batteries, combined, are used to operate the switch machine and electric locks. Also, at each bungalow, two sets of 10 cells each of 60-a.h. storage battery feed signal line control circuits each way and standby lighting.

D. C. Track Circuits

Conventional normally energized d.c. track circuits were used in this installation, using two-ohm track relays. Maximum length of track circuits is 6,000 ft., but the length varies because intermediate signal locations were spotted to the nearest pole to provide short line drops. A fixed resistor is at the battery end

of each track circuit, with an adjustable resistor at the relay end. The fixed resistor with Raco clearview arresters are in a Massey concrete box with three cells of Edison 1,000 a.h. primary track battery. Two-way Raco bootlegs are used with No. 9 solid copper cable to the bootleg, and seven-conductor No. 12 stranded twist for the track connection.

Short OS Track Circuit at Hold-Out Signals

The hold-out signals at Lexington, Jackson and Somerville are staggered 150 ft. to provide a short OS track circuit. The maintainer's call light on the track side of the instrument housing at these locations is used by the dispatcher to attract the attention of train crews, especially the local freight, and inform them to call in.

On the CTC control machine the red OS section light also comes on when there is a power failure at that location. If such is the cause of the OS light being on, and no train is in the section, the dispatcher puts on the maintainer's call light, which extinguishes the red OS section light. The CTC machine has the conventional track model diagram with indication lights and switch and signal levers with indication lamps. All electric locks on hand-throw switches are "unlocked" from a switch lever on the CTC machine. A green indication lamp is lighted when the switch is locked, and a red lamp is lighted when the switch is unlocked. Passing tracks are not track circuited, but the dispatcher turns on a siding light by means of a toggle switch to indicate when a train is in the passing track. Time locking is used on absolute block signals and electric locks, the time being controlled by a DT-10 time-element relay.

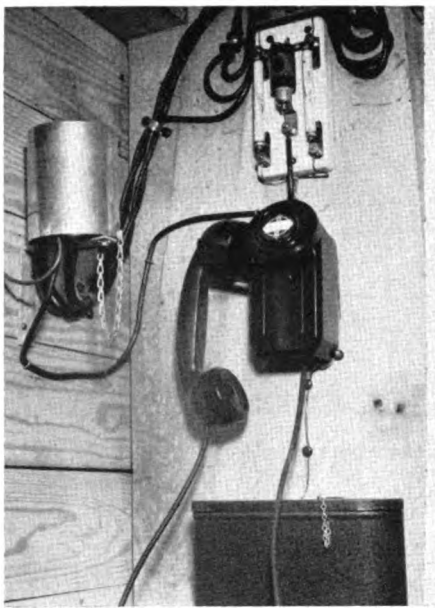
The machine for handling the Bruceton-Memphis section was added to the Bruceton-Nashville machine, making the Nashville-Memphis control machine 27.5 ft. long. A 24-pen graph records train movements on the Memphis-Bruceton section, and a 26-pen graph records movements on the Bruceton-Nashville section. Power for the CTC machine is supplied by 16 cells of Exide 280-a.h. storage battery, eight cells of which are for the Bruceton-Memphis portion of the machine.

Three signal gangs in the field did the work of installing the signal equipment: one line gang to add the bottom arm on the pole line and string wire; one concrete gang to pour all foundations except instrument cases, which are set on cast iron piers; and one wiring gang to wire and "hook up" the signals, switches, locks, etc. Four men at the signal shop at Nashville did all the case wiring. Conventional relays are shelf mounted. AMP solderless terminals were used, and the signalmen made the tags with a tag-making machine.

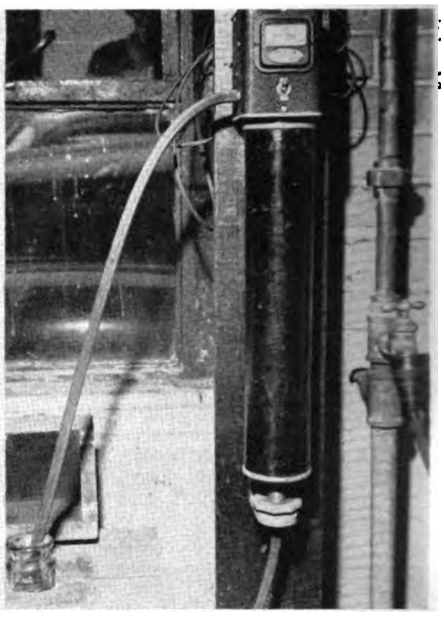
Portable gas-engine generators, 2,500 watts, delivering 21.7 amp. at 110-volts, 60 cycle, a.c. were provided at outlying points to operate power tools during construction before the commercial power was connected. The railroad now has two of these portable generators on the Nashville-Memphis territory, including one at Bruceton, and two each on the Chattanooga and Atlanta divisions.

Each maintainer has been provided with a semi-portable metal tool house, 12 ft. by 27 ft. which has space for a shop and his track motor car. Hydrion battery water units are furnished to 13 maintainers enabling them to obtain battery water from the tap water available at their shops.

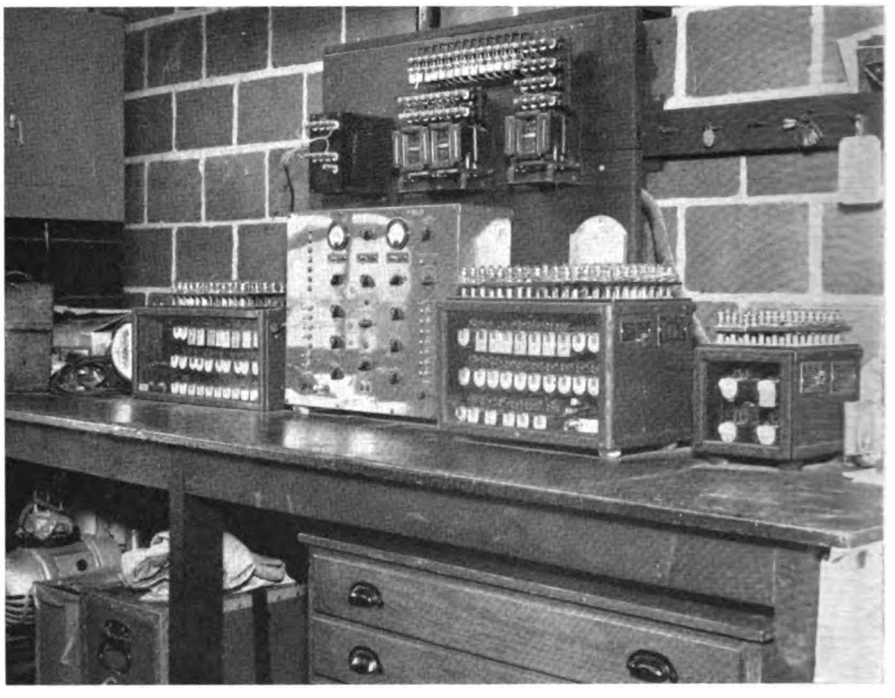
The engineering and construction of these CTC projects was directed by E. W. Anderson, signal and telephone engineer. The major items of signal equipment were furnished by the Union Switch & Signal division of Westinghouse Air Brake Company.



WAYSIDE PHONE is on message circuit



HYDRION UNIT provides battery water



MAINTAINER'S WORK BENCH and ctc test equipment at Bruceton, Tenn.