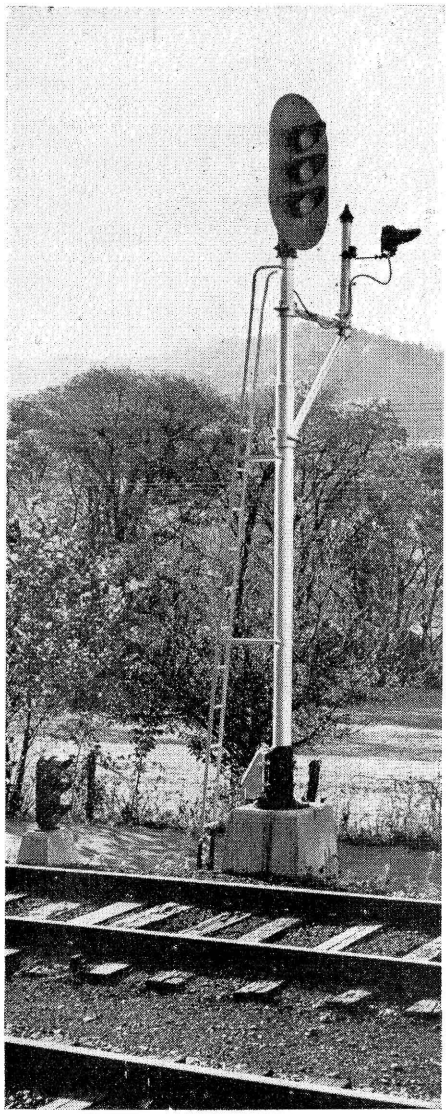
Train Movements by Signal



Main-track station-leaving signal on far side of the siding using doll bracket mast with blue marker lamp

TO facilitate, expedite and increase the safety of train movements, the Clinchfield—a 277-mi. carrier operating through the Appalachian and Cumberland Mountains between Spartanburg, N. C., and Elkhorn City, Ky.—has completed a centralized traffic control project on 122 mi. of single track between Erwin, Tenn., and Delano, Va. As shown in the accompanying map of the railroad, Fig. 1, this territory is on the northern half of the road which serves a big coal-mining area, and was chosen first for the installation of C.T.C. because it is the busiest.

Train movements in the territory were formerly governed by time table, train orders and manual block, a few short sections of two-position semaphore automatic block signaling being in service for tunnel and curve protection at Sandy Ridge tunnel, between M.P. 31.6 and M.P. 35.0, at Dante, Va., as well as for about 4 mi. between Boulder, Va., and Kermit. This signaling was all replaced as part of the C.T.C. project, which now includes power operated switches and signals at the ends of 18 passing tracks between Erwin and Delano, and which are controlled from a machine in the dispatcher's office at the railroad's headquarters in Erwin.

Coal and Perishables

The Clinchfield is principally a freight road, the passenger traffic being handled by one local train each way daily. The freight is in two distinctly different classes (1) coal, originating at mines along the northern part of the railroad, the bulk of which is moved south for delivery to connecting lines, and (2) fast through freight traffic consisting primarily of manufactured products southbound and perishables northbound.

Southbound merchandise and other manufactured products are delivered by the Chesapeake & Ohio to the Clinchfield at Elkhorn City for movement 277 mi. south to Spartanburg for delivery to the Charleston & Western Carolina (Atlantic Coast Line) for movement on south to points in South Carolina, Georgia and Florida. Similarly, fruits, vegetables and other agricultural products from these southern states are delivered at Spartanburg for the Clinchfield to move north to Elkhorn City, and on north over the C. & O. and its connections. This through traffic, other than coal, is handled in fast scheduled trains. Two of these fast through freight trains are operated each way daily, and extra sections are run as required especially during the perishable seasons.

Large quantities of coal are mined in the area near the north end of the Clinchfield between Elkhorn City and Miller Yard. This coal, for the most part is moved south for delivery to connecting lines. In addition to connections with the C. & W. C. at Spartanburg, the Clinchfield interchanges with the Norfolk & Western at St. Paul, and with the Interstate Railroad and the Louisville & Nashville at Miller Yard which is 10 mi. south of St. Paul. Also the Clinchfield in-

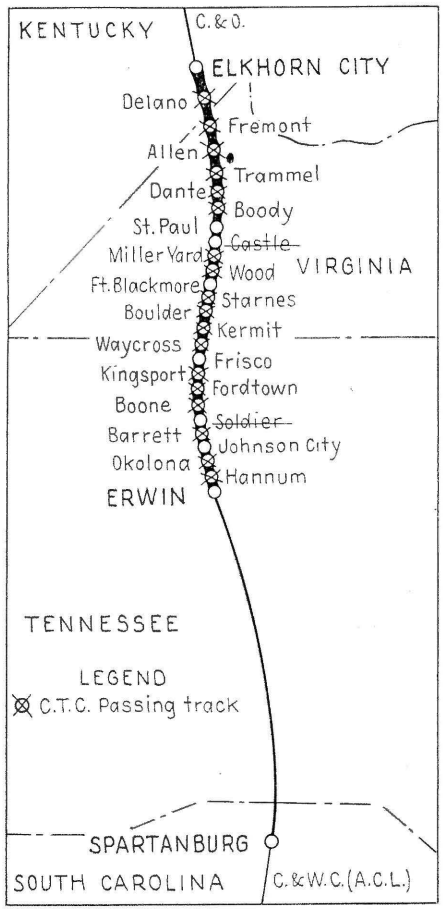


Fig. 1—Map of C.T.C. territory

terchanges with the Southern at Frisco, Tenn., and Johnson City, Tenn., and with the East Tennessee & Western North Carolina at Johnson City. The busiest period of traffic in the C.T.C. territory is between 6:00 a.m. and 12:00 noon, when an average of about 10 trains are in the territory.

Daily train movements include four freights and one passenger southbound, one passenger and three freight trains northbound, plus local freights and extras in each direction as required. Thus, there is a total average of about 30

Indication On the Clinchfield Route

Centralized traffic control on 122 mi. of single track of heavy coal carrier through the Cumberland Mountains speeds up and increases the safety of train movements

train movements daily in the territory. Two of the freight trains in each direction are time freights, averaging 75 to a 100 cars, which are handled by 4,500-hp. Diesel-electric locomotives. All other trains are operated by steam locomotives.

The most difficult operation in C.T.C. on the railroad is for northbound trains, the heaviest tonnage handled, however, being predominantly southbound—mainly coal. Northbound, the maximum ascending grade is 1.5 per cent between Boody and Trammel. The maximum ascending grade southbound is 1.2 per cent between Okolona and Hannum. The track is in good condition, and consists of rock-ballasted 112-lb. rail.

No sidings were taken out in this project, although two—those at Soldier, Tenn., and Castle, Va.—were discontinued as passing tracks and electric locks installed on the switch at each end of the sidings. The passing tracks are spaced about 7 mi. apart, and have an average capacity of approximately 85 cars, with a few sidings, such as those at Barrett, Boone, Kingsport, Miller Yard and Brady, having a capacity of 120 cars. Operating practice is to put the trains in these sidings which can leave the sidings with the least difficulty. Thus, there is no preference as to whether a passenger or freight train is put on a siding for a meet.

Train Time Saved

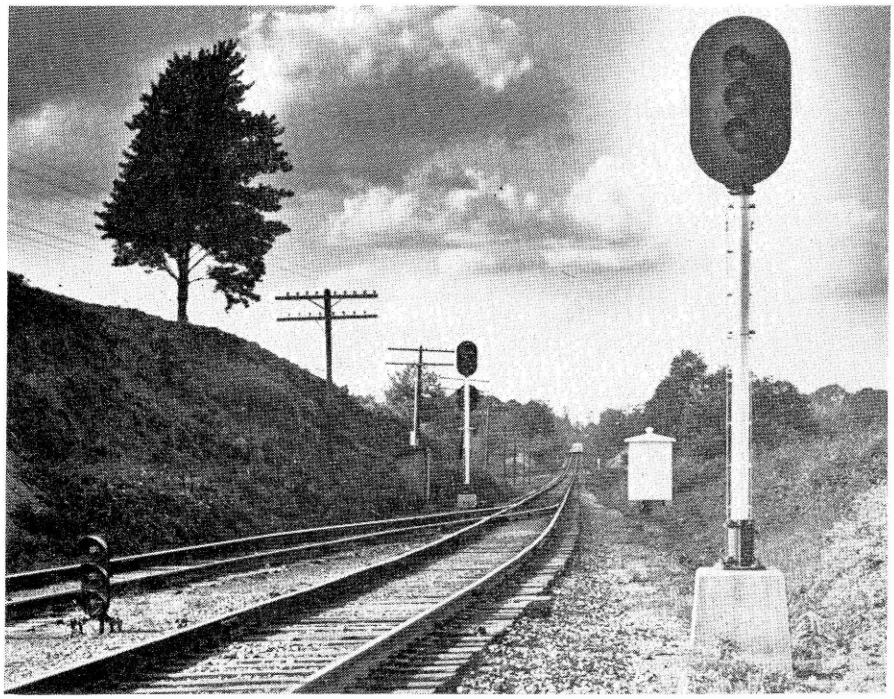
The C.T.C. is resulting in a saving of a considerable amount of train time. As mentioned previously, trains were heretofore operated under manual block system rules. Absolute blocking was in effect for southbound trains between Dante and St. Paul, about 7 mi., as well as between Frisco and Kingsport, 6 mi., for southbound trains clearing or originating at Frisco. Consequently, delays which have since been eliminated by the C.T.C., were incurred by trains waiting for clear manual blocks. Also, the dispatcher is now able to arrange meets and advance trains on closer time, thus minimizing delays incurred by trains standing on passing tracks.

The installation is also enabling trains to make non-stop meets in numerous instances. For example, northbound freight train No. 95 recently met southbound through freight train No. 18 at 7:50 a.m. at Boone, Tenn., southbound time freight No. 94 at 8:58 a.m. at Kermit, fourth siding north; and southbound passenger train No. 38 at 9:12 a.m. at Boulder, Va., the next siding north—three non-stop meets in 1 hr. 22 min. In each instance, all trains saved approximately 10 min. on each meet.

In addition, as a result of the C.T.C., a considerable amount of traincrew over-time has been eliminated. Also, four 24-hr. block offices were closed and the employees on duty therein assigned to other duties. The offices affected included Barrett in the north yards at Johnson City, Fordtown, Boulder and Wood. Two 8-hr. tricks were abolished at two other locations—Kingsport and the south end of Miller Yard—one 8-hr. trick being retained at these locations during the day for delivery of messages to trains.

Color-Light Signals

The new signals are the style P-5 vertical color-light type, which are continuously lighted and display A.A.R. Standard Code aspects. The signals are equipped with 10-volt 18-watt single filament lamps. At each end of power-operated siding, there is a two "arm" high sta-



Typical signaling at end of a siding

tion entering signal, the top "arm" of which governs train movements on the main line, and the bottom "arm" of which governs train movements into the siding. On the main line, at each end of the siding, there is a single "arm" high signal, absolute signals being identified by the absence of a number plate. These signals, where they would have to be located between the siding and main track to be adjacent to the track governed, are located to the right of the sidings and equipped with a doll post and blue semaphore lamp. The reason for this construction is that, if signals are to be located between tracks, there is insufficient clearance unless the sidings are shoved over to new centers. In this project, it would have been impracticable to move the sidings in the majority of instances because of the rough topography of the country through which the railroad operates. To do so, would have necessitated a tremendous amount of earth and rock removal.

Three-aspect Dwarfs

Three-aspect dwarf signals are used at the leaving end of all sidings. This enables trains to get out of the sidings with full knowledge of block conditions ahead, rather than to lag out on a yellow when the block may be clear, and thus incur unnecessary delay.

Signals govering moves in the single-track territory are controlled by a two-wire line circuit. The operation of similar circuits on other roads have been described in these columns previously. Under ordinary circumstances, four wires for signal control extend through power-operated sidings.

Table of C.T.C. Controlled Passing Tracks Between Erwin, Tenn., and Elkhorn City, Ky., showing Capacity in Feet

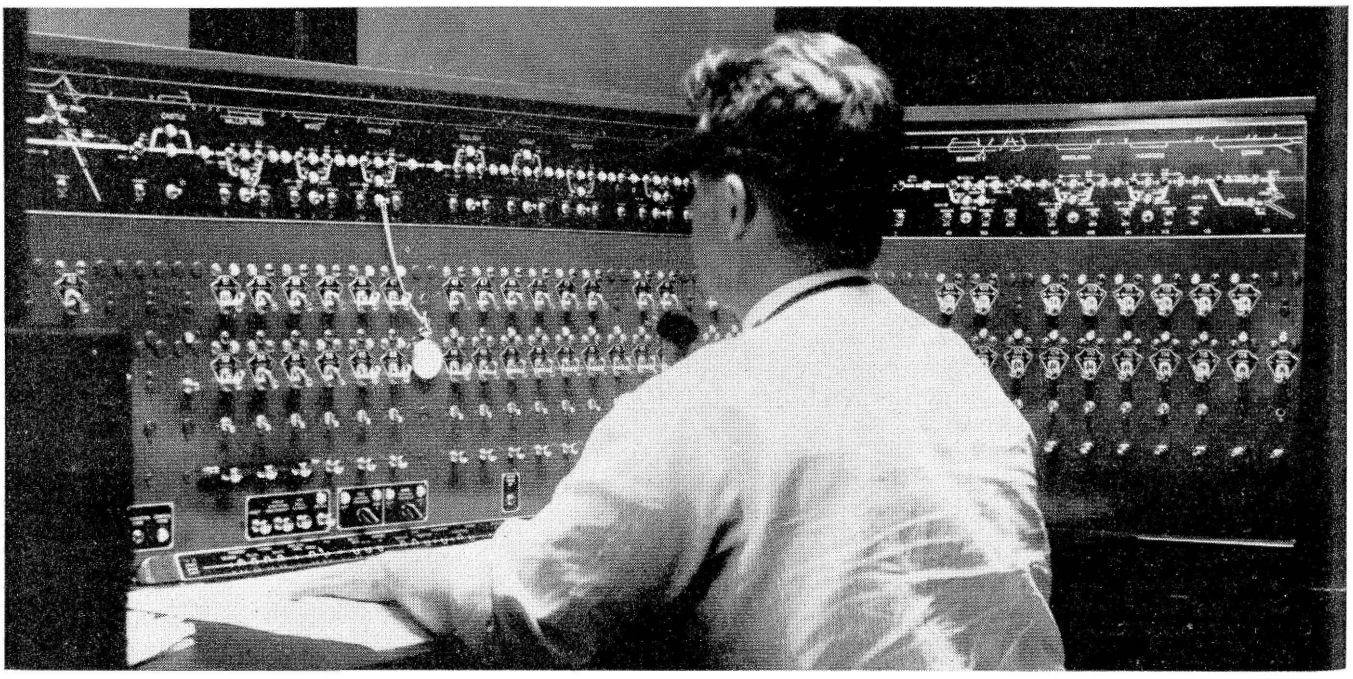
Location	Capacity-Feet
Hannum	4,182
Okolona	4,067
Barrett	(Yard)
Boone	5,239
Fordtown	3,918
Kingsport	(Yard)
Waycross	3,962
Kermit	5,018
Boulder	4,580
Starnes	4,508
Wood	4,055
Miller Yard	5,000
Boody	4,100
Dante	4,500
Trammel	4,003
Allen	4,597
Fremont	3,100
Delano	4,063

Conventional d.c. track circuits with DN-22BH biased-neutral track relays are used throughout. Grade signals are identified by a black disc with a white letter "G" on it, which is mounted on the mast below the signal head. When the signal is displaying red, this marker designates the aspect as Permissive, permitting a tonnage train on an ascending grade to pass the signal at restricted speed without stopping.

End C.T.C.

At certain points, such as for about 2 mi. through Johnson City and 3 mi. through Kingsport, C.T.C. is not in effect, for the reason that these are industrial areas, and insufficient yard tracks make it necessary for yard crews to be continuously using the main line. Entering such limits, there is a controlled two-aspect high dwarf signal and reflectorized "End C.T.C." sign. This signal is normally red for Stop, and displays red-over-yellow for Restricting when cleared. In the opposite direction at these locations, there is a standard three-aspect high signal, also controlled, with a "Begin C.T.C." sign.

The last C.T.C. signal southward governs train movements over a handthrow switch into Erwin Yard. This is a special signal—a high dwarf—and is equipped with a Take-Siding indicator below the top "arm". The normal "position" of the signal is red for Stop. If a train is to hold the main, it displays red-over-yellow for Restrciting. On the other hand, if the train is to enter the yard, the dispatcher controls the signal to display red-over-red "S", indicating Stop-and-Throw Switch. When the switch has been thrown, then the signal displays red-over-yellow, indicating Restrict-

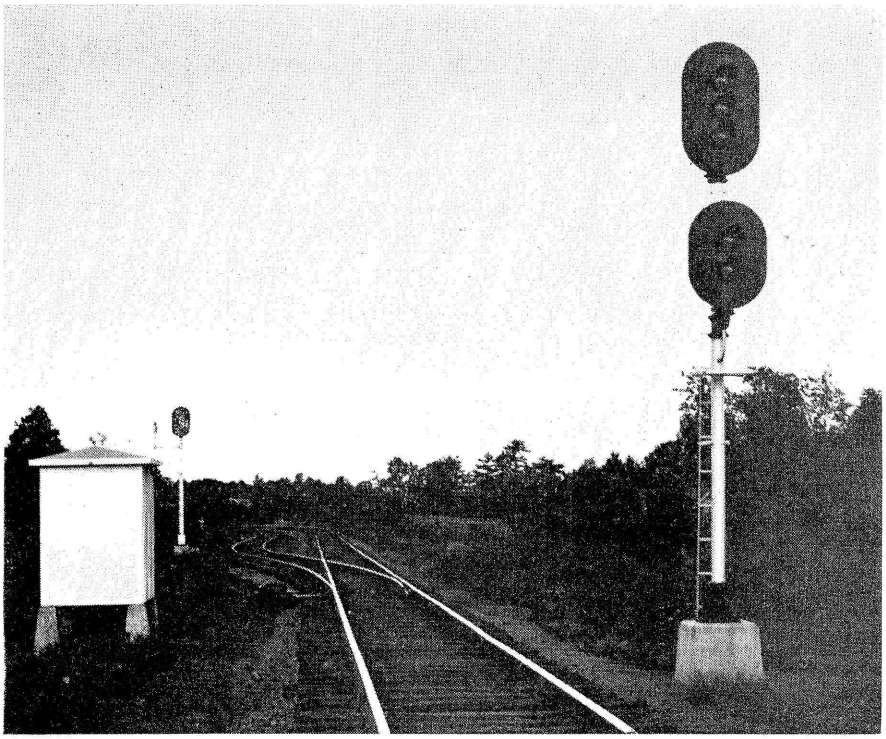


The control machine is in the dispatcher's office at Erwin, Tenn.

ing. Similar signals are in service at Kingsport and Dante.

Special starting indicators in approach to the first C.T.C. signals northward are in service in the yard at Erwin. These are the same height as high signals and are normally dark. When a train is ready to depart from the yard, the indicators are controlled to display a white letter "S", which is authority for the train to proceed down the lead to the first C.T.C. signal.

The new power switch machines are the Union Switch & Signal Company's Style M-22B dual contorl, designed for operation on 24-volts d.c. The turnouts at the ends of passing tracks are No. 10's with 16.5-ft. points, which are good for train speeds up to 15 m.p.h. Electric switch locks on main-line hand-throw switches are the Style SL-21. The majority of spurs leading from the main line are equipped with pipe-connected Hayes lift-type derails.



The signals are the color-light type

At Barrett, the south end of the power-operated siding consists of a crossover leading from the main line into a side track, with a turnout to another siding immediately adjacent to the end of the crossover on the passing track. The passing-track end of the crossover and the turnout, shown as switches No. 1 and No. 2 in Fig. 3, are hand operated, the normal positions of which are as shown in the diagram. Both of these switches are equipped with circuit controllers. The motor circuit for the main-line power-operated switch is broken through the normal repeater relay of switch No. 1. Consequently, unless this hand-throw switch is in the Normal position, the power switch cannot be moved, and since the signal cannot be cleared with either switch No. 1 or No. 2 reversed, protection is provided against derailment on the crossover or routing of a train for a meet down a track other than that prescribed for meets.

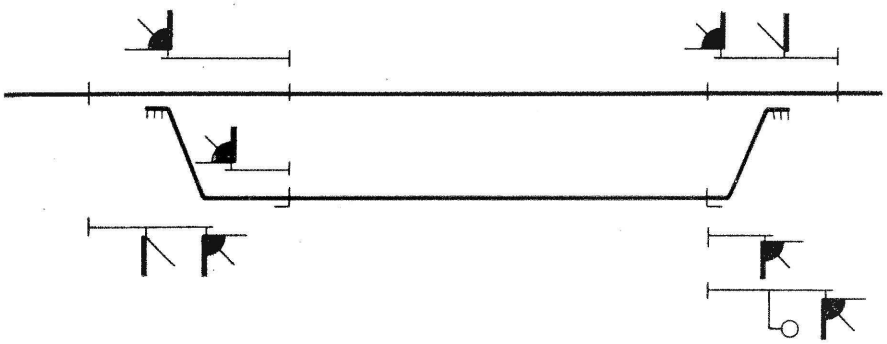


Fig. 2—Typical signaling arrangement at a siding

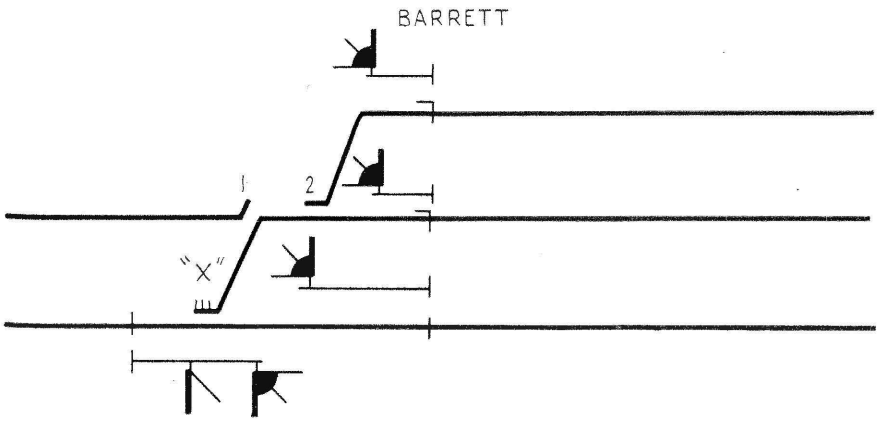
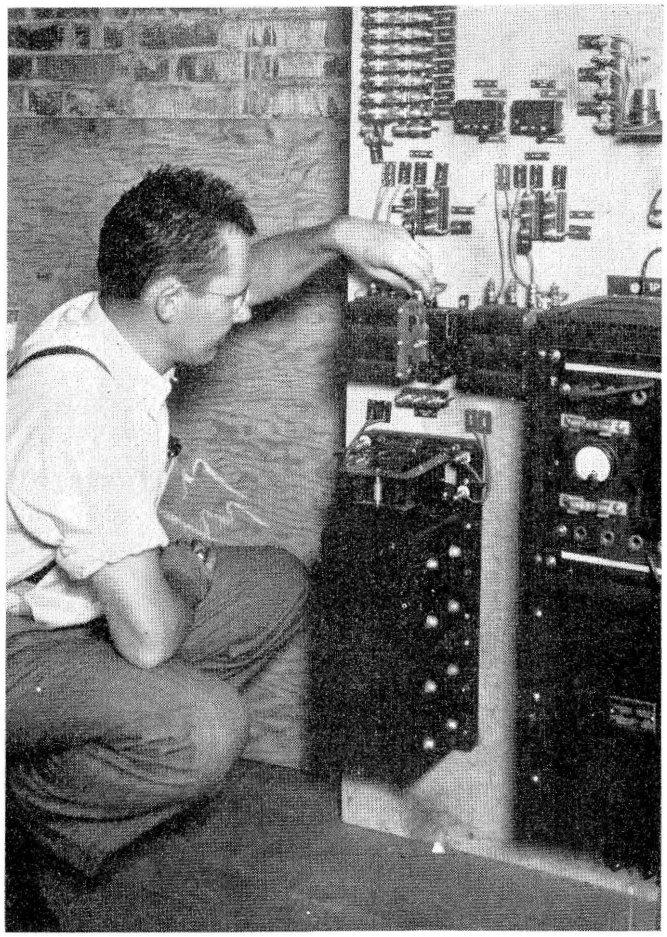


Fig. 3—Signaling arrangements at south end of Barrett

Control Machine at Erwin

The control machine at Erwin is a 10-ft. unit with two 2½-ft. wings, and includes the conventional arrangement of signal, switch and lock levers, push buttons, indication lamps and illuminated track diagram. Track model lamps are normally extinguished, and include red for OS sections and power off and white for track occupancy. There is one power-off lamp for each controlled signal locations. Green and yellow lamps are used above the switch levers for normal and reverse indications, respectively. If the switch is not locked Normal or Reverse, both lamps are dark. If the switch is normal and power is off, the switch normal and power off lamps will be lighted, but power-off will not register with the switch reversed. The passing sidings are not track circuited and, therefore, the track lamps for these



W. E. Prince, the signal maintainer at the Erwin office adjusting a rectifier

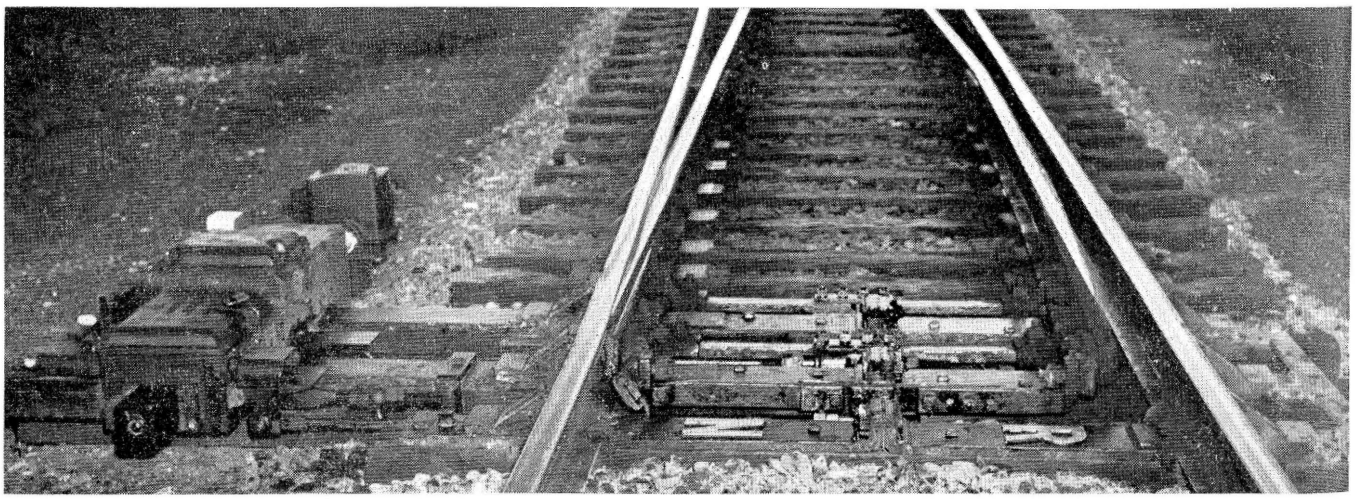
sections are controlled manually by toggle switches on the board.

Green lamps are used above the signal levers for the "L" and "R" positions, and red for the center or normal position. These lamps are normally lighted in accordance with the lever position. The red lamps above the center position of the signal levers are normally steady-burning when the levers are in their center position and the signals controlled thereby displaying the Stop aspect. However, these lamps flash when signals are stored, if the levers are moved to clear signals before switches over which they govern have completed their movement from Normal to Reverse or vice versa. After switches are locked up in one position or the other, the flashing stops, the red lamps are extinguished, and the green lamps are lighted when signals have cleared. These red lamps also flash when signals are in time, such as when a signal may be knocked down from a cleared "position" to Stop in the face of a train. The flashing ceases as soon as the time has run down, and the lamps burn steadily until the levers are again moved to clear the signals. The control machine is also equipped with a 57-pen graphic train recorder, 45 of which are in service.

Special Phone Interconnection

At Miller Yard, the Clinchfield does quite a bit of business and interchange with the Interstate Railroad, necessitating frequent communication between the Clinchfield and Interstate dispatchers. To facilitate this matter, in the row of signal levers on the C.T.C. machine at Erwin, there is a button with an opal lamp above it. By pressing this button and the code starting button, the Clinchfield dispatcher is able to send out a code which connects his telephone circuit to the Interstate dispatcher's circuit. Upon completion of the connection, the white lamp above the button on the C.T.C. panel is lighted, and remains lighted until another code is sent out to disconnect the circuit.

All facilities in this installation are controlled by code, except in the immediate vicinity of Erwin, where they are direct-wire controlled. The C.T.C. code line is divided into two sections—Erwin to Wood and Wood to Delano, 75 mi. and 47 mi., respectively. Northward from Erwin to Wood, a 21-kc. carrier for controls and a 12.8-kc. carrier for indications is superimposed upon the code line for handling the Wood-Delano section. At Wood, the 21-kc. carrier for controls in the Wood-Delano section is converted to d.c. code and d.c. indication



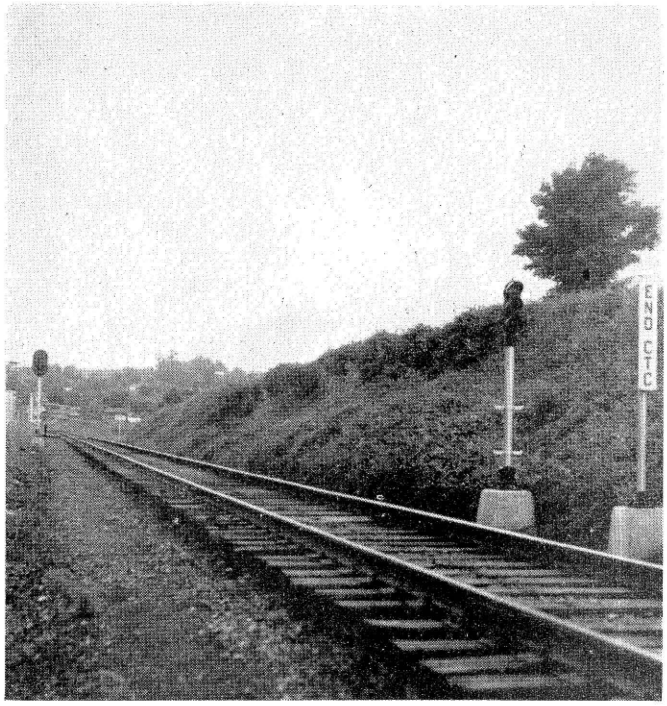
The power switch layouts are well constructed

codes in the section are converted to 12.8-kc. carrier for transmission to Erwin. To boost the code line and compensate for any leakage, such as might be encountered during wet weather, a repeater is in service at Kingsport, 42 mi. north of Erwin. This repeater is controlled by a lever on the machine at Erwin, and is normally off.

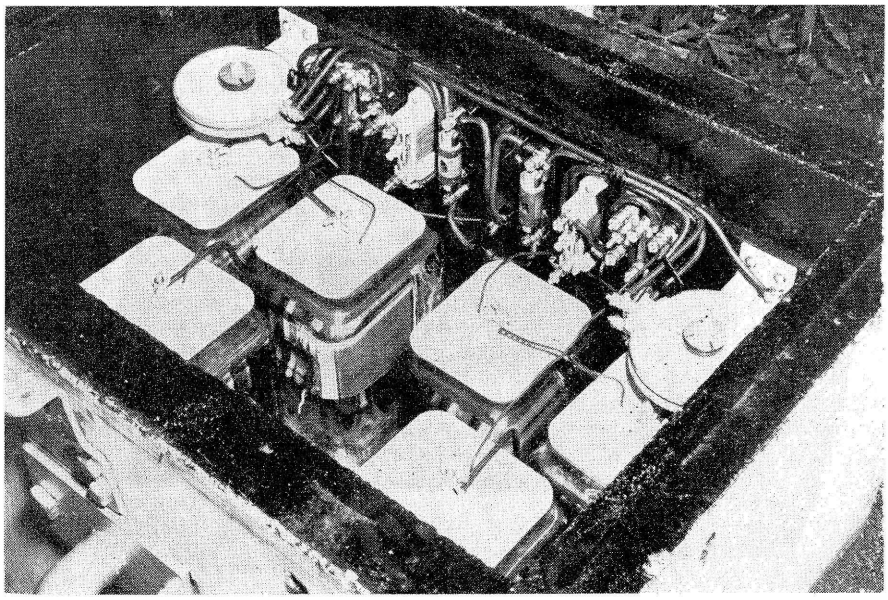
Power is picked up from commercial sources at various points along the railroad, and delivered at 220 volts a.c. to the signal locations. This circuit is not continuous, and is run only where required. At each power switch location there are 12 cells of Edison B4H nickel-iron-alkaline storage battery for operation of the switch machine and code apparatus, and 8 cells of A4H for the signal and control circuits. The code-line battery at Erwin consists of 102 cells of Edison N-2 nickel-iron-alkaline storage battery, rated at 11.25 ah. on the 5-hr. rate. The control machine battery consists of 12 cells of A6H battery of the same type, rated at 225 ah.

Where a.c. power is available, track circuits are fed by Edison B4H storage battery with recifiers. Primary battery is used at the majority of cut-section locations. In most cases, this consists of three Edison 1,000-ah. cells in multiple. Primary battery is also used for the line battery at electric lock locations not near a.c. power. All automatic signal locations, however, have a.c. power run to them.

A 5-ft. by 7-ft. sheet-metal house is in service at each power switch location for shelter of code equipment, relays, rectifiers, storage battery, except at Wood, where there is a 6-ft. by 10-ft. house, which also shelters additional code-line apparatus, this being the end of the carrier section north from Erwin. The office coding equipment at Erwin is sheltered in a panelled sheet metal cabinet in the basement of the railroad office building.



Special signal at end of C.T.C. territory to protect into non-block sections



Primary battery, to feed track circuits, are in concrete boxes

Call Lamps and Phone Booths

At each power switch location, a clear call lamp is mounted on the track side of the bungalow. The lamps are used in contacting maintainers in the field, and also serve as a means of contacting train crews when necessary.

A telephone, connected to the dispatcher's circuit, is located in a telephone booth adjacent to the signal house at each power switch location. This arrangement eliminates the necessity of train crews having to enter houses to call the dispatcher and, thus, minimizes tracking mud and dirt into the housing, especially during bad weather, to cause accumulation of dust on signal apparatus. At each electric switch lock location, there is a telephone mounted in an iron box. These phones are connected to the code line, which is equipped with a call detector that notifies the dispatcher he is wanted on that line.

The existing communications pole line was used for the new signal circuits, a 10-pin fir crossarm with steel pins having been added below the telephone and telegraph wires. This pole line consists of about 40 poles to the mile or, in other words, a pole about every 135 ft.

The C.T.C. code line is on Polyethylene covered No. 6 hard-drawn copper line wire for 33 mi. from Erwin to Fordtown, and on No. 8 40-per cent conductivity Copperweld for 89 mi. from Fordtown to Delano. Power and low-voltage line control circuits are on General Electric Type-FF Flamenol plastic-insulated wire, No. 9 conductors,

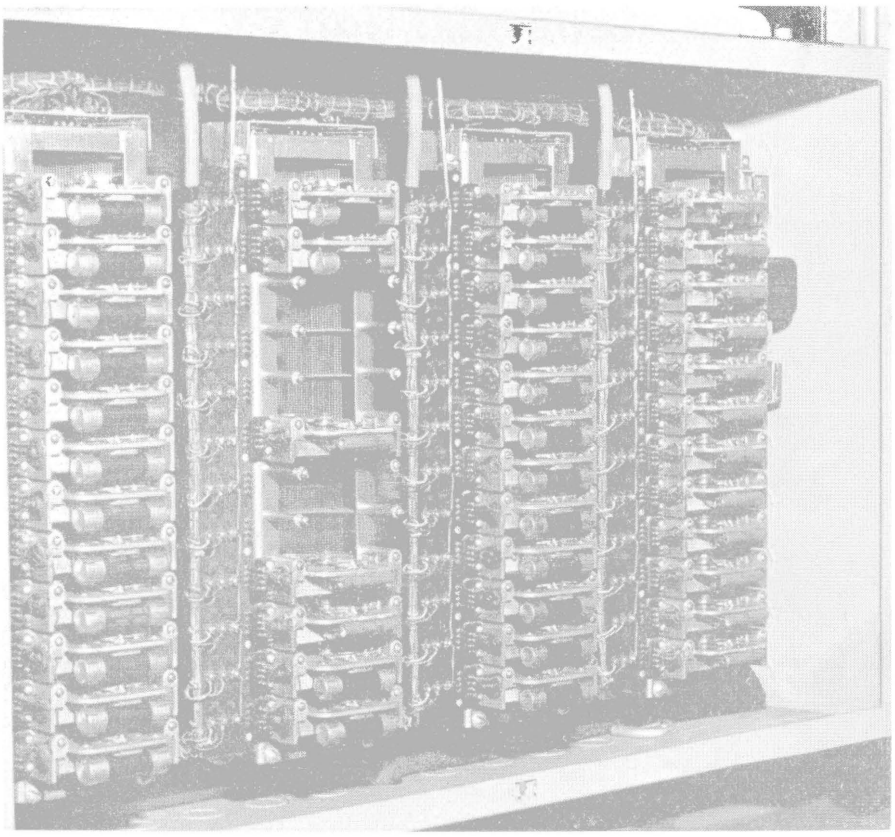
(Continued on page 107)

who then directs the crew to the next car to be unloaded.

On the open platform, the same procedure is followed in directing freight to be loaded in cars, receiving it from the city for outgoing destination, or in directing the movement of freight for city delivery. With the telephone system, it is possible for one clerk to simultaneously supervise check of a car being unloaded at each end of the freight platform, receive freight coming in from the city and send out freight for city delivery. It would be impossible for this to be done with an amplified-type communication system, or by the old method of having a clerk stay with the crews, according to Agent Robertson.

"One of the fine points about this system," Mr. Robertson said, "is that it completely does away with the necessity of members of a crew or clerks running back and forth to the office to pick up bills for checking the cars, or for returning the bills after the cars have been checked. With this system, there is neither lost time nor motion. Too, if it becomes necessary for some reason to dispatch a crew from one car to another quickly, the telephone system permits us to do it expediently." When the idea for the system was first advanced, Mr. Robertson and Mr. Elliot called in electrical engineers and explained the kind of a system they hoped to see installed. The plans were also put before Frisco officials who agreed to try it on an experimental basis.

Initial tests on the system began in July, 1949, installation was finished in mid October and, since its completion, numerous roads have sent freight men to Memphis to see it in operation. The switchboard was installed by the communications and signal department of the railroad, working in cooperation with the Bluff City Distributing Company of Memphis. The communication equipment used throughout the project was furnished by the Kellogg Switchboard & Supply Company.



Automatic phone equipment in central office of Frisco's freight house at Memphis

Clinchfield

(Continued from page 97)

being used for both power and controls.

Line breaks are dead-ended on Raco dead-end brackets, line taps extending to a conduit down the pole through Knox Porcelain Company porcelain-insulated bridle rings on the crossarms. At the bottom of the pole, the conduit enters a junction box, from which point underground cable extends to the house or instrument case. Where rock formations prevented the installation of underground cable between the pole line and instrument housings, Kerite made-up aerial cable, supported by messenger, was used.

Lightning Protection

General Electric pellet-type lightning arresters are used at each tap location on the 220-volt a.c. power line. Westinghouse Sentinel overload circuit breakers are used on all power circuits inside instrument cases and houses. The code line and signal line circuits are protected by Westinghouse Autovalve-type lightning arresters. Track circuits are protected by Western Railroad Supply Company No. 27A shunt-type arresters and General Electric Thyrite discharge resistors.

Underground Cables

Underground cables between the pole line and instrument housings, as well as between houses and signals and switch machines vary from 5 to 12 conductors. Connections to bootlegs are made with single-conductor No. 9 cable. Case wiring is Kerite TC-green, and all inside building wiring at the C.T.C. office is in steel conduit.

Each main-line hand throw switch located in C.T.C. territory is equipped with a Union Style U-5 switch circuit controller. The newer rail in the territory (112 lb.) is bonded with American Steel & Wire Company and Ohio Brass Company drive-in type rail-head bonds, as well as American Steel & Wire Company weld-type rail-head bonds. The older 100-lb. rail is bonded with two No.-9 galvanized wires with 3/8-in. double channel pins. Track circuit connections are made with Union bootlegs and American Steel & Wire single stranded-conductor plug-type bonds, and insulated rail joints are Rail Joint Company's continuous type.

New Motor Cars

Each maintainer is provided with a Fairmont M-9 motor car and a tool and motor-car house. The major items of signal equipment for this project were furnished by the Union Switch & Signal Company, and the labor was performed by the Union Switch & Signal Construction Company.