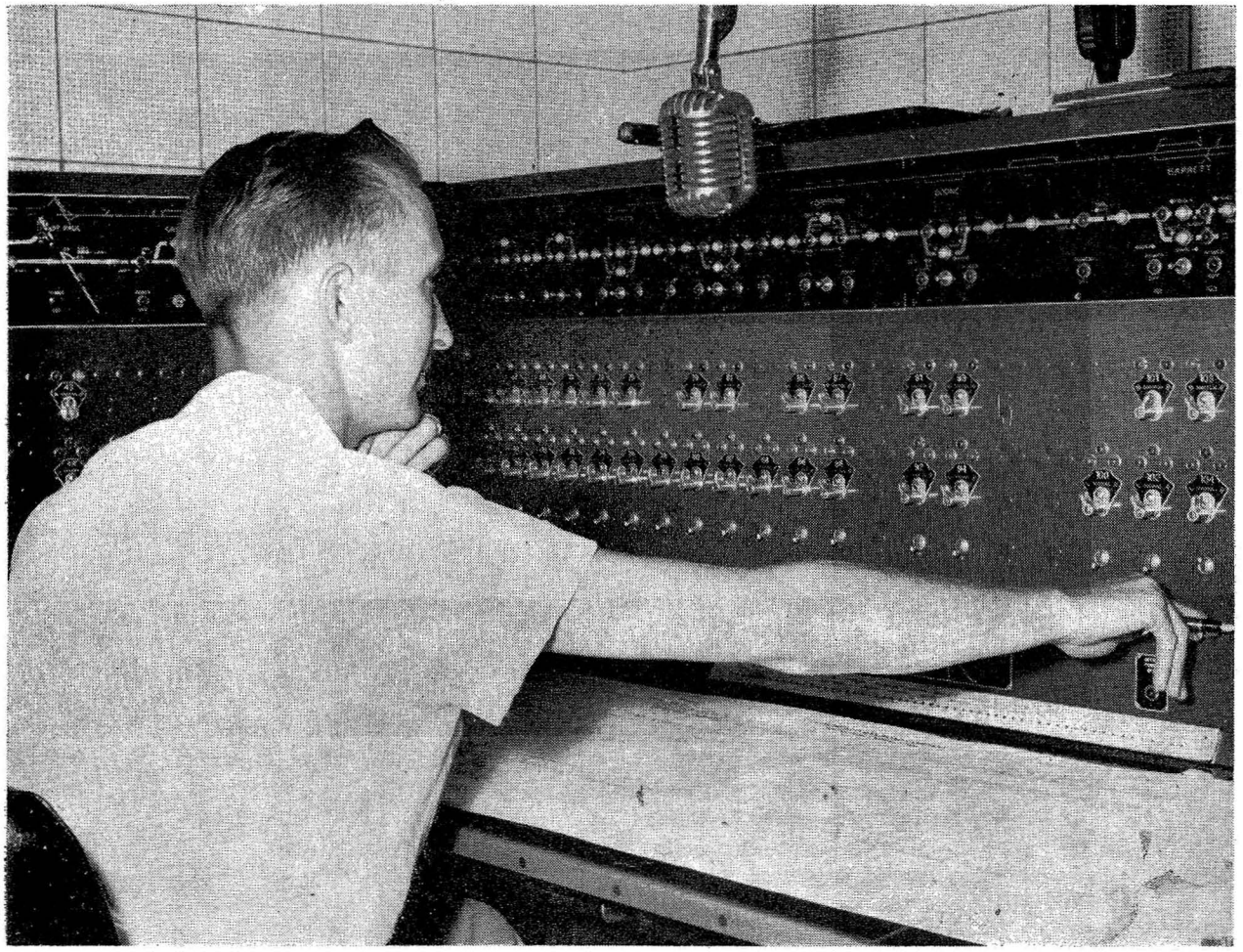


C. T. C. Keeps Trains Moving on Long Grades

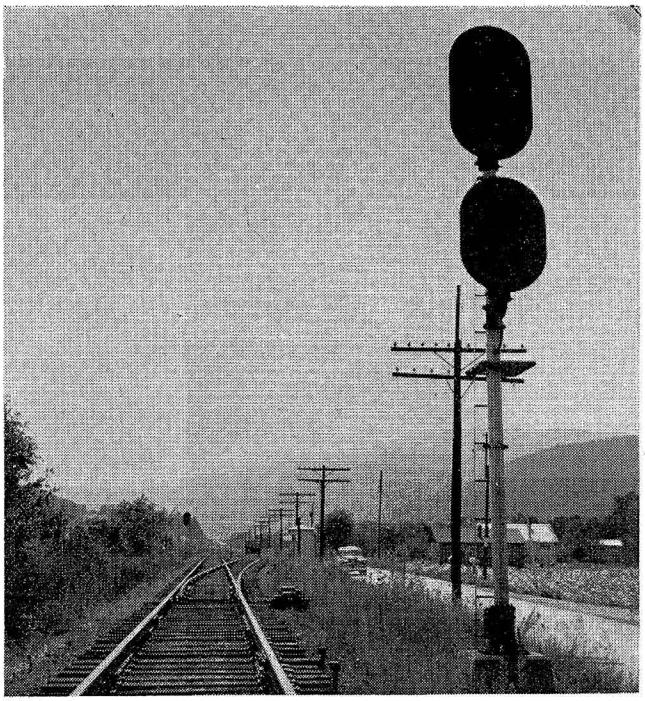
Train movements expedited on 277-mi. route handling coal and merchandise through Appalachian mountains. Special starting signals eliminate delays in getting road freight trains out of Erwin yard

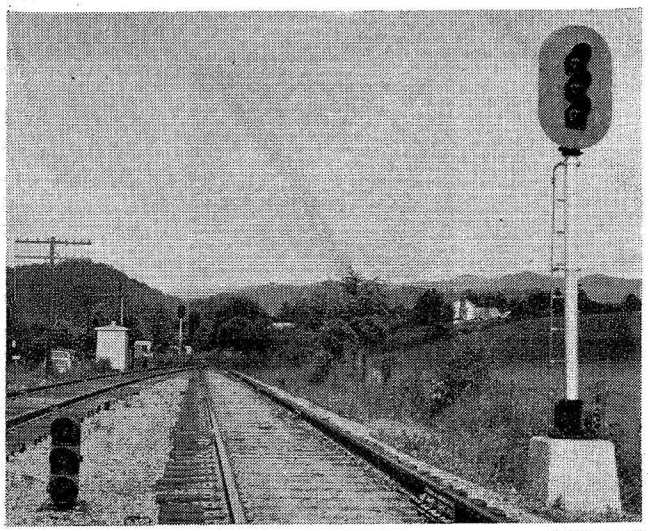
THE CLINCHFIELD has recently installed centralized traffic control on 141 mi. of single-track main line between Erwin, Tenn., and Spartanburg, S.C.; thus completing this modern form of signaling on 261 mi. of the 277-mi. main route between Elkhorn City, Ky., and Spartanburg. The northern section (Erwin-Delano) was put into operation in 1951, the southern part (Erwin-Spartanburg) was completed in 1952, and the final section, Delano-Elkhorn City will be completed in 1953.

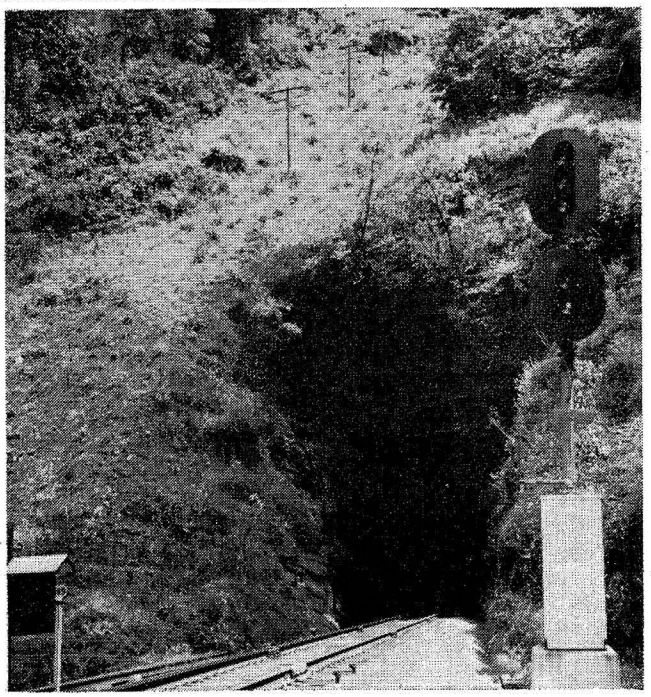
Train movements were formerly authorized by timetable, train orders and manual block. Absolute blocking was in effect for southbound trains for 7 mi. between Dante, Va., and St. Paul; for 6 mi. between Frisco, Tenn., and Kingsport (trains originating or clearing at Frisco); and for 8 mi. between Altapass, N.C., and Camp 2. Two-position semaphore automatic block signaling was in service for tunnel and curve protection at three major tunnels: from Trammel, Va., 2.9 mi. to Dante (Sandy Ridge tunnel, 8,200 ft.); Boulder, Va., 4.4 mi. to Kermit (Clinch mountain tunnel, 4,200 ft.); and Altapass, N.C., 7.6 mi. to Camp 2 (Blue Ridge tunnel, 1,850 ft.).

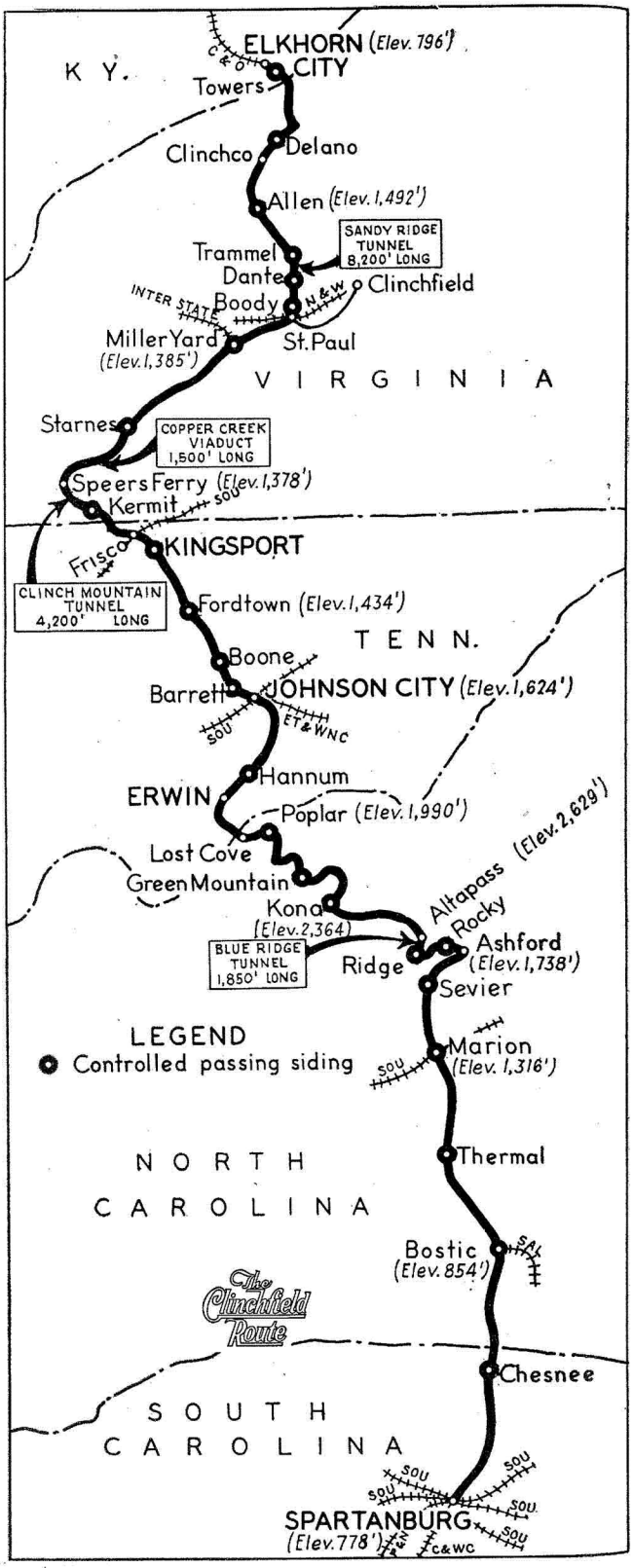
Coal, Merchandise and Perishables

The Clinchfield is principally a freight railroad. A local passenger train runs northbound on Mondays, Wednesdays, and Fridays; and southbound on the alternate weekdays. Although the Clinchfield is a prime mover of coal, manifest provided 48.6 per cent of its total revenue for 1952. This traffic is handled









Above left—Signal at entrance to passing siding

Center left—Signals at leaving end of siding

Below left—Signal at entrance to siding, where siding is on other side of tunnel

in five (three northbound and two southbound) through freight trains, with extra trains operated according to traffic requirements. At Elkhorn City, the Clinchfield receives, from the Chesapeake & Ohio, merchandise carloads for movement south to Bostic for delivery to the Seaboard, and to Spartanburg for delivery to the Charleston & Western Carolina, and P&N for movement to points in North Carolina, South Carolina, Georgia and Florida. Similarly perishables, phosphate, lumber and other products from these southern states are delivered to the Clinchfield at Spartanburg, from the C&WC and the P&N, for movement north to Elkhorn City and over the C&O and its connections.

Large quantities of coal are mined in the northern section of the railroad between Miller Yard, Va., and Elkhorn City. Much of this coal is moved south for delivery to connecting lines. The Clinchfield also moves coal northward via the C&O and N&W. Coal from the C&O, N&W, Interstate and L&N is shipped south over the Clinchfield. Coal traffic is handled in separate drag freight trains, the number depending upon the amount of traffic. An average daily movement is 500 to 600 cars, including some 200 from connecting roads.

In addition to its connection with the C&O at Elkhorn City, the Clinchfield has connections with the N&W at St. Paul, Va.; Interstate (handling L&N traffic) at Miller Yard, Va.; Southern at Frisco, Tenn.; Southern, and East Tennessee & Western North Carolina at Johnson City, Tenn.; Southern at Marion, N.C.; Seaboard Air Line at Bostic, N.C.; and C&WC, Southern, and P&N at Spartanburg. With these connections, the Clinchfield acts as a bridge line between the Carolinas, Georgia and Florida, and the vast central west and northeastern territories. All trains are handled by diesel locomotives, but 12 articulated steam locomotives are used in helper service at normal traffic levels.

Character of Line

The Clinchfield crosses the heart of the Appalachian mountains over four major summits and three minor watersheds. The railroad begins at Elkhorn City with an elevation of 796 ft. and rises to 2,629 ft. at Altapass, N.C., 187 mi. south, and then drops to 778 ft. at Spartanburg. Relatively easy grades were made possible by the judicious use of curves and tunnels. Fifty-five tunnels were drilled (179 ft. to 8,200 ft.) with an aggregate length 3.5 per cent of the total mileage of the line. Maximum ruling grade southbound is 1.5 per cent for 5 mi. just south of Erwin; and the maximum ruling grade northbound is 1.7 per cent for 1 mi. just north of Dante. Almost half of the railroad is on curves, with many up to 14-deg. in curvature. The longest tangent is only 2 mi., and the only passing siding entirely on a tangent is at Sevier.

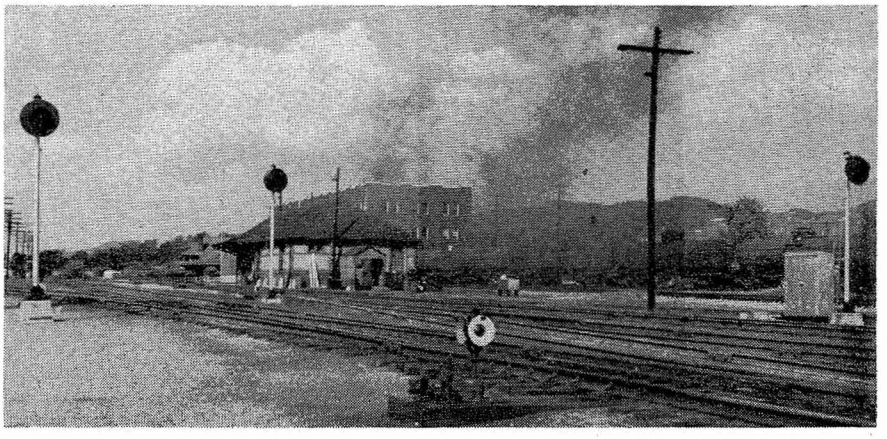
Siding Changes

The new centralized traffic control system includes power-operated switches and CTC-controlled signals at both ends of 24 passing sidings between Elkhorn City and Spartanburg. The switches and signals are controlled by the dispatcher from a machine located at Erwin, 136 mi. from the north end of the line. Prior to CTC, sidings were spaced an average of 8½ mi. apart, and held 80-100 cars. With the advent of dieselization on the Clinchfield, longer trains were run, which necessitated that sidings be lengthened. Now all controlled sidings hold 130-175 cars, and are spaced an average of 11 mi. apart. Two new sidings were installed, 17 sidings were lengthened, 11 were removed entirely and five sidings were equipped with hand-throw switches and electric locks for use as storage tracks.

By means of the illuminated track diagram the dispatcher knows the location of each train, and, through his control of signals and switches, eliminates delays at sidings, permitting almost continuous movement, with the result that trains arrive at terminals hours sooner than was possible before installation of centralized traffic control. Thus, service to shippers has been improved and greater utilization of motive power and freight car equipment has been made possible.

Colorlight Signals

The new signals are Style P-5 colorlight type, and are continuously lighted. The signals are equipped with 10-volt, 18-watt lamps. The signal on the main line at the entrance to a passing siding is a two "arm" signal with the upper "arm" consisting of three vertical light units, and the lower "arm," two vertical light units. When a train approaching a passing siding is to hold the main track, the signal will display green, yellow or red (depending upon the track occupancy ahead) in the top "arm," and red in the bottom "arm." If the dispatcher lines a power switch for a train to enter a siding, the top "arm" will display a red aspect, and the bottom "arm" a yellow aspect. This red-over-yellow is the Restricted Speed aspect.

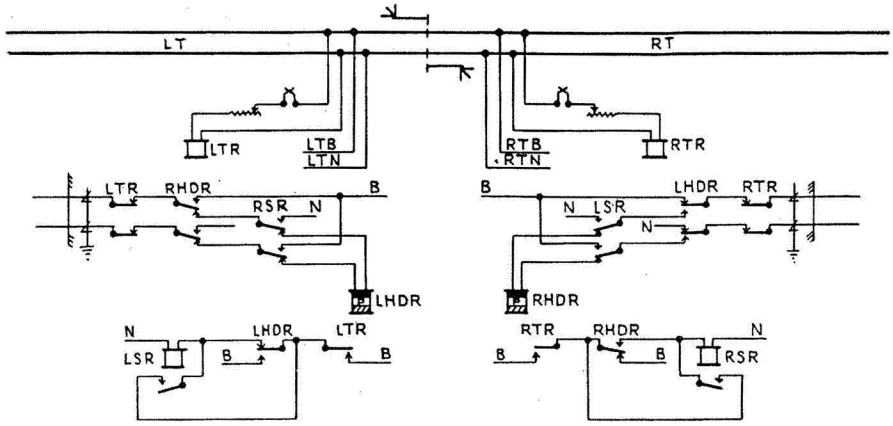


Starting signals governing movements north out of Erwin yard

At locations where a siding joins the main track at the entrance of a tunnel, the "two-arm" high signal for this siding is located at the other entrance to the tunnel. Thus an engineman is informed, before he enters the tunnel, whether he is to hold the main line, or enter the siding. Three-aspect colorlight dwarf signals, Union Style N-2, are used as leave-siding signals.

Grade signals are identified by a white letter "G" on a black disc, which is mounted on the mast below the signal head. When the signal is displaying red, this marker designates the aspect as Permissive, allowing a tonnage train on an ascending grade to pass the signal at restricted speed without stopping.

This installation includes three-aspect intermediate automatic block signals, so that following trains can



Circuit diagram of "floater" track relay at automatic signals

be operated in a siding-to-siding block in the conventional manner. These intermediate signals are spaced for automatic blocks ranging from about 6,000 ft. to about 10,000 ft. In the siding-to-siding blocks ranging from 2.7 mi. to 8 mi. long, there are usually two double locations of intermediates. Three double locations of intermediates were installed in the longer siding-to-siding blocks, as for example in the 12 mi. between Erwin and Poplar. The signal control relays are the 400-ohm polar type and are controlled by one two-wire line circuit which is fed northward to control southward signals, or fed southward to control northward signals. The direction of the feed is established as a part of the control for clearing the signal.

The track circuits are the conventional normally-energized d.c. type, using the new DN22BH ½-ohm biased neutral relay, which not only has good shunting characteristics, but also has the advantage that it will operate reliably on long track circuits—up to about 8,000 ft. on this Clinchfield project.

A two-wire line circuit is used between each approach signal and the associated end of siding to carry in the track-occupancy indication and approach controls. In a siding-to-siding block, with three double locations of intermediates, track battery feeds both ways from the middle intermediate signal location, and is carried through cascaded track circuits to the distant signal; so that track occupancy can thus be detected through the entire block by only running approach wires from the end of siding to the distant signal. In order to establish direction for following moves, at the middle set of automatic signals, the stick relay is controlled initially by a "floater" track relay. This floater relay is adjusted so that the relay will remain down a sufficient time for the respective HD relay to release. Since contacts of the relay at the far end of the circuit control the HD relay, the stick relay will remain energized until the HD circuit is again energized to release it.

The beginning of CTC to the south of Erwin is marked by a sign "Begin CTC." Beside this sign is a dispatcher-controlled CTC signal which is a colorlight three-aspect high signal. This is the first CTC signal south of Erwin, and there is also one of these signals with a special sign "Begin CTC" at the north of Erwin.

To Depart from Erwin Yard

The Clinchfield has developed special "starting" signals to move trains out of the yard, through the switching area and to the first CTC signal governing entrance into CTC territory. Each starting signal consists of a normally-dark single lamp unit on a 12-ft. mast. When controlled by the dispatcher, it displays an illuminated white "S." For northbound trains ready to depart from Erwin yard, there are three of these starting signals, one on the main track, one on the north yard lead and a third on a ladder track leading to the north yard lead.

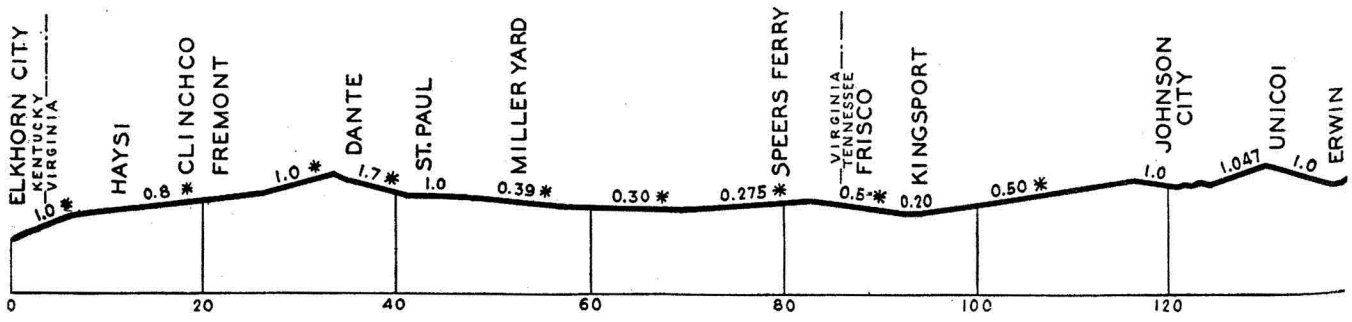
When a northbound train is ready to depart, the dispatcher is notified. If he is ready for the train to pull out through the yard area and out onto the CTC territory, he will control the starting signal to display an illuminated "S," and clear the first CTC signal north of Erwin. This action directs the train to leave the yard, go onto the main track and enter CTC territory. Thus, the train departs promptly and does not block the main line while waiting for the first CTC signal to be cleared.

If, however, a southbound train is approaching Erwin yard, the dispatcher, by not clearing the starting signal, can hold the northbound train in the yard until the opposing train is in the yard.

The power switch machines on the southern part of the CTC are Union Style M-23B, dual control, designed for operation on 24 volts d.c. The turnouts at the ends of sidings are No. 16 with 30-ft. points, which are good for diverging moves up to 35 m.p.h. Electric switch locks on main-line hand-throw switches are Union Style SL-21. Most of the spurs leading from the main line are equipped with pipe-connected Hayes lift-type derails. The switch machines on the northern part of the CTC are Style M-22B dual control, operating on 24 volts d.c.

New Building

A one-story brick and cement block extension has been added to the rear of the main office building of the Clinchfield in Erwin. This ell contains the chief dispatcher's office, the CTC control machine room, and



the relay and battery room. The extension is soundproofed, radiant heated and fireproof.

The control machine has a 7½-ft. center section and two 5-ft. wings. The panel contains the conventional arrangement of signal, switch and lock levers, push buttons, indication lamps and illuminated track diagram. Track model lamps are normally extinguished, with red for OS sections and power-off, and white for track occupancy. There is one power-off lamp for each controlled signal location. 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. In the first portion of CTC installed, passing sidings were not circuited for track-occupancy indications, so that the track lamps for these sidings were lighted by manual control of toggle switches on the control panel. With the completion of CTC, all sidings are now track circuited, and the track occupancy lamps on the panel are lighted in the conventional manner.

Green lamps are used above the signal levers for the "L" and "R" positions, and red for the center or normal position. The red lamps above the center position of the signal levers are continuously lighted when the levers are in their center position, and the signals controlled thereby are displaying the Stop aspect. These red lamps will flash when signal controls are stored; i.e., when the levers are moved to clear signals before switches, over which they govern, have completed their movement. After the switches are locked up in one position, or the other, the flashing stops, the red lamps go out, and the green lamps are lighted when the signals have cleared. These red lamps also flash when the signals are in "time," such as when a clear signal may be taken away. The flashing stops as soon as the time has run out, and the light burns steadily, until the lever is again moved to clear the signal. The control machine is equipped with a 57-pen graph train recorder.

Locks on Hand-Throw Switches

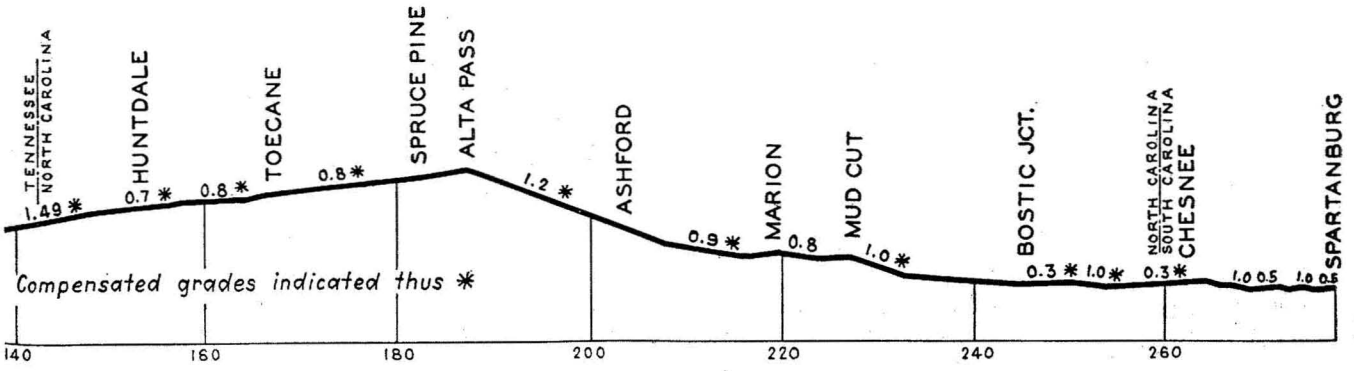
Main-line hand-throw switches are electrically locked. When these switches are unlocked, movement of the switch operates a lift-type Hayes derail on the side track. Sidings at Castle, Waycross, Spruce Pine and Brice are hand-throw electrically locked. The Clinchfield uses two methods for releasing electric locks: the short track circuit release, and the time release. In sections where there are more than two electric locks, the time release is used, but where only one electrically-locked switch is located, the track circuit release is used. With the track circuit release, the train or engine is stopped 100 ft. ahead of the switch. A train or engine standing on this track section will give the unlock. The track circuit is usually three rail-lengths long, or about 120 ft. With the time release method, the electric lock will release within a few minutes after the removal of the switch padlock, depending on the length of the circuit. Train crews must call and receive the dispatcher's permission before using hand-throw switches equipped with electric locks.

Approach Locking

Because of the grades on this railroad, it is highly important to eliminate train stops. For this reason, approach locking rather than time locking was applied to avoid even those few train stops that may be involved when necessary to "take away" signals and change a line-up. For example, the dispatcher may have lined up a route and cleared a signal for a main track through move. But later he sees, from his illuminated track diagram, that this train is not making as good time as he expected. Therefore, he has the opportunity to advance an opposing train. With approach locking, if the first train is on the far side of the next siding, he can take away the signal for the first train, and immediately set up a route for this second train, thus keeping it going. Whereas if time locking only were in service, the dispatcher would have to wait for the time to run out before he could change the route. The extra flexibility of the approach locking to avoid the delay of the time interval if no train is on the approach section, is being used to an advantage. Also the two-light block indication is available without cost of additional line wires, since the block is indicated by the approach relays.

Code Control of CTC

All facilities in this installation are controlled by code, except in the immediate vicinity of Erwin. Direct-wire circuits control the first switch north of the depot. The CTC code line is divided into four sections: Erwin to Starnes, 67 mi.; Starnes to Elkhorn City, 68 mi.; Erwin to Marion, 82 mi.; and Marion to Spartanburg, 58 mi. The Erwin-Starnes section controls and indications are handled by d.c. code. Superimposed on the line on this section is a 12.8 kc carrier for controls and 21.0 kc carrier for indications for the Wood Elkhorn City section. The Erwin-Marion section controls and indications are handled by d.c. code. Superimposed on the line on this section is an 11-kc carrier for controls and a 17-kc carrier for indications for the Marion-Spartanburg section. To boost the code line and compensate for leakage, caused by or incurred during sleet storms, two repeaters are in service, one at Kingsport, 42 mi. north of Erwin and the other at Kona, 37 mi. south of Erwin. These repeaters are controlled by levers on the control machine at Erwin, but are normally kept off.



The CTC code line is also being used for the dispatcher's telephone circuit. At Miller yard, the Clinchfield has considerable interchange business with the Interstate Railroad, necessitating frequent conversations between the Clinchfield and Interstate dispatchers. To facilitate this, the Clinchfield dispatcher has a connection from his telephone circuit to the Interstate dispatcher's telephone circuit. To make this connection, the Clinchfield dispatcher pushes two buttons on the CTC control machine: one is a special button with an opal lamp over it, and the other is the code starting button. Upon completion of the connection, the white lamp above the special button is lighted, and remains lighted until another code is sent out to disconnect the circuit.

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 runs only where required. At each power switch location, there are 18 cells of Edison B4H nickel-iron alkaline storage battery for operation of the switch machines and code apparatus, and 8 cells of A4H for signal and control circuits. The code line battery at Erwin is furnished by means of a rectifier. Stand-by a.c. is available for operation of the rectifier in event of power failure.

Where a.c. power is available, track circuits are fed by Edison B4H storage battery, with rectifiers. Primary battery is used at the majority of cut-section locations. In most cases, this consists of three Edison 1,000-a.h. cells in multiple. At Lost Cove, N. C., 6 mi. south of Erwin, the power is not available. The intermediate signals and track circuits at this location are fed by primary battery, and the signal lamps are approached lighted. Primary battery is also used for the line battery at electric lock locations not near a.c. power.

At each power switch location a 5-ft. by 7-ft. sheet-metal house contains the code equipment, relays, rectifiers and storage batteries. The equipment housings at Starnes and Marion are 6 ft. by 10 ft. to hold the additional carrier equipment, these points being the ends of the carrier sections. The office coding equipment is in sheet-metal cabinets in a room behind the CTC control machine.

At each absolute signal location, a white call lamp is mounted on the track side of the equipment house. The lamps are used for 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 phone booth adjacent to the instrument house at each power switch location. At each electric switch lock location, a telephone is mounted in an iron box.

The CTC code line is polyethylene covered No. 6 hard-drawn copper line wire for 33 mi. north from Erwin to Fordtown, for 51 mi. south from Erwin to Altapass; and on No. 8, hard-drawn copper for 106 mi. north from Fordtown to Elkhorn City, and 87 mi. south from Altapass to Spartanburg. The 220-volt a.c. power distribution and the local signal line control circuits are on No. 9 Copperweld with General Electric Company Type FF Flamenol plastic insulation.

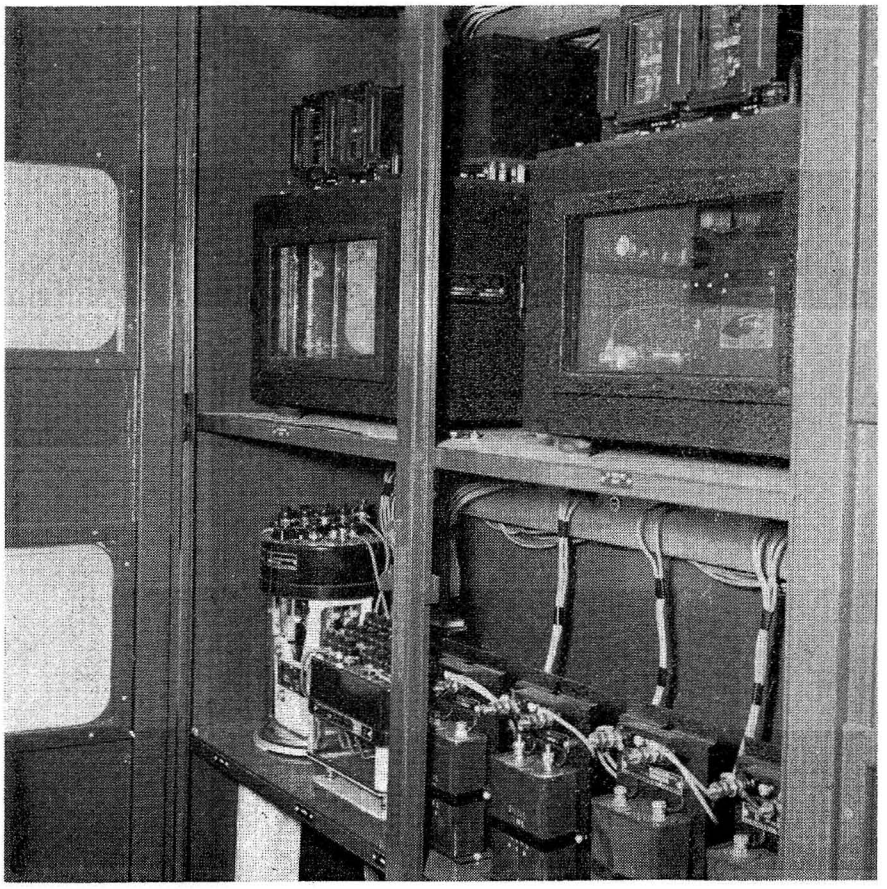
Line breaks are dead-ended on Raco dead-end brackets, line taps extending to a conduit down the pole through porcelain-insulated bridle rings on the crossarms. At the bottom of the pole, the conduit enters a junction box, from which point underground cable extends to the house or instrument case. Where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

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. Track circuits are protected by Western Railroad Supply Company No. 27A shunt-type arresters and General Electric Thyrite discharge resistors.

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 CTC office is in steel conduit.

Rail bonds used are American Steel & Wire Company style BD-2 electric weld-type rail-head bonds. Track circuit connections are made with Union bootlegs and AS&W stranded conductor plug-type bonds. Insulated rail joints are Rail Joint Company's continuous type.

CTC, from Erwin to Spartanburg, as well as the Delano-Elkhorn City section, was installed by railroad forces. The major items of signal equipment were furnished by the Union Switch & Signal-Division of Westinghouse Air Brake Company.



Coding equipment in relay room at Erwin dispatcher's office