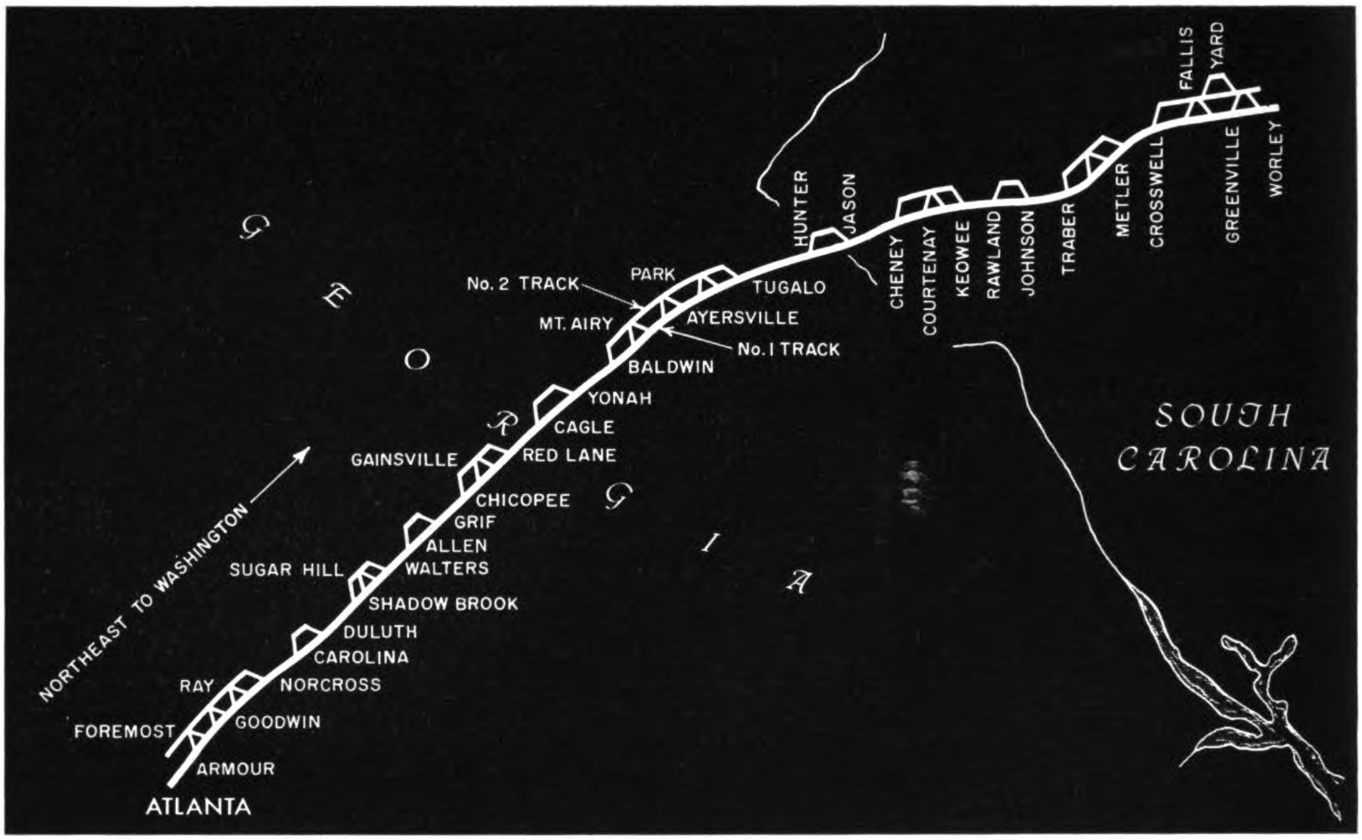


FIG. 1—In the 150 miles between Foremost, Ga. and Worley, S. C., 62 miles of one main track were removed

Special Combinations of . . .

Single-Track and Two-Track

. . . Replace Double Track on the Southern

BEFORE — Conventional double track, with hand-throw sidings with spring switches at leaving ends, automatic block for right-hand running, and train movements authorized by time-table and train orders; were previously in service on 150 miles of the Southern Railway between Worley, S.C., and Foremost, Ga., near Atlanta.

AFTER — Now this territory consists of intermittent sections of single-track and two-track, with no sidings. The 11 sections of single main track total 62 miles, and 12 sections of two main tracks total 90 miles. Adequate track capacity has been provided by installing centralized traffic control for train movements by signal indication both ways on all tracks.

Changes made in this project included the removal of 11 sections of one of the previous main tracks,

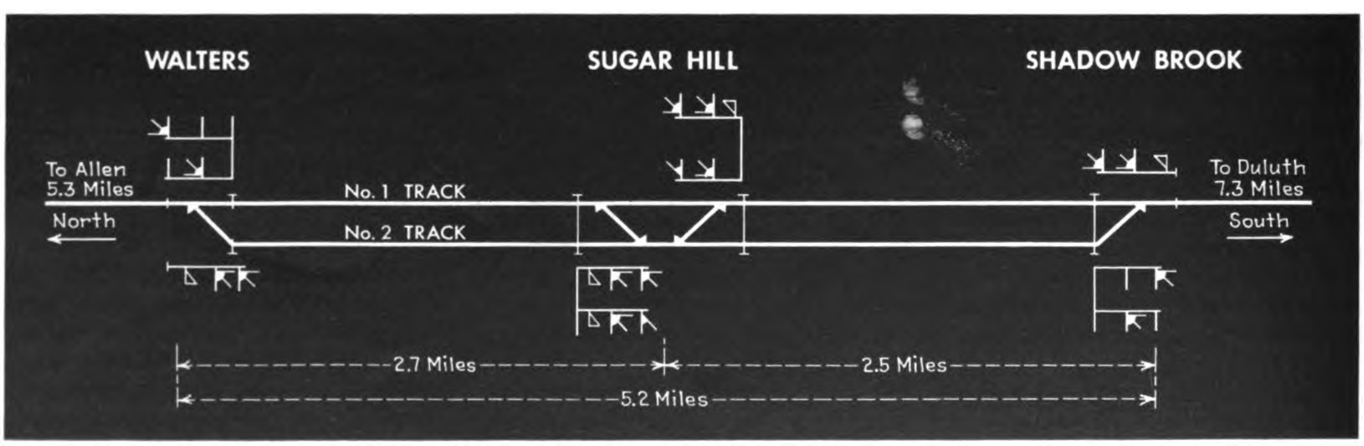


FIG. 2—Plan of tracks, switches, crossovers and signals in the Walters-Shadow Brook section of two-track

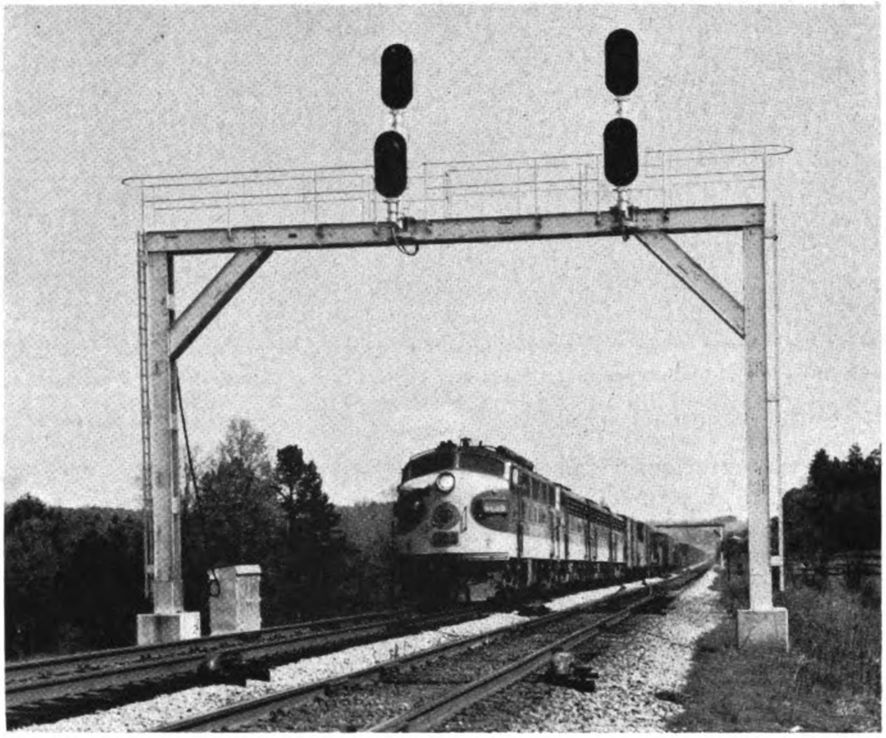
totaling 62 miles, and also 17 sidings totaling 18 track miles. Several important factors were considered when deciding which sections of second main track were to be removed. In general, both main tracks are left in place where needed for meeting or passing trains; extra long sections being left on long grades. Also, both mains were left in place through industrial switching areas, so that one track, or the other, can be used by the local road crews to serve industry tracks, thereby leaving the other main track for use by through trains of either direction.

Typical Layout

The layout of a typical section of two-main tracks is shown in Fig. 2. The old southward main track was removed from Walters north to Allen, 5.3 miles, and from Shadow Brook south to Duluth, 7.3 miles. This left 5.2 miles of existing two main tracks between Walters and Shadow Brook. Both of these tracks are now signaled for train movements in both directions, the same as two single track lines side by side. Such a section is termed "two-track." At Sugar Hill, which is the central point of this length of two-track, a set of double crossovers was installed, so that the trains can be diverted from either track to the other.

Other similar sections where both main tracks were left in place with one set of double crossovers near the middle are: (1) Haywood to Traber, 10.5 miles; Keowee to Cheney, 8.6 miles; and Red Lane to Chicopee, 7 miles.

At five other locations, the sections where both main tracks were left in place, range from 2.3 miles to 5 miles, and no crossovers were installed. These sections are: Johnson to Rowland, 4.0 miles; Jason to Hunter, 3.6 miles; Yonah to Cagle, 5 miles; Grif to Allen, 2.2 miles; and Duluth to Carolina, 2.3 miles. From Tugalo south to Mt. Airy, about 17 miles, the grade ascends southward at rates ranging up to 1 per cent, and then descends at 0.9 for about 2 miles through Baldwin. To provide additional track capacity for trains running at reduced speed on these grades, the two main tracks were left in place on the 20 miles between Tugalo and Baldwin, with a set of double crossovers at each of three equally spaced locations, Park, Ayersville and Mt. Airy.



Trains meet and pass on two-track, each track signaled for either direction running

Both main tracks were left in service for 13.9 miles through the industrial area from Norcross to Foremost, which is near the yards at Atlanta. In this 12 miles, a set of double crossovers is located at each of three places, Ray, Goodwin, and Foremost. The north end of this project is at a set of double crossovers at Worley, which is 3 miles north of the passenger station at Greenville. Two-track now extends from Worley through Greenville to a new end of two-track at Crosswell, 8.3 miles from Worley, with a set of crossovers at Fallis. Two power single switches on No. 2 track connect to tracks leading to the north and south ends of the Greenville yard.

Between Greenville and Atlanta this railroad was built diagonally across the watershed sloping southeastward from the Blue Ridge mountains. Thus the railroad crosses several rivers and the ridges between. Therefore the grade is uphill and down, normally ranging up to about 1 per cent. The longest grade is about 1 per cent for 15 miles ascending southward from the Tugalo river to Mt. Airy. Curves are numerous, and normally range up to about 3 degrees, with a few up to 4 or 5 degrees.

For the most part, the rail is 132 lb, and the track, ties and ballast are well constructed and maintained. Maximum permissible train speeds are 80 mph for passenger trains and 60 mph for freight trains. The signal system now in service, as well as previously, includes an intermittent automatic train stop system, which will stop a train if an engineman disregards a signal displaying a Stop aspect or any other restrictive aspect.

The normal daily traffic on this territory includes 12 passenger trains, 6 through freights, and 3 switch locals, each serving a portion of the territory. In addition to these 21 regular trains, extra road trains are operated as required, and numerous switch engine moves are made to serve industries. Freight trains using five diesel units are operated, handling 9,000 tons northbound and 7,500 tons southbound.

How Trains Keep Moving

The sections of second track removed were, in nearly all instances, the previous southward main, so that, at each of the new ends of two-track, the No. 1 track (on the east side) is the "straight track," and the turnout is the No. 2 track,

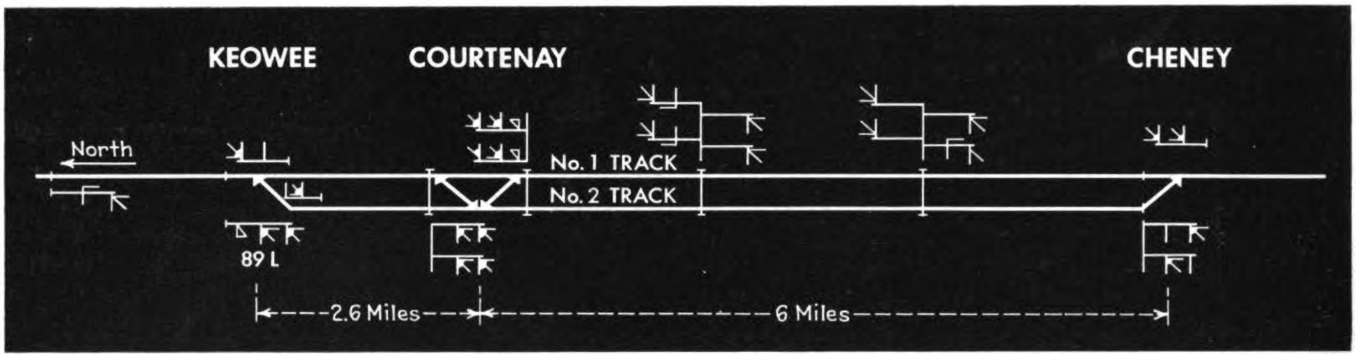


FIG. 3—Plan of tracks, power switches and signals in the Cheney-Keowee area, where trains meet and pass without stopping

which was previously the southward main. Therefore, when only one train is involved, it is routed through on the No. 1 "straight track," thus requiring no speed reduction to make a diverging move. When two trains are involved, in either a meet or a pass, the train being given "preference" is usually routed on the "straight track." Nearly all such meets are made with neither train having to stop.

Different routings may be required when more than two trains are involved. (See Fig. 3.) For example, a northbound freight may be approaching Cheney ahead of northbound passenger train No. 36, which is to meet southbound passenger train at Courtenay or Keowee. The northbound freight is diverted to the other track, No. 2, at Cheney, and keeps moving. The northbound passenger train No. 36 continues on track No. 1 to pass the freight before reaching the crossover at Courtenay, where this passenger is diverted to track No. 2 to run on to Koewee.

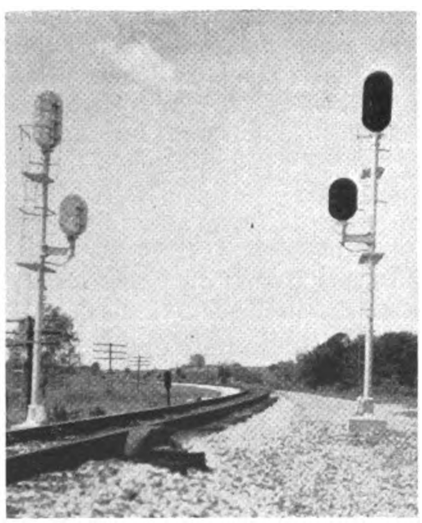
In the meantime, the southbound passenger train is routed past Keowee on "straight" track No. 1, to meet not only the northbound passenger train but also the northbound freight. Thus the combined meet and pass are accomplished. Nine times out of ten, such moves are made with none of the trains being required to stop.

Diverging Moves at 45 mph

An important time saver in this new system is that the turnouts at ends of two-track, and the new crossovers between main tracks are No. 20, with special 39-ft curved switch points, so that trains are authorized to make diverging moves at speeds up to 45 mph. These high-speed turnouts were installed at 24 crossovers and 22 single switches at ends of two-track.

Of corresponding importance is the fact that special signal aspects, and controls, were installed to direct enginemen to bring their trains up to and through these turnouts at 45 mph. When a home signal is cleared for a movement over a diverging route, the indication displayed is "Diverging Route Clear" red over green, and also the signal in approach displays yellow over green staggered, which gives the engineman advance information that a diverging route, good for 45 mph, is lined up for him.

If a home signal is also the approach to another home signal controlling movement over a diverging route, for example signal 89 L at Keowee, a special marker, consisting of a triangular piece of sheet metal, painted yellow, is mounted on the mast. On such a signal the "Limited Clear" aspect, red over green with yellow marker, indicates, in addition, "Approach next signal at limited speed."



Double intermediate signal location

Previously freight trains lost time when waiting on sidings for passenger trains, of the same direction, to pass. Manifest freight No. 154 is scheduled north out of Atlanta a couple of hours ahead of passenger train No. 48. Therefore, this freight had to get in the clear for the passenger train at some hand-throw siding. The dispatcher had limited opportunity to inform the freight crew concerning delays which the passenger may have encountered. Therefore, the freight usually took siding at least 15 minutes before the scheduled arrival of the passenger. If the passenger train was late, this additional time was lost. Some of the sidings were not long enough for the freight trains, and, therefore the pass had to be made by "sawing," which lost 10 to 15 minutes for the passenger as well as 45 minutes to 1 hour for the freight.

Thus in making this pass each night, the freight train No. 154 could lose considerable time as compared with present practice, in which both of these trains continue at normal speed while the passenger runs around the freight. Similar moves are made each day when two southbound passenger trains go around corresponding southbound freight trains. Such moves and savings of time occur at various times each 24-hour period.

Service to Industries Improved

In the 150 miles between Worley, S.C., and Foremost, Ga., there are numerous industries and more are coming. In many instances industries are served by spurs which are connected to the main track by hand-throw switches. Some industries are served by switch engines, others by local freight crews. Previously with the double track, yard

Power turnouts and crossovers are No. 20, good for 45 mph

limits were in effect throughout each of the various industrial areas; a switcher crew could occupy a section of main track, except for the necessity to clear for first-class trains, or flag.

Second and inferior class trains, including some of the important freights, were required to operate through all these yard limit industrial areas at yard speed, prepared to stop within one-half the range of vision.

Therefore, when planning the new track layout, both main tracks were left in place through these industrial switching areas. Now, when an engine is to serve industries, the conductor secures working limits, and the control office sets up controls and blocks levers, which gives the switch crew exclusive use of a section of main track. While this crew is serving the industries connected to that track, the through trains are routed over the other track. Thus two new objectives are attained: (1) The switch crew can proceed efficiently with its work, without flagging, and without interruptions to clear for through trains, and (2) yard limits are eliminated, so that road trains are not required to reduce speed.

On this territory practically all of the track maintenance, such as the removal of ties and rail and tamping ballast, is done by on-track power machines. Previously, with the right-hand running on double track, these power track machines had to be gotten off the track for road trains.

Now on those sections totaling 90 miles where both main tracks are in service, the track machines can work without interruption on a section of main track which may be four to eight miles long, and in the meantime all trains are operated on the second main track.

Why No Sidings are Needed Now

Previously, with double track all the way, trains were operated right-hand running, and the automatic block signaling was arranged accordingly for movements with the current of traffic. Single-direction sidings were connected to each main track, nine such sidings on the southbound and eight on the northbound. Hand-throw switch stands were in service at these switches, with mechanical switchman at the leaving ends, so that trains could depart without stopping.

In the new track arrangement with the CTC system, all passes as well as meets are made on main tracks, with very few stops. Therefore, there was no further need for the previous sidings, which were removed, a total of 18 miles of siding track, and 34 No. 10 main track switches and turnouts being included.

In the previous double track, No. 10 crossovers were located at numerous towns and other places where they might be required in emergencies or for use by local freights, to go from one main track to the other when servicing industries. There were a total of 52 such crossovers in the previous double track arrangement on the 148 miles between Greenville and Foremost; 32 of these crossovers were removed as part of the change over.

Code Cable Buried for 150 Miles

The previous automatic signaling on this territory was the straight a.c. type. This system was installed in 1917 and 1918, when commercial a.c. was available at only a few widely separated cities, and therefore, the system included a 4,400-volt three-phase power distribution circuit on a signal department pole line.

Commercial a.c. electric power is now available at numerous places all along the railroad. Therefore, there is no further need for the 4,400-volt three-phase power distribution line. Furthermore, the new signaling utilizes the Trakode system, so that no local line wires are required for signal controls. This left only the two wires for the line coding circuit. Thus the problem was to provide for this code line circuit, so that the signal pole line could be retired and removed.

One thought was that perhaps this code line circuit could be on line wires to be added to the existing communications pole line along this railroad. An answer to that, perhaps, in the course of a relatively few years, radio and microwave will be applied to the extent that this communications pole line may be removed. A conclusion, therefore, was that a two-wire buried cable should be installed throughout the 150 miles to handle the CTC code line circuit.

This cable includes two No. 10 solid copper wires, with insulation and outer covering specially designed for this project. This cable made in lengths of 5,000 ft, each such length being on one reel. In the field, each reel was handled on a cable trailer, pulled by a crawler type tractor. By this means the cable was laid in the bottom of the trench as it was dug by the power trencher machine. In sections where rock was encountered, several inches of soft dirt was placed under and over the cable.

At the end of each 5,000-ft length of cable, the connection to the next 5,000-ft length is made in a junction box which is installed on a concrete post about 3 ft above ground level. In each junction box the metal tape on the cable from one direction, i.e., south, is connected through a Raco gap type lightning arrester to ground. The metallic tape on the other leg of the cable is directly grounded. Thus only one end of each 5,000 ft is so connected. The reason for not directly grounding both legs of the metallic tape is to prevent possible trouble by earth currents accumulating on the shielding tape and being passed on to the next section.

At the crossing of rivers, the CTC code line is on open wires on a pole line, this construction being used rather than conduit on a bridge because of less likelihood of broken wires due to vibration.

Throughout this project, a.c. commercial power is now purchased at many places, especially at all the power switch layouts at ends of two-track sections and at power crossovers. If a.c. commercial power is not available at intermediate signals or other places where needed, a 220-volt or 440-volt circuit was installed. This power circuit is on two No. 10 solid copper wires in a two-conductor buried cable of conventional power cable construction. This cable, on those sections where required, is buried in the same trench with the CTC code cable.

Trench for 148 miles of CTC code line cable was dug with a power ditcher

Power Trench Machines

The trenches for the buried cable were dug about 6 in. wide and 30 in. deep along the right of way on one side of the track. Two crawler-mounted Cleveland power trench machines were used. One machine would be used on a typical section of 6 to 8 miles, while the other was used on the next section of 6 to 8 miles. In good digging, a machine would dig an average of 52 ft of trench in 5 minutes. As much as 6,300 ft of trench was dug in a day by one machine. Overall production was one-quarter mile per day for each of the two machines. To get the ditcher machines across bridges they were operated on the ties. The Southern Railway purchased these machines for this project. They more than paid for themselves and are still in service.

In the new track arrangement there are 20 hand-throw crossovers between main tracks, which are now equipped with electric locks, and also there are 129 hand-throw main track switches, leading to spurs or secondary tracks, which are equipped with electric locks.

At these electric lock locations a new type of high-frequency overlay track circuits are used for the automatic release of the lock when a train on the main track is to use the switch. The advantage of the over-lay track circuit is that no insulated rail joints are needed to isolate this track circuit and, furthermore, the conventional coded track circuit feeds on through without interruption.

If a train has cleared the main and is ready to enter the main via a hand-throw switch, the conductor secures permission from the control office. If granted, he unlocks the padlock, opens the door and waits for the time release to run down.

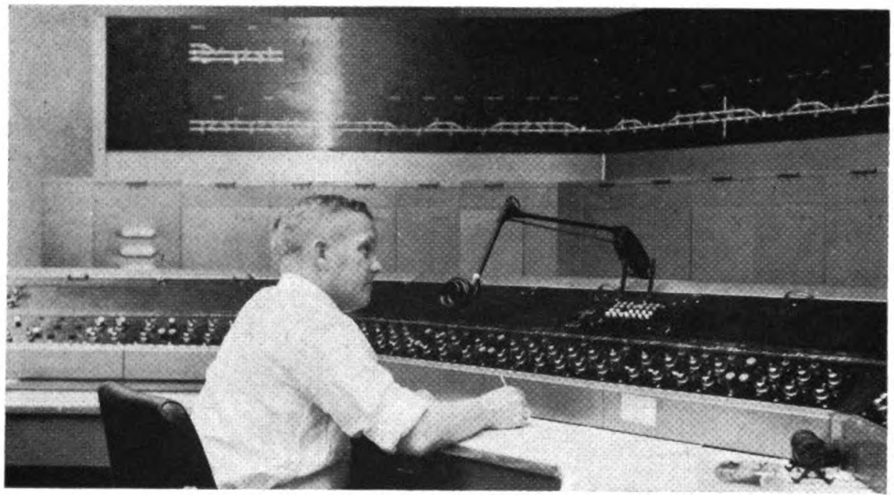
Dragging-equipment detectors, of the self-restoring type are in service on both main tracks at three locations on the territory; at M.P. 511 near Central; M.P. 517 near Courtenay; and at M.P. 557 near Mt. Airy. On the signals approximately 2.5 to 3 miles beyond these detectors there is a set of two red lamp units in a vertical row, mounted below the regular signal units. In all instances these special red units are more than maximum train length beyond its corresponding detector. When dragging equipment on any car on a train operates a detector, the special red lamps on the signal ahead of the train are flashed alternately about 30 times per minute. An approach signal indication is given in advance of the flashing red lights.

As part of the project a one-story brick and concrete building, 30 ft by 50 ft,was constructed at Greenville to house the offices for the chief dispatcher and the dispatcher where the CTC control machine is located, as well as a room for the signaling equipment. This building has no windows but is completely air conditioned. It has a system of automatic fire detectors and C-O-Two fire extinguishers. Predetector units are located in the equipment room as well as inside of the control machine and relay cabinets at the control office.

Compact Control Machine

On conventional CTC machines an illuminated track diagram extends across the top, the switch and signal levels for each power switch layout being mounted on the panel below the symbol for the corresponding switch. Thus, on such conventional machines the requirement for the diagram has been the controlling factor in determining the length of the control machine.

In contrast, the control machine for this new Southern project is of a special type designed to be compact and therefore easy to manipulate. The illuminated track diagram is a separate large-sized panel, mounted at a level of 8 ft above



Code start button is in face of signal lever (bottom row, switch levers above)

floor line, and at an average of about 5 ft from the dispatcher when seated in his chair. Each section of this diagram is 12 in. high. The center section is about 9 ft long and the side wing panels each about 5 ft long, thus totaling about 19 ft.

The panels are black, each track being represented by a white line ¼ in. wide. The turnouts of single switches and crossovers are represented by small movable sections of metal, so that the route lined is indicated by a continuous white line ¼ in. wide. Mounted in the lines representing tracks are small lamps, which are lighted when corresponding sections of main tracks are occupied. Each signal is represented by a symbol which includes a lamp that is lighted green when the corresponding signal is displaying any proceed aspect.

At the symbol for the point of each power switch, there is an opal lamp which is lighted while the corresponding switch is in transit or at any time when the switch is not in the position to correspond with its lever.

Having thus provided a large scale diagram with the indications, all that was left for the actual control machine was the levers. The levers are at 2½-in. centers, horizontally, on a panel 7 in. high, mounted at a sloping angle on the dispatcher's desk. The switch lever for each layout is above the signal lever. With these vertical rows 2½ in. apart horizontally, the levers for switches and signals for the 24 power crossovers and 24 power single switches require 10 ft total length. This total is divided into a center panel and two wings set at an angle. Automatic train graphs are countersunk in the top of the desk. These arrangements provide maximum ease and comfort for the train dispatcher.

Code Start in Signal Lever

For each field location, such as a power switch, the switch lever is just above the signal lever. A small red lamp in the face of each switch lever is lighted when electric locking is in effect to prevent operation of the switch even if the lever were thrown. After positioning the switch lever and the signal lever, the line code is sent by pushing the button in the face of the signal lever. Thus space is saved by this idea of mounting the button in the signal lever rather than separately on the panel.

These factors are an aid in reducing the vertical dimension of the control panel to about 8 in. Thus this machine is designed so that one panel could be placed above the one now in use. Also, there is space on the large board for a second row of illuminated track diagram all the way across.

This installation includes important modern electronic equipment known as Syncroscan, by means of which conditions at field location, such as position of each switch, aspect of each signal, and occupancy of every track section, are "scanned" every 8 seconds, and the corresponding indication lamps on the track diagram are checked accordingly. This automatic system of continuous scanning of field conditions is very fast, at a rate of 100 indications per second, so that manipulation of the machine is never slowed down to wait for incoming indication codes. Controls and indications are transmitted automatically and simultaneously.

New Power Supply

The batteries are the nickel-iron type made by Thomas A. Edison Industries. Power switches are operated by A4H 150-a.h. batteries. Local circuits and standby power for signal lamps are fed from A6H 225-a.h. batteries. Track circuits are fed by A4H 150-a.h. cells, one cell for short circuits and two cells in series for long circuits up to 9,000 ft. At electric lock locations the overlay track circuits are fed by 4 cells of 1000-a.h. Carbonaire type primary battery, made by Edison.

At the Greenville control office, standby a.c. power at 120 volts is provided by an Onan gasoline engine-driven a.c. machine, the output being rated at 3.5 kw. If the commercial a.c. fails, this engine is started automatically, and takes over the load in less than 30 seconds.

The signal equipment on this new installation is operated on direct current energy from storage batteries, which are on floating charge through rectifiers. The a.c. is purchased from commercial sources at numerous locations, as explained previously.

Highway Trucks for Maintainers

On this CTC installation, each maintainer is furnished a "pick-up" type highway truck, by means of which he covers his territory. Each truck is equipped with large lockers for tools and extra parts. Previously, with the double-track layout equipped with automatic block, each maintainer used a track motor car.

This new single-track, two-track arrangement was conceived and handled by the operating department of Southern. The rail, as well as most of the ties and ballast, were reused elsewhere, which eventually provided rail for a new classification yard at Atlanta. The new centralized traffic control was planned by the Southern's signal department. The General Railway Signal Company furnished the signaling equipment.