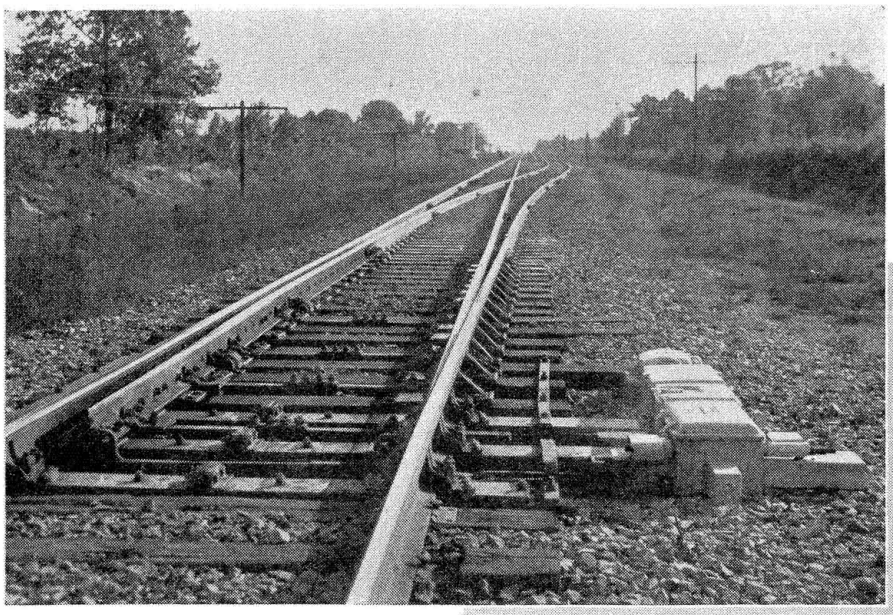
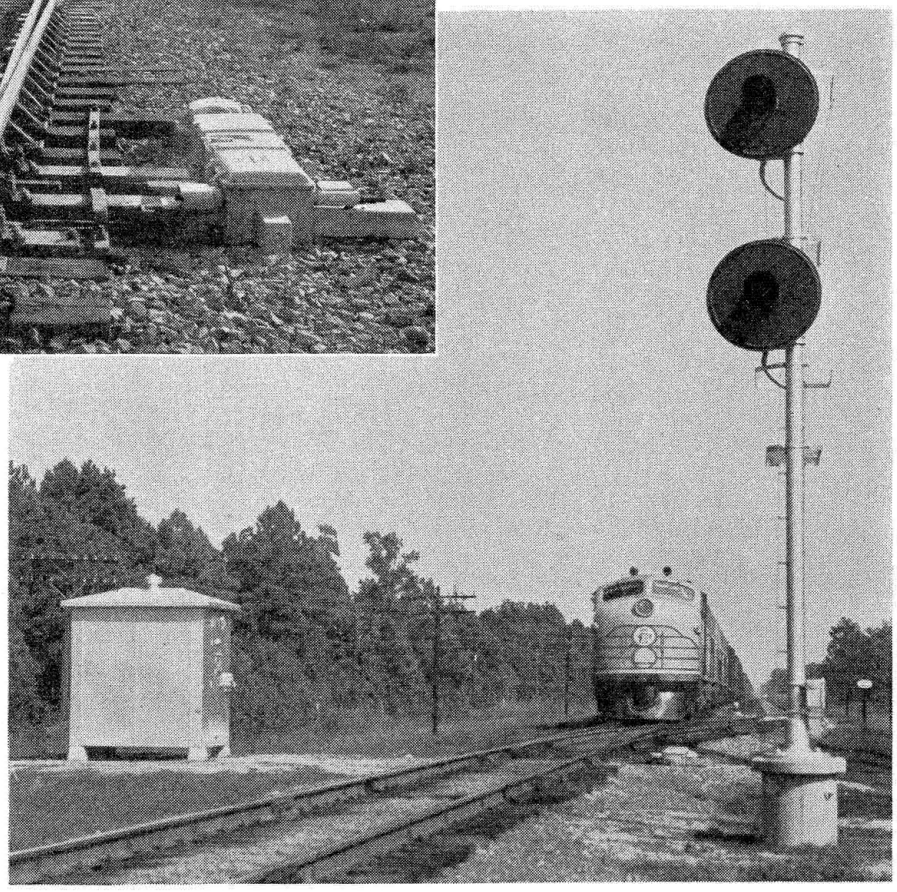
C.T.C. on





Above—The power switch layouts include adjustable rail braces and insulated plates Right—The signals at the south end of typical siding

THE ST. LOUIS Southwestern has recently completed the installation of centralized traffic control on 121 miles of single track between Pine Bluff, Ark., and Lewisville, this being a bottleneck section, with a further handicap of numerous curves and several grades.

On the north end, the St.L.S.W. has its main line from East St. Louis south to Pine Bluff, in addition to branch lines connecting to Wyatt, Mo., Caruthersville, Mo., Blytheville, Ark., Memphis, Tenn., Gillett, Ark., and Little Rock, Ark. Traffic to and from all these main lines and branches is concentrated at Pine Bluff.

A Bottleneck Section

Similarly at the south end, the main line extends through Texarkana, Ark., Tyler, Tex., and Waco, while other main lines branch off from Lewisville to Shreveport, La., from Mount Pleasant, Tex., to Dallas and Ft. Worth, and from Tyler to Lufkin. Thus the 121 miles between Pine Bluff and Lewisville is somewhat of a bottleneck from both directions. Furthermore, in this territory the railroad crosses four major rivers and passes through hilly country with several stiff grades and numerous curves, all of which tend to increase the number of trains as well as the time on the road.

Pine Bluff is on the south bank of the Arkansas river at an elevation of 212 ft. above sea level. The bridge over the Saline river, 28 miles south of Pine Bluff, is at an elevation of 150 ft., and the bridge over the Ouachita river, at Camden, 69 miles south of Pine Bluff, is at an elevation of 121 ft. At Lewisville, which is 6 miles north of the bridge over the Red river, the elevation is 265 ft. Between the four rivers, the railroad crosses rolling hilly country with considerable rise and fall, reaching elevations up to 348 ft. at various places. The grades range up to a maximum of about 1.0 per

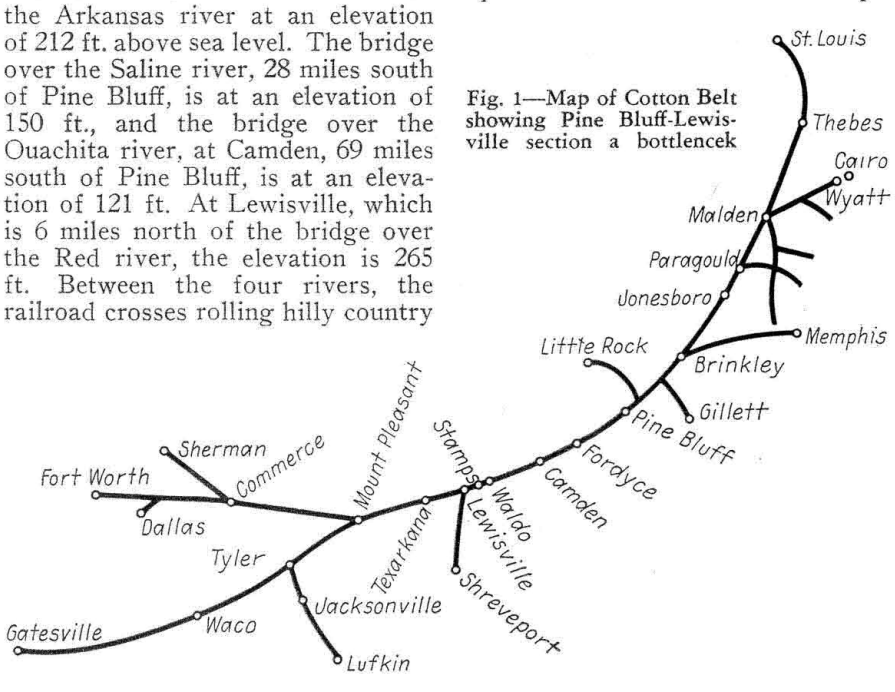


Fig. 1—Map of Cotton Belt showing Pine Bluff-Lewisville section a bottlencek

121 Miles of the Cotton Belt

Project between Pine Bluff, Ark., and Lewisville, facilitates trains on single track where grades and curves did cause delays

cent but the grades at this maximum are not long, ranging to about 1.5 miles at the most. The maximum grade southbound is 1.17 per cent. The maximum grade northbound is 1.14 per cent. The ruling grade is one per cent.

The Class 800 locomotives, which are used on most of the through freight trains, are rated at 2,900 tons southbound and 3,300 northbound between Texarkana and Fordyce, and 3,300 between Fordyce and Pine Bluff.

On some sections the curvature is light but on some sections through the hills, the curves are numerous and range up to 4 deg.; for example, in the 4 miles just north of McNeil there are seven curves, three of which are about 2 deg., one 3 deg. 10 min., one 3 deg. 55 min., and two 4 deg. In the five miles north of Stephens there are 10 curves ranging up to 4 deg. In the 2 miles north of Buena Vista there are nine curves ranging up to 4 deg. On two curves the speed of freight trains is limited to 25 m.p.h., on two curves to 35 m.p.h., and on one curve to 40 m.p.h., elsewhere the limit is 50 m.p.h. Within the station limits at Camden there is one 5-deg. curve and a 6-deg. curve but speed limits are in effect here because of the station, street crossings and water station. The track is in good operating condition with 112-lb. rail in service on the greater part of the division.

For many years the Cotton Belt has had an enviable reputation for fast freight service. The Blue Streak is a fast freight train, leaving St. Louis each evening with deliveries in Little Rock, Memphis and Pine Bluff the next morning, as well as in Fordyce, Camden, Texarkana and Shreveport, by noon or late afternoon the next day, and various points in Texas, including Dallas and Fort Worth, the second morning. More extensive fast freight service is planned for the post-war period.

The "Morning Star" passenger train is operated daily between St. Louis-Memphis on the north and points in Arkansas and Texas on the south end. The "Lone Star" passenger train is operated each direction daily between Memphis, Tenn., and points in Texas, by way of Pine Bluff and Lewisville. Quite likely new equipment and faster schedules will be arranged for these as well as perhaps additional trains in the near future. The first objective of installing the centralized traffic control was to improve safety and reduce delays to war-time freight traffic on the Pine Bluff-Lewisville section, but this new signaling will continue as a benefit in the improvement of train schedules and performance in the post-war period.

Previously the train movements on this division were authorized by timetable and train orders, no auto-

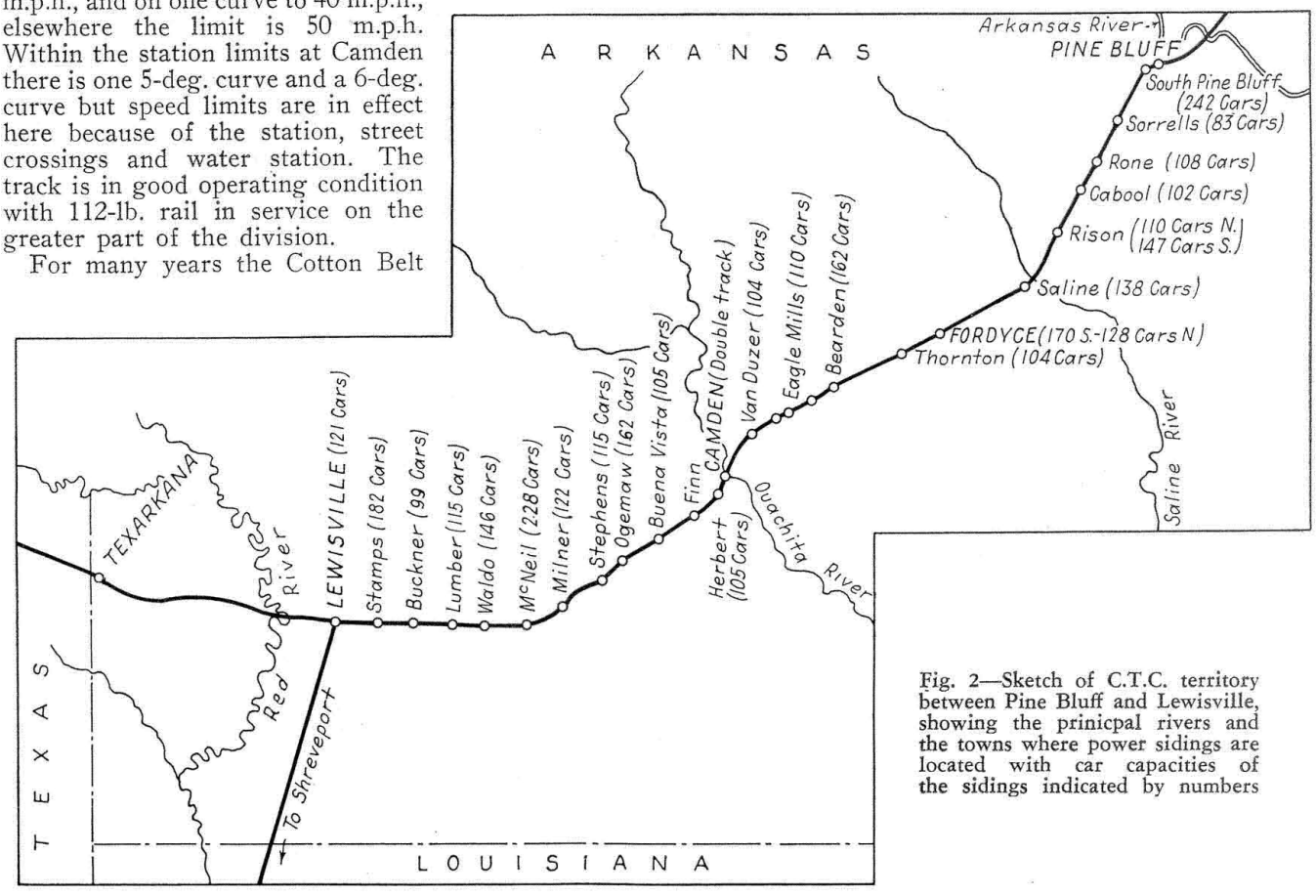


Fig. 2—Sketch of C.T.C. territory between Pine Bluff and Lewisville, showing the prinicpal rivers and the towns where power sidings are located with car capacities of the sidings indicated by numbers

matic block signaling being in service, and the switches at sidings were operated by hand-throw stands. As the volume of traffic increased during 1942 and the early part of 1943, the number of trains increased to as many as 40 per day, with a maximum of about 45. With this many trains, the train order system proved to be entirely inadequate, many of the trains encountering excessive delays to the extent that the congestion on this division was a drag on the operations of the through routes on the remainder of the railroad. A decision was made, therefore, to install centralized traffic control on the entire 121 miles of single track between Pine Bluff and Lewisville.

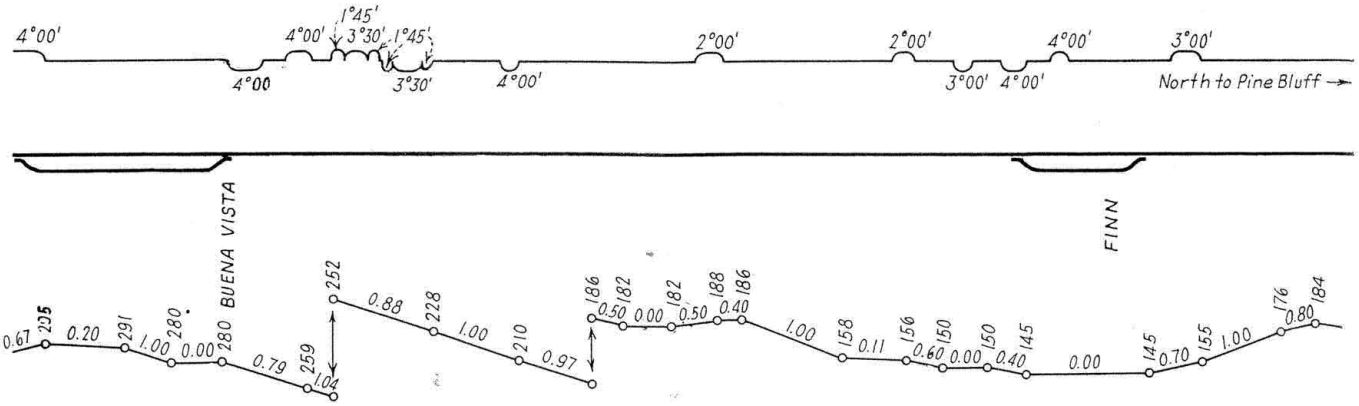
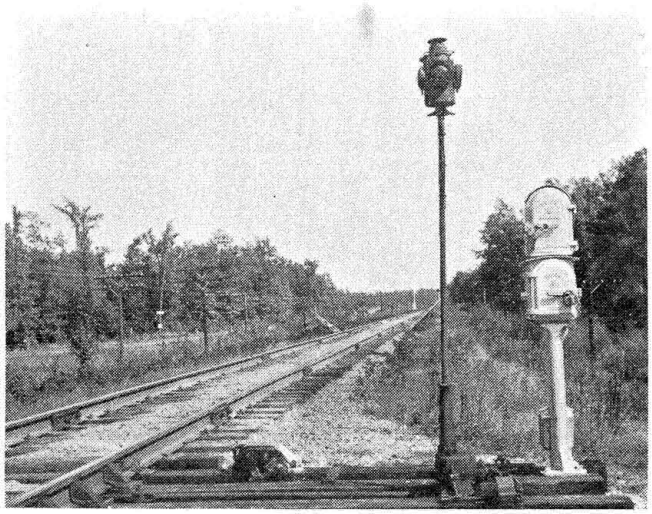


Fig. 3—Profile diagram showing heavy grades and curavature between Buena Vista and Finn, 5 miles

Layouts of Sidings

At Camden, the train speeds are restricted to 15 m.p.h. on account of street crossings and station layouts, and also most of the trains stop here for water. In order to prevent delays here, the former siding, 2.7 miles long, was converted to a northward main track signaled for one direction, while the former main track is signaled for both directions. The remainder of the 121 miles between Pine Bluff and Lewisville is single track, and equipped with C.T.C. for operation of trains by signal indication.

During the past few years, certain sidings had been lengthened, so that five sidings now have capacities ranging from 70 to 84 cars, two sidings range from 90 to 99 cars, seven sidings from 102 to 115 cars, and other longer ones at 145, 147, 166 and 228 cars. In addition, at Stamps and at Ogemaw, special sidings hold up to 194 cars. At Rison there are two sidings arranged as a lap, in which one siding holds 110 cars and the other 147 cars. At the north end of Fordyce a single-track Rock Island main track crosses the Cotton Belt, this crossing being protected by a mechanical interlocking which also includes the north switch of the east siding which will hold 172 cars. The locations and capacities of the sidings are indicated on the map in Fig. 2. The centralized traffic control project included the installation of electric switch machines for the operation of the switches at 18 sidings, in addition to the ends of double track switches at both ends of Camden and the south end of the



Each hand-throw main track switch is equipped with an electric lock and a telephone connected to the dispatcher's line

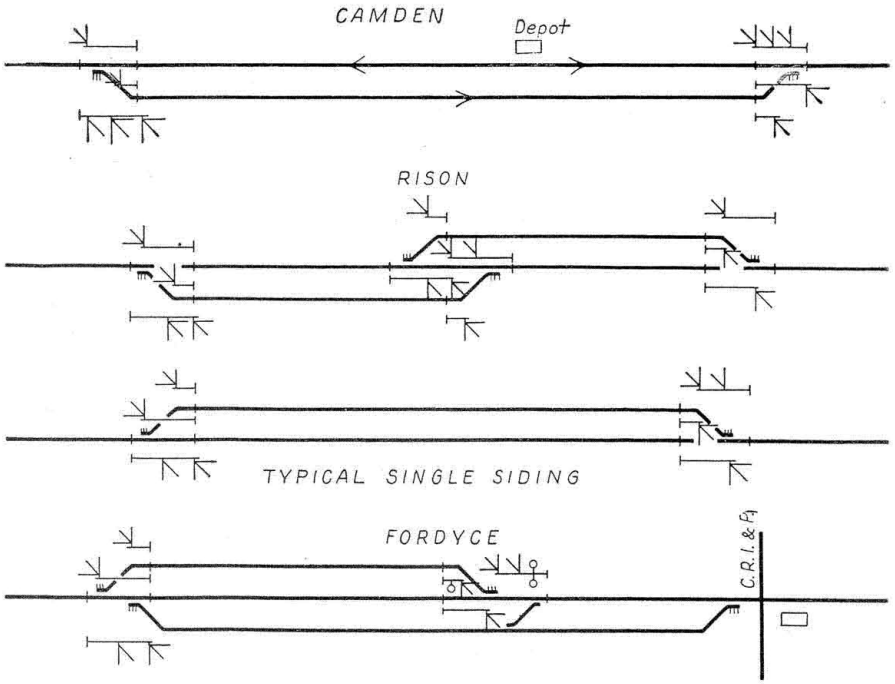


Fig. 4—Track and signal layouts at a typical siding and at Camden, Rison, Fordyce

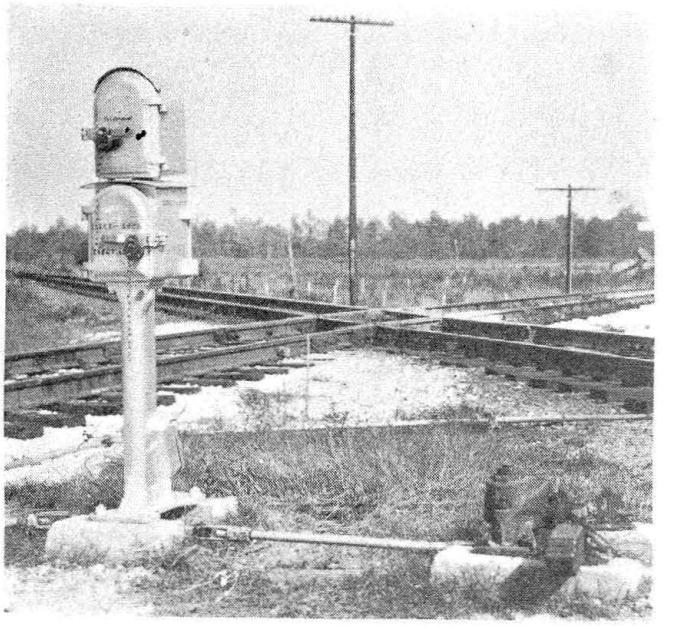
east siding at Fordyce, the south end of Pine Bluff and the north end of Lewisville, thus totaling 40 power switch layouts, each of which includes the standard arrangement of semi-automatic C.T.C. controlled signals for directing train movements by signal indication.

Previously when using hand-throw switch stands, some of the sidings could not be used by heavy trains because the grades are such that if a train stopped for the brakeman to throw a switch, the train could not be started again on the grade. At other locations the grades were adverse for a train to get started if it stopped to let the brakeman close the switch after the train was out on the main track. With power switch machines, these train stops are avoided, thus increasing flexibility and reducing train delays, because more sidings are now available for use by heavy trains.

At certain main track hand-throw switches leading to industry spurs or short sidings not used for passing through trains, electric locks were applied to the previously existing hand-throw stands. A total of 52 switches are so equipped, and these locks can be released under the control of the dispatcher in charge of the C.T.C. control machine.

Protection at L.&A. Crossing

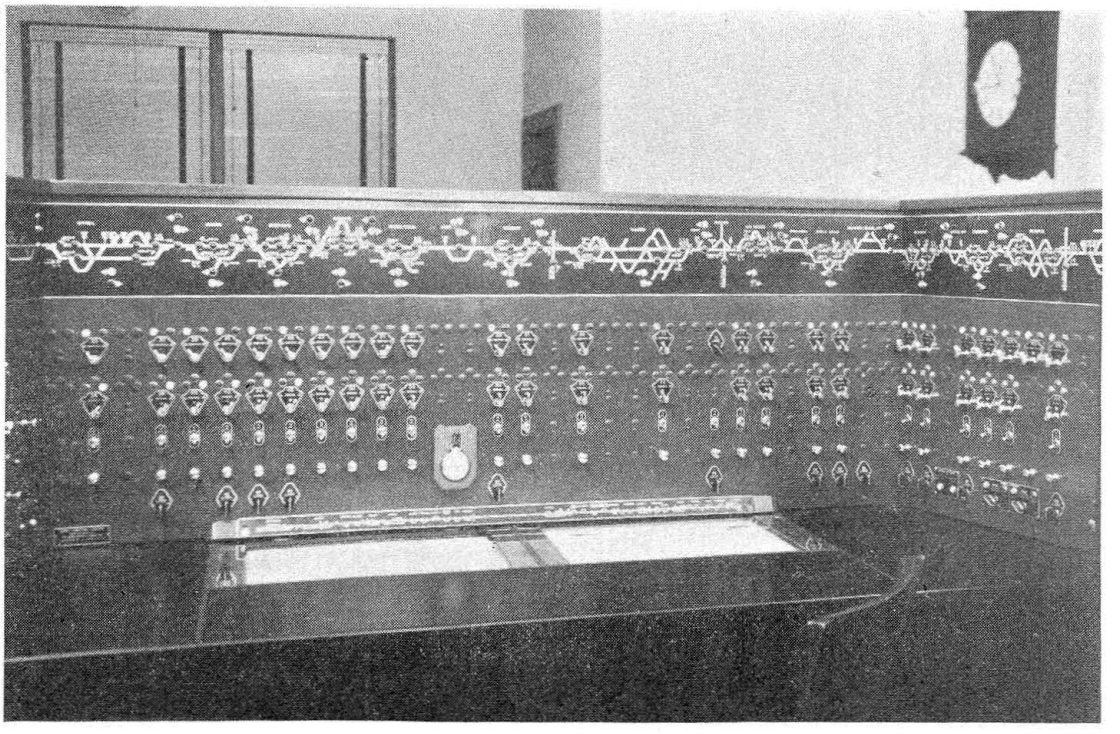
At Stamps, a single-track main line of the Louisiana & Arkansas crosses the Cotton Belt main track and siding. As a part of the new program, an automatic interlocking was installed to protect this crossing. Normally the signals are set to display the Stop aspect on both roads. For example, if a train approaches on the L.&A., the signals on the St.L.S.W. are locked at Stop, and the signal for the L.&A. train is cleared.



Railroad crossing at Warner is protected by derails on the Rock Island which are operated by a stand at the crossing which has an electric lock

At Warner, Ark., about 4 miles north of Camden, the Rock Island installed a spur track which crosses the St.L.S.W. to serve a Navy Ordnance Plant. As protection for this crossing, interlocking home signals were installed on the St.L.S.W. with Hayes derails on the Rock Island which are pipe-connected to a switch stand at the crossing. The operation of this stand is controlled by an electric lock which is under the control of the dispatcher in charge of the C.T.C. machine, as well as being controlled locally by track occupancy of certain track circuit limits and approach sections.

When a Rock Island switch engine is ready to move over the crossing, the conductor uses the telephone to inform the St.L.S.W. dispatcher. Then if the dispatcher is ready for the move to be made, he sends out a release control, and this unlocks the lock if no train on the St.L.S.W. is occupying the home signal limits or an approach section. When the lock is released, the conductor can operate the crank to pull the plunger out of the rod, so that he can then operate the stand to throw the derails



One control machine at Pine Bluff handles the entire 121 miles using carrier current equipment to form the three separate sections

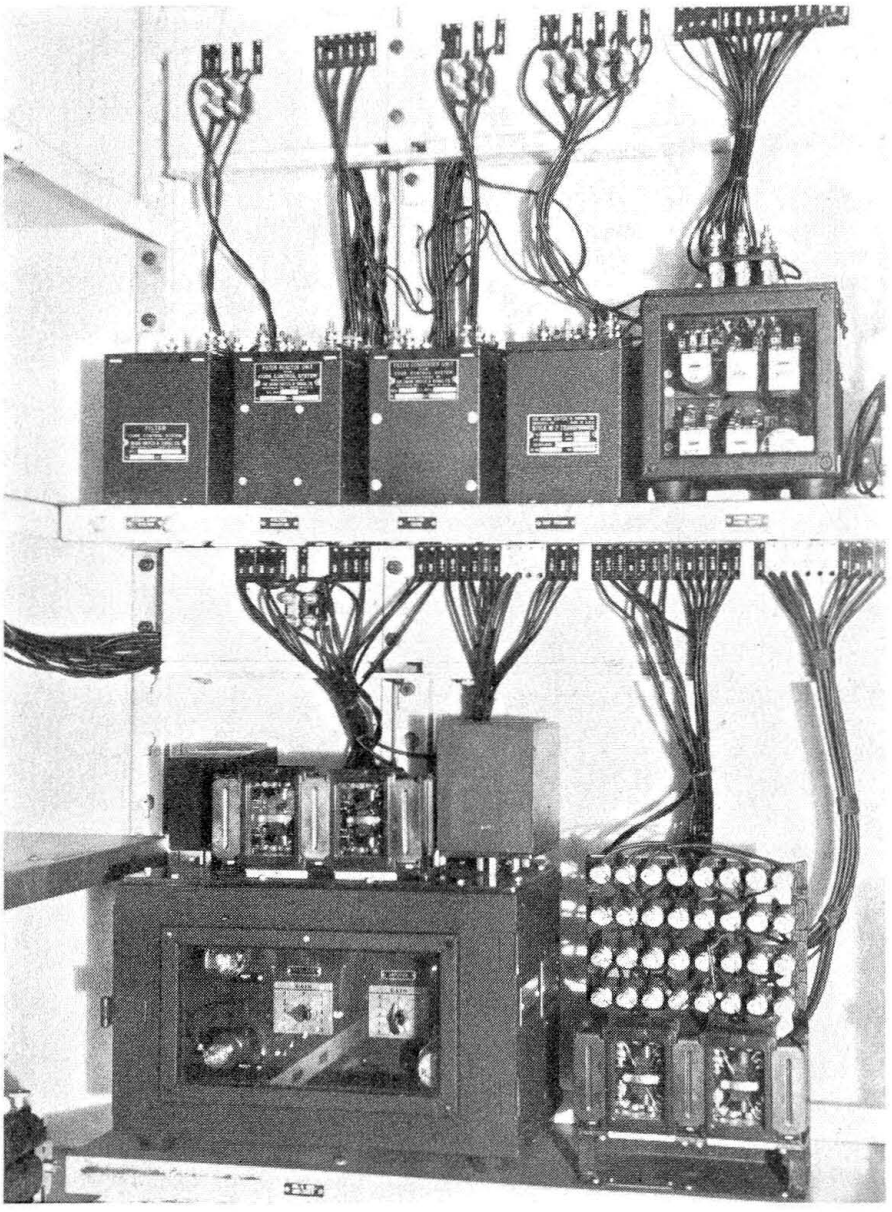
off the track. Also when the lock is released, the home signals on the St.L.S.W. are set at the Stop aspect, and remain at this aspect until the Rock Island train has moved over the interlocking limits and the derails are placed normal and the lock is restored to normal.

Co-operative Control at Fordyce

At the crossing of the Rock Island and the St.L.S.W. at Fordyce, the mechanical interlocking was continued in service. This plant includes the north switch of the east siding. When the dispatcher in charge of the C.T.C. machine at Pine Bluff wants the leverman at Fordyce to line up for a train, a C.T.C. control code is sent out just the same as if the dispatcher were controlling the switches and signals, but at Fordyce the result is that certain numbered indicator lamps on the leverman's desk are lighted. Based on this information, the leverman throws the levers in his mechanical interlocking machine, then indications of the position of the switches and aspects of signals are sent in by C.T.C. code to the machine at Pine Bluff. Thus the results are accomplished over the C.T.C. code line circuit without the necessity for telephone conversation.

The C.T.C. Control Machine

The C.T.C. control machine for the entire 121 miles is located in the dispatcher's office at Pine Bluff, which is also the headquarters of the division superintendent. None of the available offices were of fireproof construction, and, therefore, a new one-story brick office building was constructed to house the telegraph office and dispatcher's office, in which the C.T.C. control machine is located.



Carrier equipment in sheet-metal house at south end of Stephens

As shown in one of the pictures, the panels of the machine are arranged in a "U" shape so that the dispatcher can reach any lever without leaving his chair. The illuminated diagram includes lamps which repeat track occupancy of each section of main track between sidings, each section of main track opposite a siding, each detector section at a power switch layout, and each siding, this latter feature requiring the installation of track circuits on sidings which are used also in the control of take-siding signal aspects.

Another feature of this machine is the provision of small arrows and lamps above the diagram which are lighted to show the direction of traffic between sidings, and similar arrows and lamps below the diagram indicate the direction of traffic on the sections of track opposite the siding (on the siding). These traffic direction indicators are a time saver for the dispatcher in the operation of the machine. The top row of levers control the power switches, and the next row control the signals at the switches for authorizing train movements. Toggle levers under the signal levers are for control of maintainers' call lamps at the instrument houses near each of the power switches. At the bottom of the panel there are several push-to-turn buttons which are for the control of the electric locks on the hand-throw main track switches.

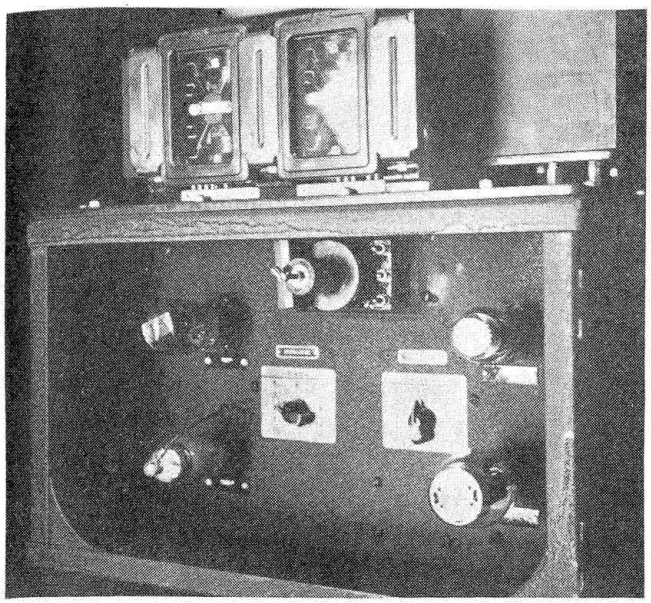
In the top of the desk portion of the machine there is an automatic train graph which has pens that indicate when trains pass through each of the OS sections at the 40 power switch locations. The dispatcher draws in connecting lines which complete a graphic record of trains.

Carrier Saves Line Wires

One of the interesting features of this project is the use of carriers on the C.T.C. code line circuit, by means of which it is possible to use one control machine for the entire division, and to locate this machine at division headquarters in Pine Bluff, which is the extreme north end of the division between Pine Bluff and Texarkana.

The C.T.C. line code system handles codes from the control machine to the various field stations to control the switches and signals, and codes are returned to the office to indicate the positions of switches, the aspects displayed by signals and the occupancy of track sections by trains.

With ordinary d-c. code impulses, only a limited number of field stations can be handled on one line circuit because the coding might be delayed too much during heavy traffic.



Carrier equipment in office at Pine Bluff, with door removed to show electronic apparatus

On this project the C.T.C. line codes are handled on two line wires which extend from Pine Bluff to Lewisville. This territory as a whole, however, is cut into three separate line coding territories which all operate over these same two line wires. On the first section of 40 miles between Pine Bluff and Fordyce, the outgoing and incoming codes are ordinary d-c. impulses. In this 40 miles the line wires also "carry" 13 k.c. outgoing impulses which at S. Fordyce are converted to conventional d-c. impulses to go on out to the field stations between S. Fordyce and S. Stephens to control the switches and signals. Also the indications from these field stations come on by d-c. impulses to S. Fordyce where they are converted to 19 k.c. impulses which are "carried" over the two wires to the office at Pine Bluff. Similarly 11 k.c. impulses go out from Pine Bluff to S. Stephens for controls on the S. Stephens to Lewisville section and 17 k.c. impulses are returned from S. Stephens to Pine Bluff. The high-frequency carrier current does not interfere with the conventional d-c. impulses, and, therefore, the one two-wire line wire circuit serves for three separate sections so that controls can go out to or indications can be received from any one or all three sections.

Telephone communication is superimposed on the code line, with telephones located at each power switch location, and at each electric switch lock.

The signals on this installation are the searchlight type. The signals are located in the conventional arrangement for centralized traffic control as shown in the typical drawing herewith. Each signal is located at the immediate right of the track governed, which, at one end of each siding, necessitated that the siding be thrown over to 19-ft. 6-in. centers to locate the main track station leaving signal at the right of this track.

Each station-entering signal has two operative searchlight heads, and the track circuits on the sidings enter into the control of these signals. When the power switch is reversed for a train to enter a siding which is not occupied, the signal can be cleared to display an aspect of red-over-yellow. If the siding is occupied by a train of the opposing direction, the signal cannot be controlled to display an aspect to enter.

The turnouts at the south end of Fordyce, South Pine Bluff, North Saline, South Saline, and at North Ogemaw are No. 16, good for diverging train movements at 20 m.p.h. At the remainder of the power switch layouts at sidings, the old No. 10 turnouts good for 10 m.p.h. are still in service and cannot be replaced until new steel is available.

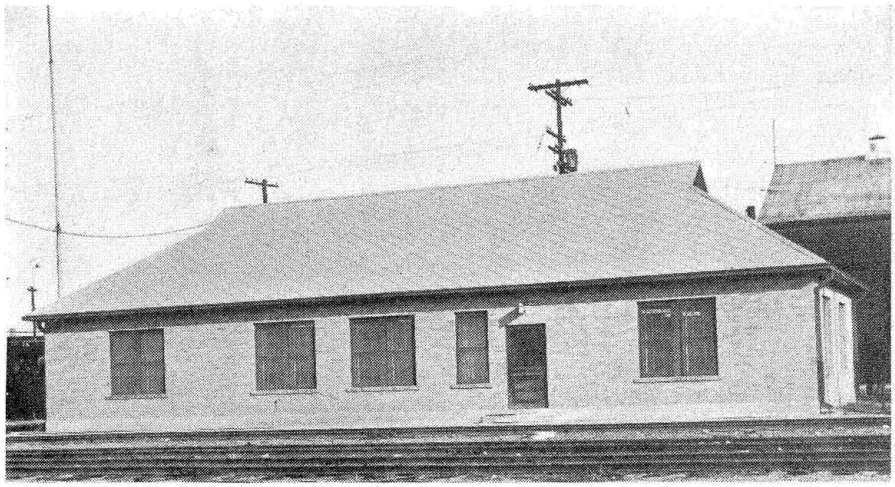
Track Circuits on Sidings

Track circuits were installed on the sidings not only to control the signals for directing trains to enter but also these track circuits control track occupancy indication lamps on the control machine so that the dispatcher is informed of the location of trains when on sidings. In order to control both of the signals for entering without requiring line wires, the CTC machine at Pine Bluff is wired to handle this feature. The passing track rule 105 is still in effect. All track circuits on this project are the conventional d-c. type using 4-ohm d-c. neutral Type DN-11 relays, and the length of these track circuits range up to a maximum of 5,000 ft.

Signal Line Control Circuits

The A.P.B. line circuits for the automatic controls of signals between sidings are of the type in which only two wires are used, these wires being for the control of southward signals when the C.T.C. is lined up for southbound trains, or these same wires control northward signals when the line up is for northbound trains. This circuit was explained in detail on page 462 of *Railway Signaling* for August, 1942.

At an intermediate signal, for example, this line circuit connects directly to the 250-ohm operating coil of the searchlight signal, thus avoiding the need for a line relay. These



New one-story brick building at Pine Bluff includes dispatcher's office

coils are protected by Western Railroad Supply Co. type 22A arresters between the signal and the line wire taps.

Control of Electric Locks

The electric locks on hand-throw main track switches are controlled by special push-to-turn levers at the bottom of the panel on the dispatcher's C.T.C. control machine. If a local freight train, for example, is on the house track at Finn and is ready to leave, the conductor uses a telephone at the switch to talk with the dispatcher. If the dispatcher is ready for the train to depart, he operates the proper lock lever which causes a line code control to go to the south end of Herbert which is the nearest field station north of Finn. From this field station, energy goes out on a two-wire line circuit 60WLSPI to Finn, as shown on Fig. 5.

Also as a result of the operation of the lock lever, signal controls go to the field stations at signal 3430 south so that energy from this point southward on the two-wire signal line control circuit 3431G4 and N3431G3 to Finn to energize relay 60SAR. Also energy is fed northward from Buena Vista on the two-wire signal line circuit 3431G8 and N3431G7 to Finn to energize relay 60NAR. One or the other of the two relays 60SNR or 60NAR will not pick up if there is a train on the main track between Buena Vista and Herbert, also the station leaving signals must be at Stop.

When the conductor at the switch opens switch lock door, relay 60WLPBR is energized, which closes a contact to complete the line circuit to pick up relay 60WLSPR. With relays 60WLSPR, 60NAR and 60SAR picked up and the door contact closed, the circuit is complete to energize the electric lock 60WL at the north switch at Finn as well as the electric lock 60AWL at the south switch, provided the switch lock door is open. Then the conductor can operate the crank to pull the plunger out of the lock rod so that he can throw the switch for the train to pull out on the main track.

When a train on the main track is to enter the house track at Finn, the dispatcher throws the switch lock lever which sends a line code to the field station which places energy on the line wire circuit 60WLSP1 and N60WLSP. Then when the train arrives at Finn, it shunts track circuit 3448T which releases track relay 3448TPR. A contact in this relay completes the circuit to energize relay 60WLSPR. This closes a contact to energize time-element relay 60WLTER and a front contact in this relay completes a circuit through

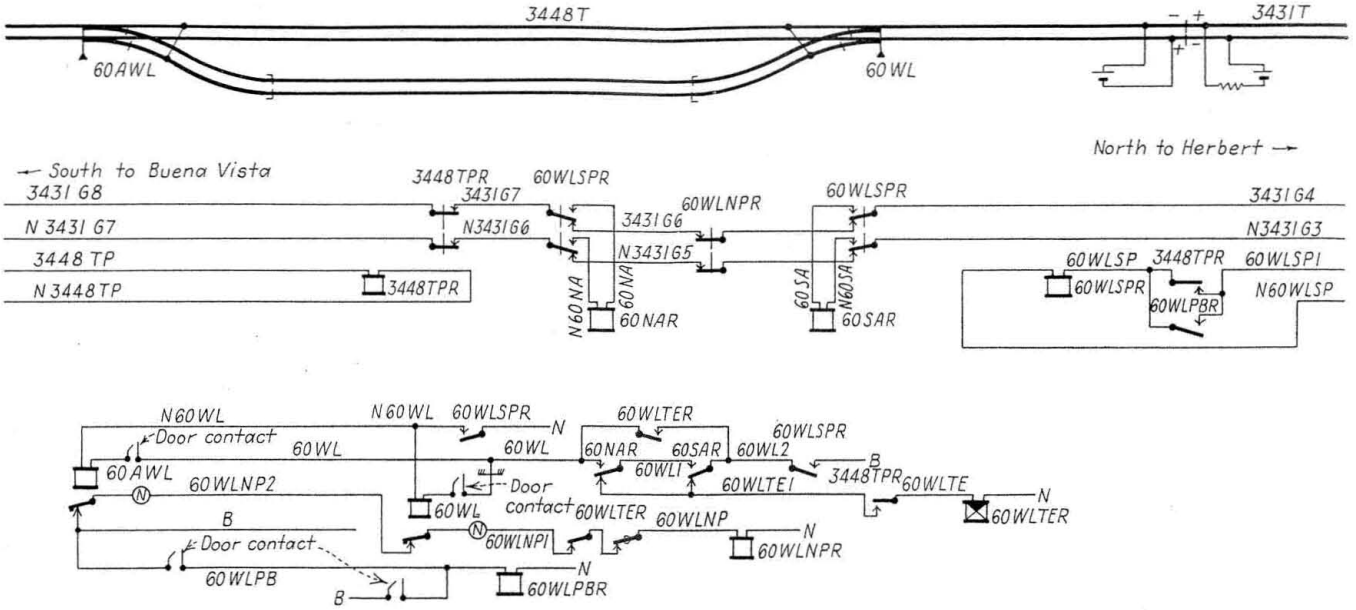
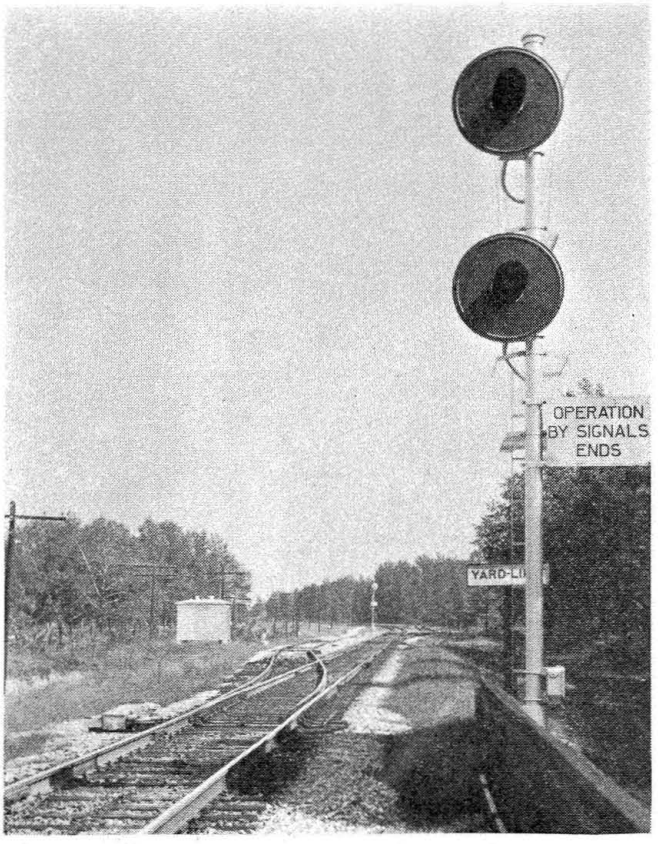
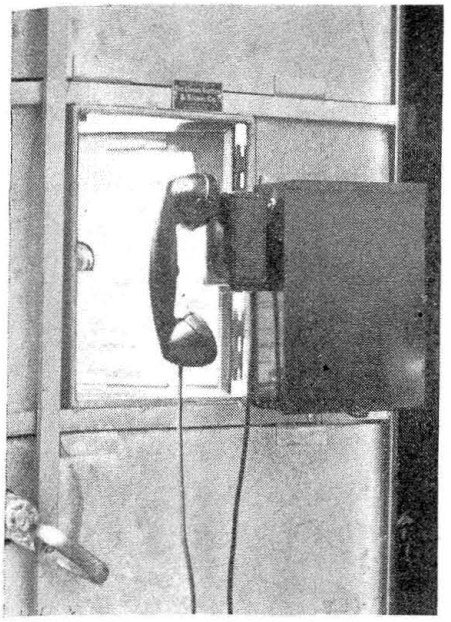


Fig. 5—Circuits for control of electric locks on hand-throw switches at Finn



Power switches and signals at south ends of two sidings at Fordyce, Ark.



Telephone mounted on inside of door to sheet-metal instrument house with small door that can be opened by the trainmen, thus saving the cost of a separate booth

the door-contact to energize the lock coil 60WL or 60AWL. When the train stops at Finn, the conductor opens the door of the lock which closes the door-contact and this completes the circuit through the door-contact, 60WLSPR up, 60WLTER up, and 60WLSPR up, to energize the lock coils 60WL. Then the conductor can operate the crank to pull the plunger so that he can throw the switch.

The switch lock normal repeater relay, 60WLNPR, is normally energized, but is released when the time-element relay is energized, or when either lock is picked up. Front contacts in this relay 60WLNPR are included in the two-wire signal line wire circuit so that no signal can be cleared leading to the switch unless the switch is locked and any time locking has expired.

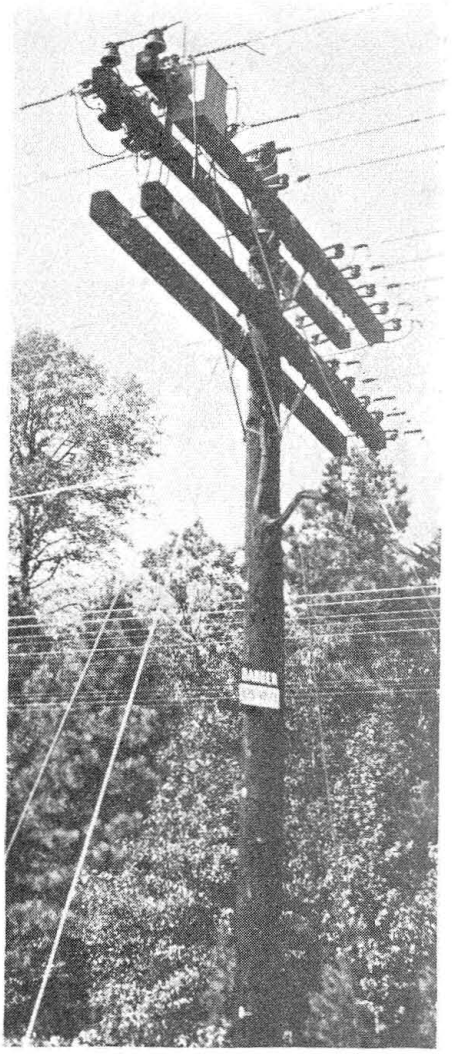
A summary is that the two-wire either direction signal line circuit is used in the control of the electric locks to check occupancy of the station-to-station block and to check the station-leaving signals in the Stop position. The control of the lock from the lever requires a circuit from the nearest field station to the lock.

The two line wires for the either-direction control of automatic signals serve also to check the station-to-station track occupancy of the station-to-station block.

New Signal Pole Line

On this division the Western Union pole line was constructed with one crossarm and short poles, so that it was not practicable to add a crossarm for the signal line wires unless the pole line was completely reconstructed which was estimated to cost considerably more than a new separate pole line for the signal line wires. This new pole line, built by signal forces, includes 25-ft. poles with a minimum of 17½ in. circumference at the top, these poles being Southern pine creosoted full length with a retention of 8 lb. of creosote per cubic foot. The poles are set 30 to the mile which is about 176 ft. apart. Higher poles ranging from 35 ft. to 55 ft. were used at highway crossings and in station limits. The crossarms are creosoted pine, 10 ft. long with a capacity for 10 pins.

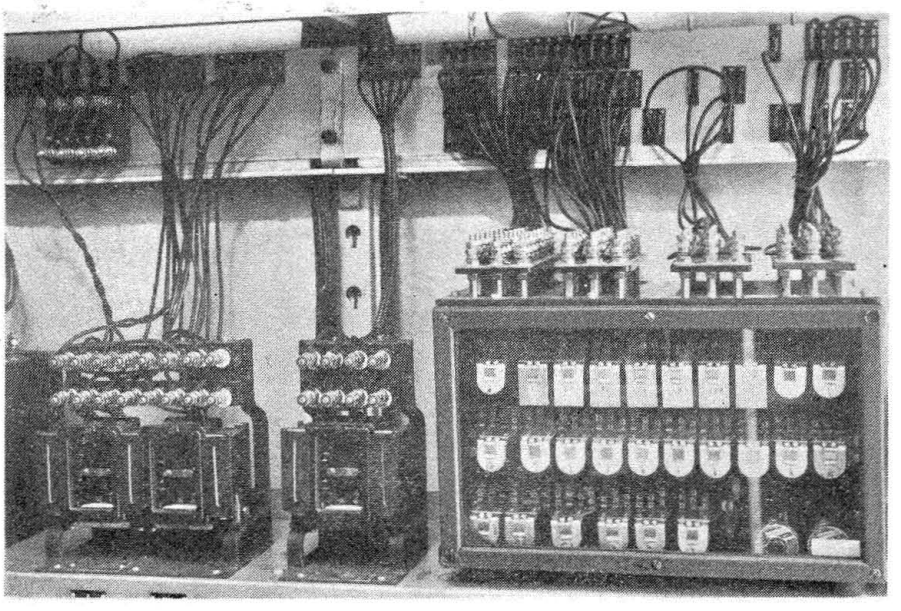
The two line wires for the C.T.C. code are No. 10, 40 per cent Copperweld with weatherproof covering, and the two line wires for the automatic controls of signals are the same kind of wire. The two line conductors for the 550-volt a-c. power distribution circuit are each made up of one No. 10 Copperweld 30 per cent, and two No. 10 solid copper wire which are all twisted together to form the equivalent of No. 6 copper conductors. These line conductors are bare.



Typical pole in new line

The insulators for the code and the signal line circuits are Ohio Brass Company No. 30518, and the insulators for the 550-volt a-c. wires are the saddleback type with a single skirt.

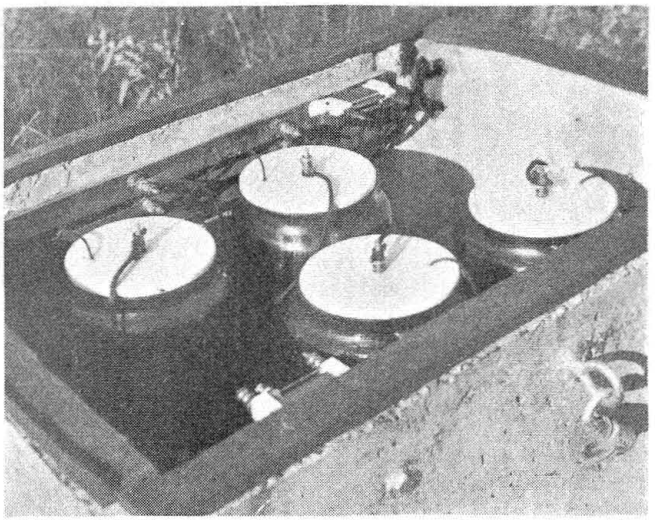
This 550-volt power distribution circuit is fed at 5 locations, so that the length of the feeds range from 12 to 15 miles from the feed point to the far end, and the voltage of low



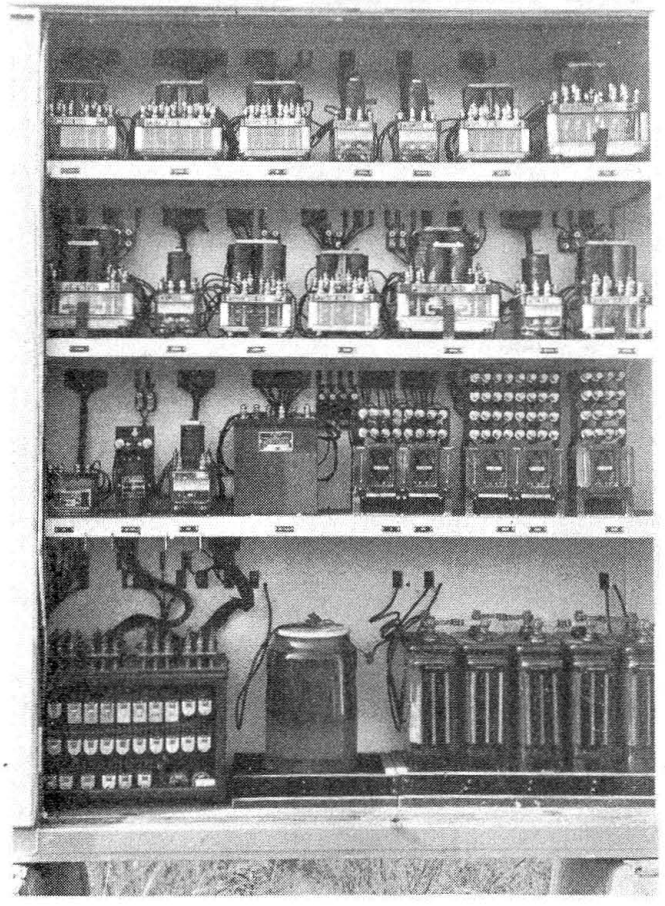
Line coding apparatus in sheet-metal house at the south end of Stephens, Ark., is typical of that at all the field stations

side of the line transformers range from a maximum of about 118 volts to a minimum of about 105 volts at the far end. On a typical section of 25 miles with 8 power switch layouts, the power for an average month was 1,300 k.w.h.

At the power switch layouts the 550/110-volt line transformers are the General Electric Company air-cooled type, rated at 250 watts, and at intermediate signal locations at 150 watts. The low-voltage transformers in the signal cases feed the signal lamps and the rectifiers for charging the storage batteries or floating the primary battery.



The track circuits are each fed by a set of 1,000-a.h. primary batteries



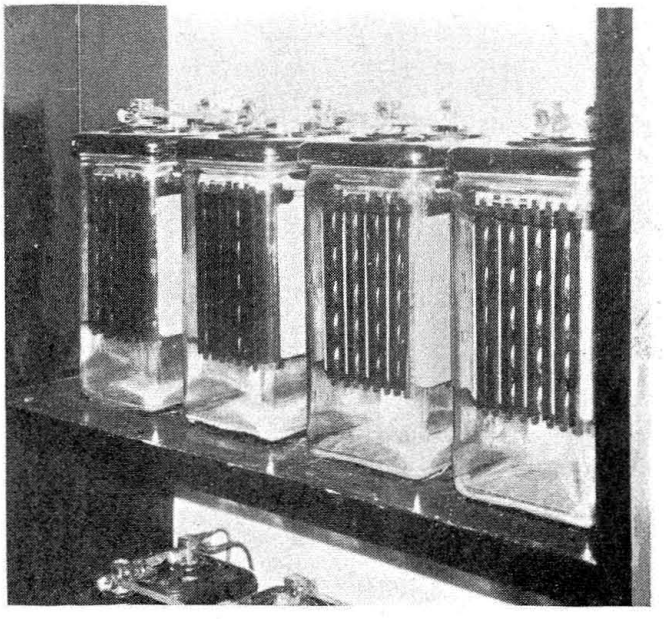
At Rock Island crossing at Warner the apparatus is in a sheet-metal case

At each power switch layout there is a set of 13 cells of Exide 80-a.h. storage battery for operating the switch machine as well as feeding coding apparatus and local circuits. At each intermediate signal there is a set of 5 cells of DMGO-5 batteries to feed line circuits and act as a stand-by for the signal lamp. Each track circuit is fed by three cells of Edison 1,000-a.h. primary battery connected in multiple. At locations where a-c. power is available these primary batteries are connected to a rectifier which normally takes all but about 10 m.a. of the load. At outlying track feed locations the primary batteries feed the track circuits directly.

The rail joints on the main track are bonded with Cadweld bonds. Each bonding crew had a portable grinder made by the Mall Tool Company and driven by a small Briggs & Stratton ¼-h.p. motor which was mounted on a round base that could be skidded along the ties or ballast. With this tool, spots on the rails were ground clean before applying the Cadweld bonds.

On the sidings much of the rail was worn with an overhanging lip that would have required too much grinding if Cadweld bonds were to be used; therefore, on these old rails plug-type head-of-rail bonds, furnished by the American Sheet & Wire Company, were used. The insulated wires and cables on this project were furnished by the Kerite Insulated Wire & Cable Company.

This centralized traffic control, including the new pole line, was installed by the St. Louis Southwestern forces under the jurisdiction of W. S. Hanley, chief engineer, and under the supervision of B. J. Alford, signal engineer. The plans and major items of material were furnished by the Union Switch & Signal Company.



Power switches and code euqipment are operated from sets of storage cells