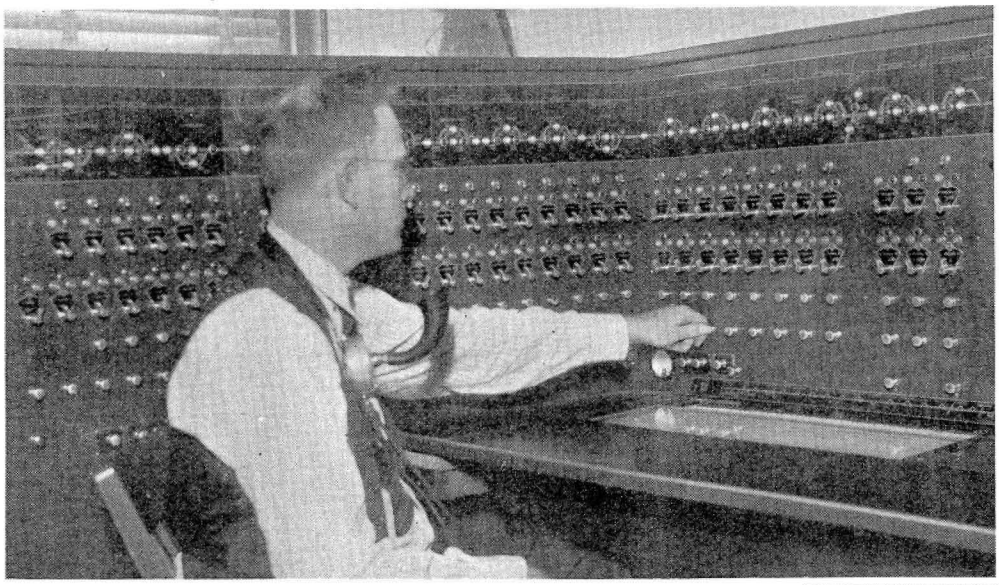
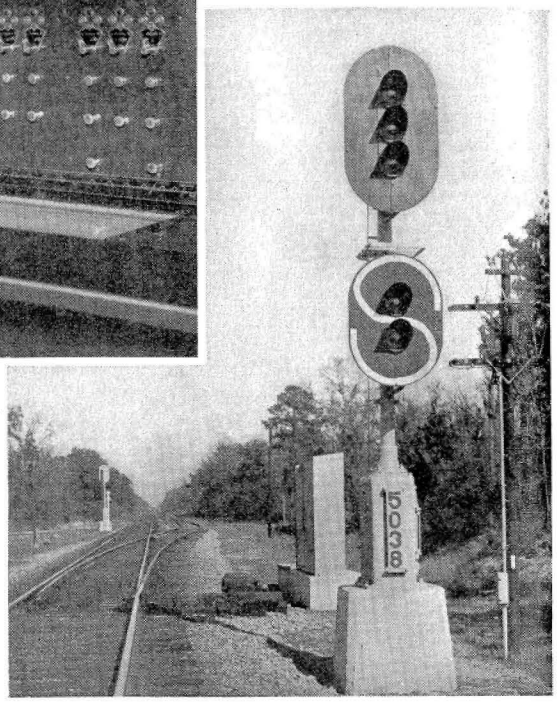
Centralized Traffic Control Installed on





Average running time of freight trains reduced one hour—New carrier current apparatus facilitates line code operation

As a means for increasing track capacity and reducing train time, the Seaboard has installed centralized traffic control on 64.6 miles of single-track main line south from Savannah, Ga. to Thalmann. North from Savannah to Hamlet, N.C., the Seaboard has two lines, the one via Charleston, S.C., being used primarily for freight service, and the other line via Columbia, S.C., being used primarily for passenger service. From Gross, Fla., 107 miles south of Savannah, alternate lines are available through Jacksonville, Fla. and to various points in Florida. The result is that the section of single track between Savannah and Gross is a bottleneck. The daily traffic on this territory includes 12 scheduled passenger trains and 4 or more extra sections, as well as 20 to 24 freight trains. Thus the total number of trains daily, ranges from about 32 to as many as 40 or more. An additional complication is that numerous meets are scheduled in this territory.

Character of the Line

A large part of the line between Savannah and Thalmann extends through wooded swamps or low land, with the track on a fill about 12 to 15 ft. above water level. For short sections approaching low ridges, the grade ranges up to 0.5 per cent, but for practical purposes, the line may be said to be level. For extended sections, the line is tangent, one section being tangent for 28 miles. Curves are few and far between, the maximum curvature being about 2 degrees. The rail throughout is 100-lb. section, with tie plates, good ties and rock ballast, all of which are well maintained.

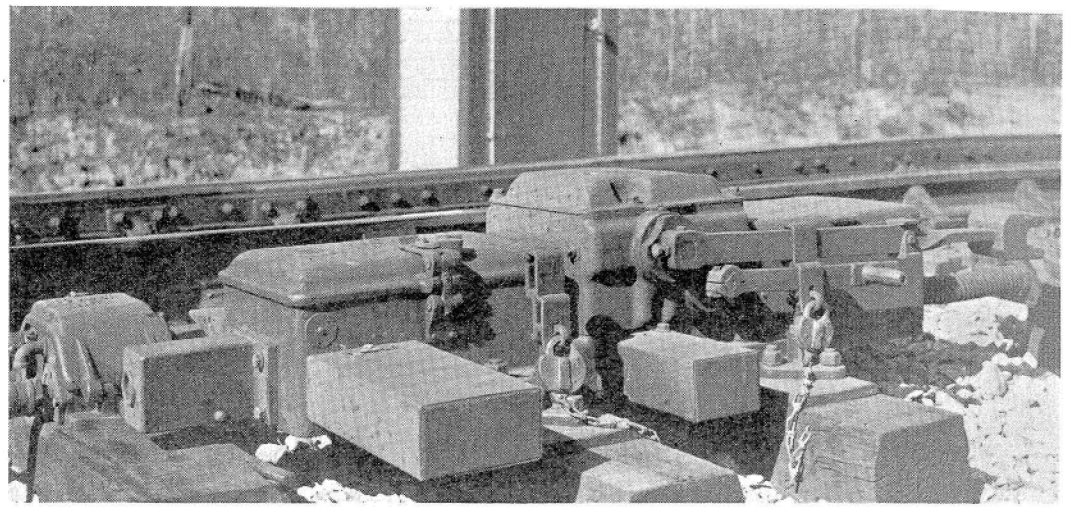
The maximum authorized speed for passenger trains operated by diesel-electric locomotives is 75 m.p.h., for passenger trains hauled by steam locomotives, 70 m.p.h., and for freight trains, 50 m.p.h. Speed restrictions are in effect at railroad crossings and on one drawbridge.

Automatic block signaling has been in service in this territory since 1927, train movements being authorized by time table and train orders. As traffic increased during the early months of 1942, the trains lost too much time when making meets and passes under train order operation, and at sidings equipped with hand-throw switches. In order to increase the track capacity and reduce delays, the logical procedure was to install centralized traffic control including power switch machines and semi-automatic signals to authorize train movements, thereby superseding train orders. The number of trains operated is the same throughout the Savannah-Gross territory, but at present more meets and passes are made in the section between Savannah and Thalmann; therefore this 64.6 mile section was equipped with C.T.C. first.

Three Passing Tracks Removed

Passenger trains of the Seaboard use the tracks of the Savannah Union Station Company for 1.8 miles between the passenger terminal and Florida Junction, at which point an electric interlocking protects a cross-

64.6 Miles of the Seaboard



Left—the C.T.C. control machine in the office Center — Signals at the end of a passing track Right—A power switch

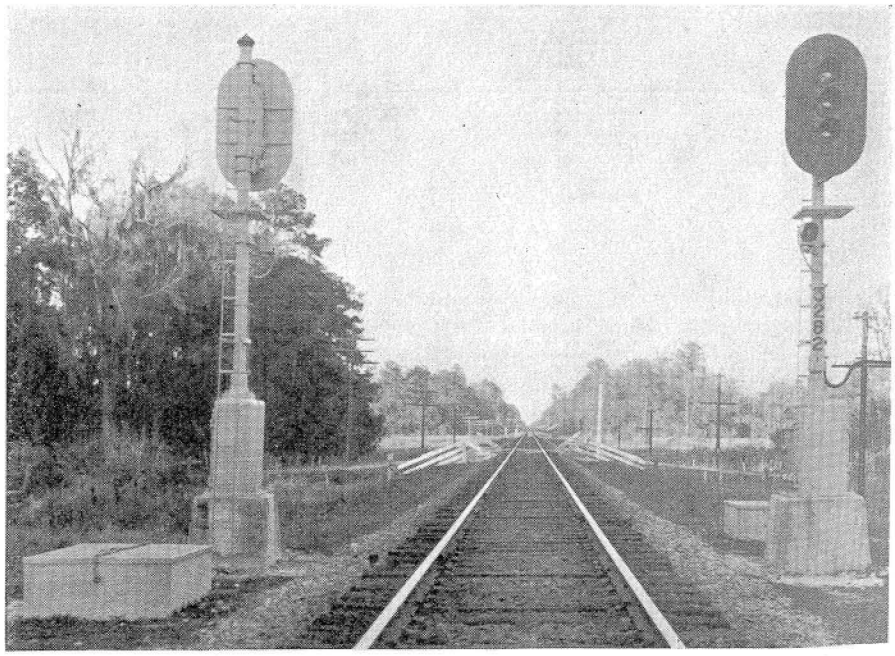
ing between the Seaboard and the Savannah Union Station Company, as well as including a junction switch between the Seaboard and the Savannah Union Station Company tracks. At Blossom, 1.3 miles south of Florida Junction, there is a junction switch with a cut-off which is used by certain trains.

Knowing from past experience that C.T.C. would permit trains to get over the territory more quickly and thus reduce the number of passes and meets, three passing tracks, at Ford, Pineland and Anderson, were removed. This left 14 passing tracks between Florida Junction and Thalmann, the locations and car capacities being shown on the accompanying diagram.

At Everett, a crossing with the Southern is protected by an electro-mechanical interlocking which also includes the operation of the south switch of the southward siding and the north switch of the northward siding. Also at Burroughs, a crossing with the Atlantic Coast Line is protected by an electro-mechanical interlocking which includes the control of the south switch of the passing siding at this point. Except for these switches, all passing track switches between Florida Junction and Thalmann were equipped with electric switch machines as a part of the new C.T.C. project. Also as a part of the C.T.C., an electric switch machine was installed at the junction switch at Blossom and at the north switch at the end of the southward passing track at Thalmann. The two switches near the crossing at Thalmann are operated by hand-throw stands handled by the operator. The south switch of the northward passing track is operated by a power machine which is controlled by the operator at Thalmann.

Signaling Arrangements

In the previous automatic signaling, a double location of head blocks was located about 50 ft. from each passing track switch. In order to increase the speed of trains when entering or departing from passing tracks, the old No. 10 turnouts were replaced with new No. 16 turnouts. When installing the longer turnouts, the switches were moved, thus requiring that the station-entering head-block signals be moved, and a two-aspect color-light "arm" was added for directing trains to enter the passing track. A special feature of the Seaboard signaling is that the letter "S" is painted white on the face of the background shield on each of these lower "arms." This letter serves as definite information to an engineman that a yellow aspect in this "arm" under a red in the upper "arm" indicates that the power



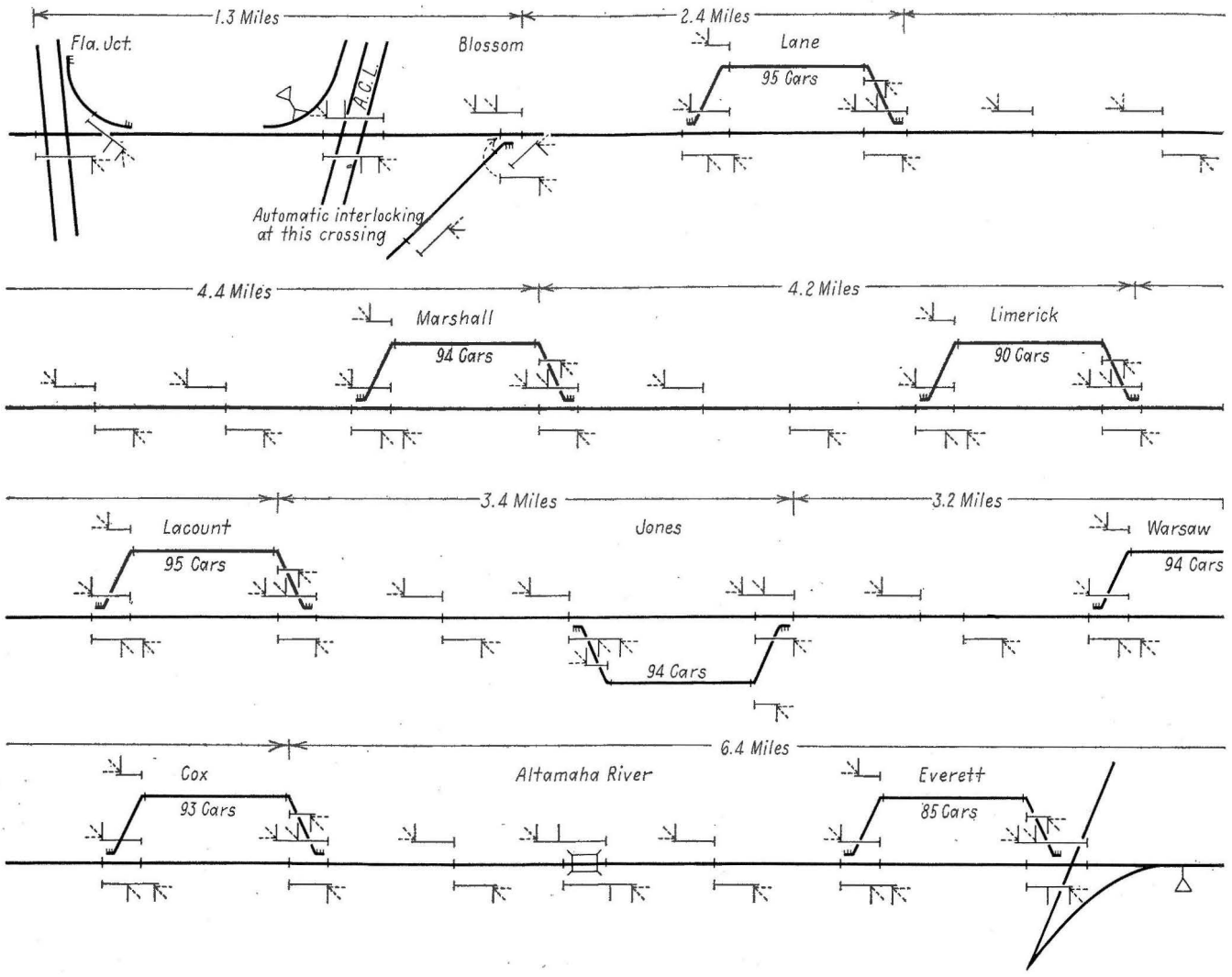
An intermediate signal location

switch is reversed for the train to enter the passing track.

As a part of the C.T.C. project, a track circuit was installed on each passing track to indicate to the dispatcher when the siding is occupied, and the controls are arranged so that the red-over-yellow aspect is displayed when the passing track is either occupied or unoccupied. The passing tracks, in most instances, are long enough and located in such a manner that the speed need not be reduced below 25 m.p.h. until after most of the train is on the passing track. Thus these features save considerable train time when entering and leaving passing tracks.

The main line station-departure signals were moved to new locations opposite the fouling points on the passing tracks. For the most part, this line extends through swamps, the tracks being on a fill. The expense of adding fill to permit throwing the passing track to provide clearance for a main line station-departure signal did not seem to be justified. Steel to construct cantilever signal bridges was not available. For these reasons, at one end of each passing track, the main line station departure signal is on a bracket mast at the field side of the passing track, a doll mast being provided to show that the signal applies to the main track. New three-aspect color light dwarfs were added as leave-siding signals.

The intermediate signals were relocated as required to provide adequate spacing in accordance with the braking distances of modern trains and speeds. On account of the swampy nature of the soil, large deep concrete signal foundations, poured in place, were required, and in some instances, it was necessary to drive a pile and pour the foundation on top of the pile. The old foundations were discarded by digging holes and toppling the foundations into the holes to bury them.



Track and signal plan of the centralized

Benefits of the C.T.C.

The principal benefit of the C.T.C. has been to get trains over this territory in less time without increasing the maximum permissible speeds.

Under the previous operation with train orders, the speed of trains had to be reduced when approaching and passing train order offices, not only to permit the engineman to see the aspect displayed by the train order signal, but also to permit train orders to be handed up to trainmen. An analysis of this matter by the Road Foreman of Engines is that, on the average, each train saves about 10 to 12 minutes on the 64 mile C.T.C. territory due to the elimination of these speed reductions and some stops previously required at train order offices. This saving applies equally to passenger as well as freight trains.

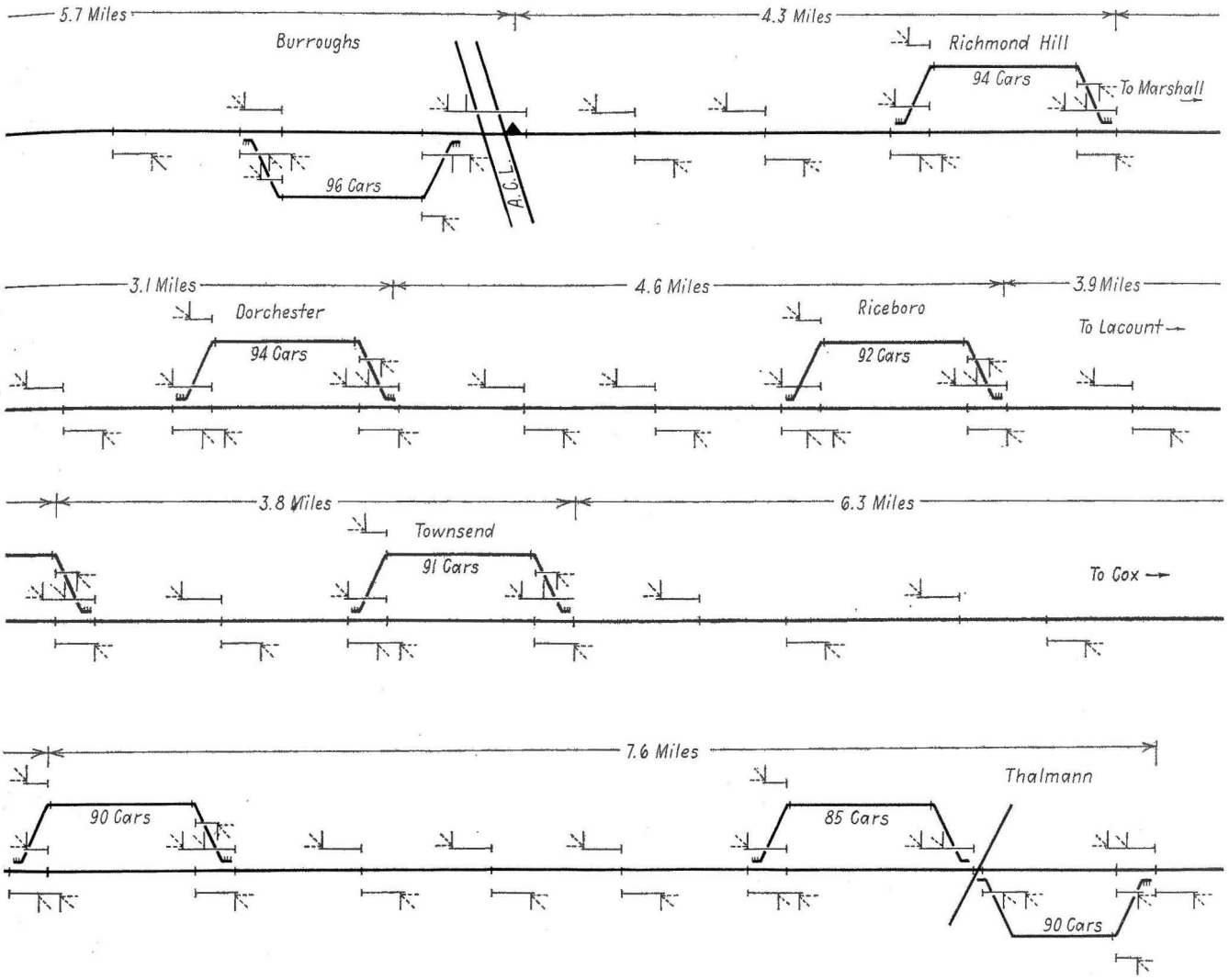
Previously when the switches were operated by hand-throw stands, the trains had to be stopped to permit throwing the switches before entering a passing track, as well as after leaving. With the new power switches, the trains can pull into passing tracks at 25 m.p.h. without stopping. Likewise when leaving, trains can accelerate to 25 m.p.h. and pull out without stopping. This time saving amounts

to 12 to 15 minutes for a train departing from one passing track, moving over a section of main line and entering another passing track. Oftentimes this saving permits a train to be advanced one or more stations when otherwise it would have been held.

Under the previous method of operation, train orders had to be issued and delivered possibly an hour or more prior to the time meets or passes were to be made at certain stations. In the meantime, if some train did not make the time anticipated by the dispatcher, there was no means for changing orders to advance trains which were waiting. By means of the information on the C.T.C. control machine, the dispatcher knows the locations of and progress being made by each train, and he can, therefore, advance trains for close meets or passes.

For example, on a recent day, the dispatcher anticipated that he would put a northbound perishable freight train in the passing track at Cox to let a following passenger train pass. The passenger train, however, lost time, and the freight train was directed to keep moving all the way to Richmond Hill where it took siding to let the passenger train by. Thus the freight was advanced about 40 miles under C.T.C. operation, which would not have been possible with train orders. Train movements of this character are underway practically all the time. In some instances, as many as 16 trains are kept moving on the 64 mile territory. The Road Foreman of Engines and the Dispatchers, who have made a close study of operations, report that the freight trains are now covering the 64 mile territory in an average of one hour less time than previously.

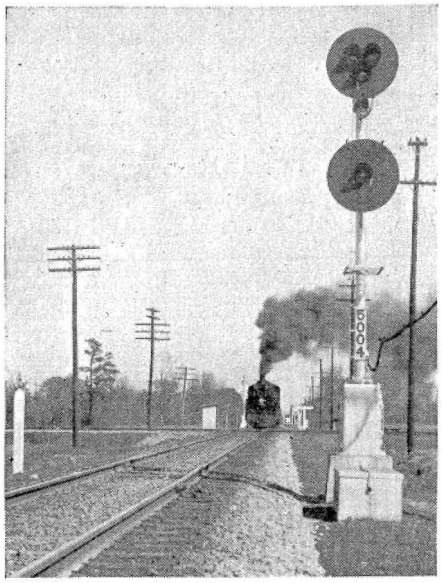
The fact that these locomotives arrive at their terminals an hour sooner, permits them to be available for the next road trip that much sooner, all of which has been a decided help in relieving a shortage of power. Previous studies by the Road Foreman of Engines show that approximately 20 percent of the fuel and water was consumed while trains were standing on passing tracks. As the C.T.C. territory is now being operated, the trains lose very little time on passing tracks, the total average time saving of one hour being at the rate of 20 percent of the total for the mileage involved. Likewise, tests have proved that the elimination of a stop will save from 1,000 to 1,500 lb. of coal for a tonnage freight train and 500 to 700 lb. for a passenger train as compared with running through at authorized speed. The C.T.C. with the power switches is saving many such train stops daily on this territory, and although no means is available for measuring the fuel saving, obviously, a considerable amount of fuel is being saved. Furthermore, in some instances, freight trains can pass up water stops that otherwise would be required, which in each case saves at least 10 minutes time.



traffic control territory

Protection at A.C.L. Crossing

At mile post 500.3, a double track of the Atlantic Coast Line crosses the Seaboard main line, this crossing be-



Automatic interlocking

ing protected by an automatic interlocking which has been in service for several years. An interchange track between the two roads connects with the Seaboard at a main line hand-throw switch, 600 ft. north of the crossing. A Hayes derail, operated by a hand-throw stand is located at the clearance point on this turnout. As a part of the protection in the new C.T.C. project, an electric lock was added to this derail stand.

When a train on the connecting track is ready to depart, the conductor telephones to the dispatcher in charge of the C.T.C. control machine, and if no train is occupying the station-to-station block, and the semi-automatic signals are displaying the Stop aspect, the dispatcher can send out a control code which will release the electric lock to permit the derail to be removed from the rail.

As information to the conductor, an indicator is provided at the derail. When he pushes a button, a lamp will be lighted if the dispatcher has sent a code which should release the lock if other circumstances in the field are correct. If the lamp is lighted but no release is effected on account of some other train standing on a track circuit, the dispatcher can telephone the conductor, who can then effect a release of the lock by operating a clockwork time release which causes the signals in both directions to be set at Stop. After the time period has expired, the lock is released. Then, with proper flag protection, the train can enter the main line and proceed.

Power Supply

As a part of the automatic signaling installed in 1927, a signal pole line was constructed throughout this territory. This line included a 4400-volt single phase, 60-cycle power distribution circuit on two No. 4 ACSR wires. When changing over to C.T.C., the old 750-watt line transformers at switch locations were replaced with new 1500-watt transformers. Each of the electric switch machines is operated by a set of 21 cells of Edison B4H storage battery on floating charge. With 30 volts at the battery, a machine will operate a switch in about 11 seconds. The switch battery is split, with connections for feeding the line code apparatus. Each track circuit is fed by two 1,000 a.-h. Edison primary cells, which render an average life of about 10 months. All track relays are of 2 ohms resistance.

A.C.-Primary at Intermediates

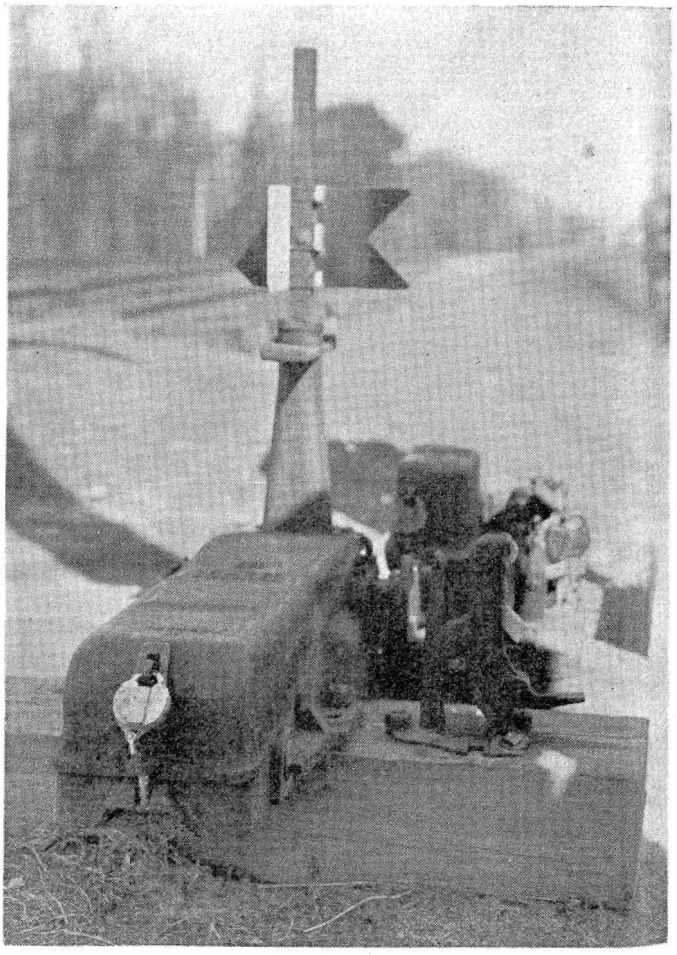
At some intermediate signals, there is a set of 15 cells of Edison 1,000 a.-h. primary cells which normally feeds the line control circuit. A rectifier across this battery carries all the load except about 10 m.a. normal discharge from the battery. On the average, these sets of battery render a life of about 48 months.

The signal lamps are fed from the low voltage transformers except that, in case of an a.c. power failure, a power-off relay switches the lamp feed to the battery. Continuous lighting is in effect for all signals.

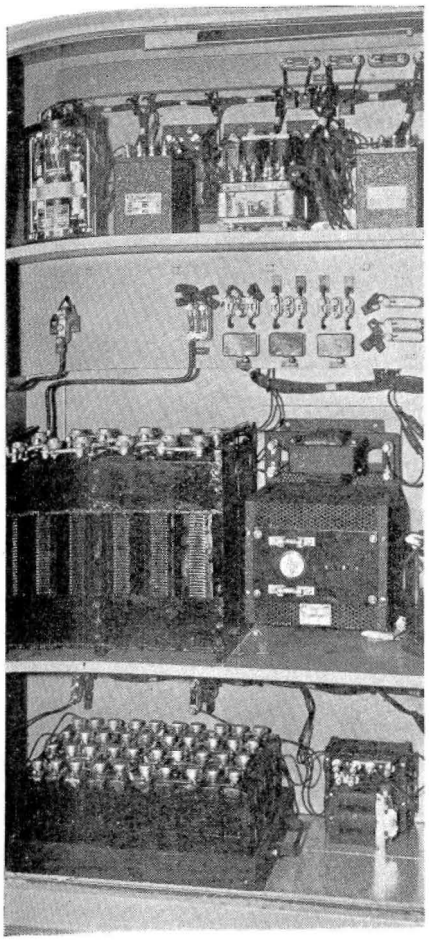
Coded Carrier for C.T.C. Line

The C.T.C. control machine is located in the dispatcher's office in the Union Station building in Savannah. The controls are sent to the field stations and indications are returned by means of the Union Switch and Signal Company multiple time code system, multiple line application, using a pair of No. 8 bare copper line wires from Savannah to the south end of the territory. The new and interesting feature of this project is the use of coded carrier current for handling the coded controls to and indications from the field stations on the half of the territory remote from the office.

On the 39 miles of territory between the control office at Savannah and the south switch at Jones, the control of switches and semi-automatic signals at the 19 field stations, as well as the return of indications, is handled by ordinary d.-c. code impulses, the same as on numerous previous C.T.C. projects. This system is complete unto itself, separate code sending and receiving apparatus being used in the Savannah office.



Hand-throw switch stand with an electric lock

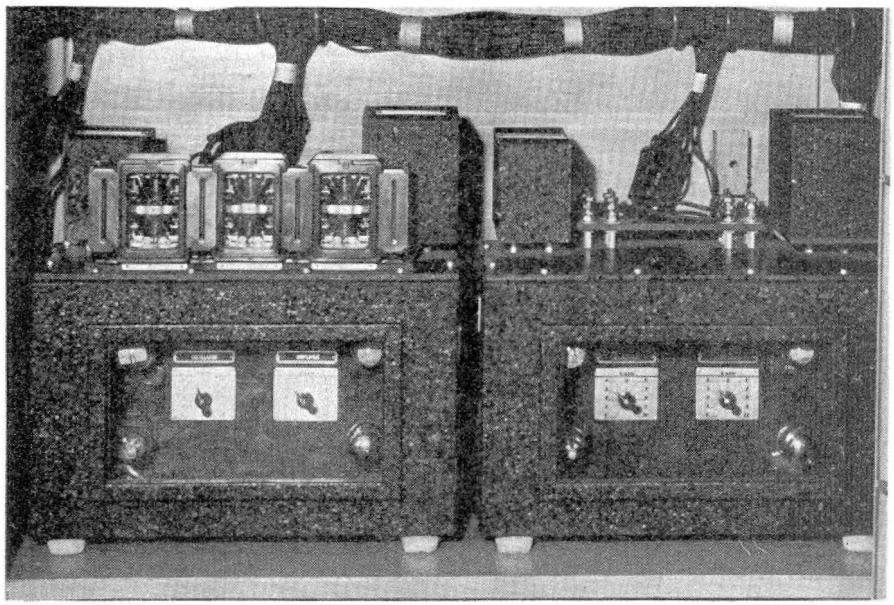


Power supply at the office

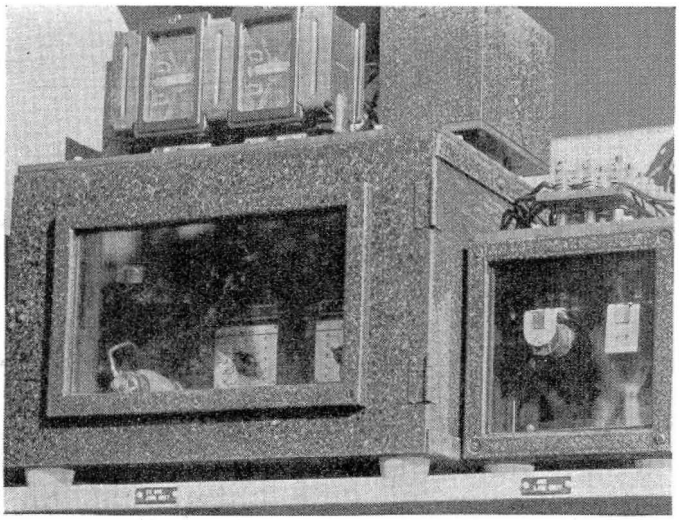
The control of switches and semi-automatic signals at 11 field stations, as well as the return of indications, on 20 miles from Jones south to Thalmann is handled by a different line coding system which includes separate code sending and receiving equipment in the Savannah office. This second system utilizes codes at high frequencies which are superimposed on and transmitted direct in one direction or the other between Savannah and Jones on the same pair of line wires which are used also by the conventional d.c. line codes to and from the field stations in the Savannah-Jones territory. At these field stations and at Savannah, special devices, known as filters, prevent interference between the conventional d.c. codes and the high frequency codes and, therefore, controls to or indications from any of the field stations in the Savannah-Jones section can be handled simultaneously with controls to or indications from any of the field stations in the Jones-Thalmann section. In addition, the filters permit the same pair of line wires to be used also as a telephone circuit.

The advantages of this carrier system are numerous. On this busy railroad, the dispatcher in charge of the control machine may want to send out controls to widely separated field stations at exactly the same time, and when meets or passes are being made at close timing, a few seconds delay may avoid the stopping of a train. Furthermore, the dispatcher's work is based on the information given by indications on his machine and, therefore, it is just as important that indication codes come in promptly as it is that the controls go out promptly. The carrier saves an enormous amount of copper, that would be necessary to provide an additional circuit.

A 16-step control code cycle goes out in about 4 seconds, or a 16 step indication code cycle comes in in the same length of time, but only one control or indication code cycle can be handled at one time by the conventional d.c. time code system on the pair of line wires. Experience shows that when trains are numerous, some delays may result if more than 30 to 35 field stations are controlled as one unit. By means of the carrier system, an extended territory is cut into sections, with about 20 field stations in each section; for example, there are 19 field stations in the Savannah-Jones section. At present there are only 11 field stations in the Jones-Thalmann section, but as the C.T.C. is extended southward, more field stations will be added to this section to make a total of 20 to 25; then a second carrier section will include the succeeding 20 or more field stations. Thus, in the total 107 miles between Savannah and Gross, there will be the conventional d.c. code section between Savannah and Jones, then the first carrier section between Jones and probably White Oak, and a second



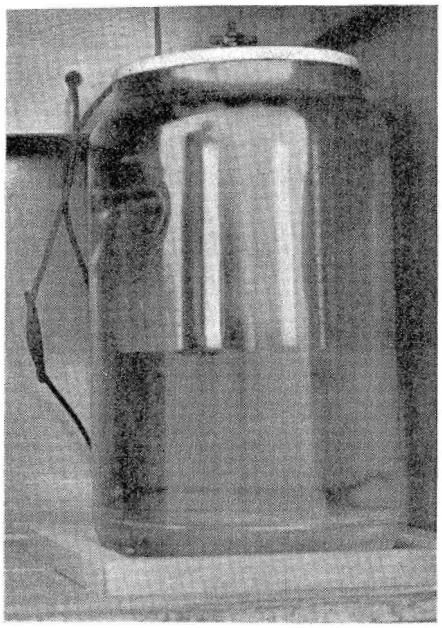
Carrier equipment at the office

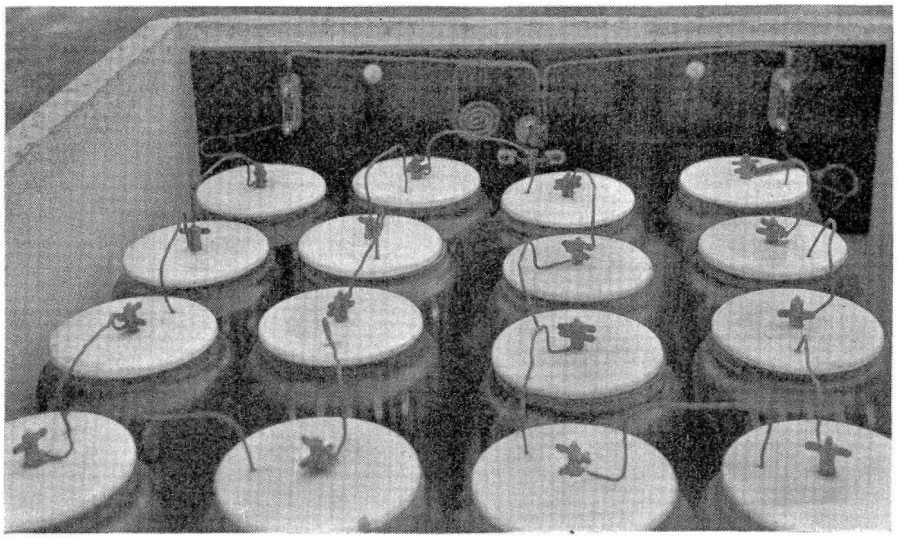


Carrier equipment at Jones

carrier section between there and Gross.

For the Jones-Thalmann section, the control codes are at 10,000 cycles





per second and the indication codes at 12,000 cycles. For a second carrier section, the controls would be at higher frequencies, such as 15,000 for controls and 18,000 for indications. Thus by using various frequencies, any reasonable number of sections ranging up to 35 field stations each can be controlled simultaneously with only one pair of wires throughout the overall territory. With this arrangement, the control machine can be at either end of an extended C.T.C. territory, or could be remote from any part of the territory.

Details of the Carrier

At the Savannah office, and for use exclusively for the coded carrier section, there is a separate office line coding unit, impulse transformer and impulse relay T. Also at the office, there is an oscillator which delivers steady 10,000-cycle energy by means of a vacuum tube circuit. The output of this 10,000 cycle energy is normally shunted by front contacts of the L relay, which in turn is energized through back contacts of the transmitter relay T. When a carrier code cycle is to be sent out, the T relay is energized for each impulse, which releases L, thus removing the shunt and allowing an impulse of 10,000-cycle energy to feed through over the pair of wires to the field station at the south end of Jones, at which point this energy is picked up by a receiving filter and is amplified to operate a C relay, which is again released at the end of the impulse. Thus the C relay at Jones follows the code impulses sent out by the L relay at Savannah.

The pair of line wires from Savannah end at Jones, there being no physical connection between these wires and the pair that extends on south from Jones to Thalmann, except for a band pass filter which passes voice frequencies in order to allow the telephone system to extend from Savannah to Thalmann.

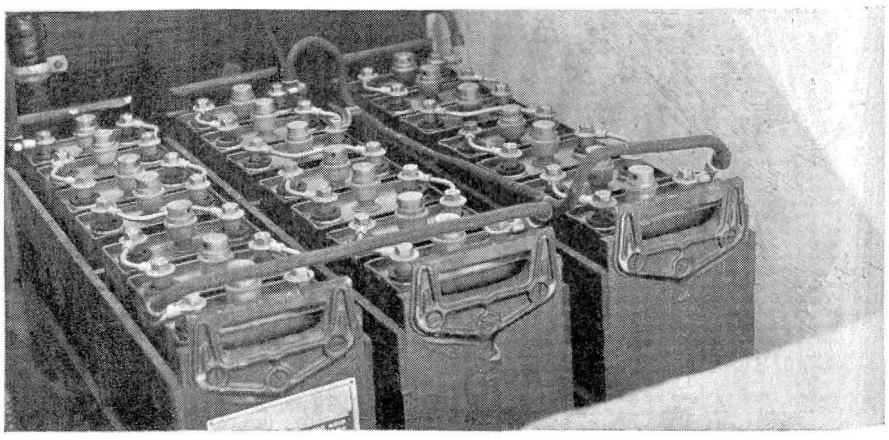
As far as the normal operation of the system is concerned, it is the same as if a separate pair of line wires extended from the office through each of the sections of C.T.C. territory. Thus the use of carrier frequencies reduces greatly the requirements for copper line wire.

Assembly of Carrier Equipment

The basic elements of each set of coded carrier equipment, including the oscillator and amplifier tubes, are mounted and wired in a standard sized sheet metal case. The panel of each set is equipped with scales and knobs for operating rheostats for adjusting the voltage of outgoing codes and for adjusting the amplification of incoming codes. The front of each case is enclosed with a glass door. These sets are identical and interchangeable with the exception that the office units are equipped for 10,000-cycle transmission and 12,000-cycle reception, while the Jones units are equipped for 12,000-cycle transmission and 10,000-cycle reception. The filters and oscillator coils, however, are plug connected and can, therefore, be changed easily, so that office and field oscillator-amplifier sets can be interchanged if desired.

The transmitter filter, which is plug connected, is applied at the left portion of the top of any standard oscillator-amplifier set. This filter passes the frequency for which it is tuned and is high in impedance to every frequency except the one to which it is tuned. A plug-connected receiving filter is applied at the right portion of the top of any standard oscillator-amplifier set. A receiving filter is of the same general construction as a transmitting filter. These filters are tuned and sealed by the

Upper left—One of the primary battery cells on a track circuit. Above—Set of 1,000-a.h. primary cells at an intermediate signal location. Below—Storage battery at one of the power switches



manufacturer and require no adjustment in the field. The relays used in connection with the coded carrier are the plug-connected type KP, and are mounted on top of the oscillator-amplifier set. Three such relays are required on the set at Savannah, two at Jones.

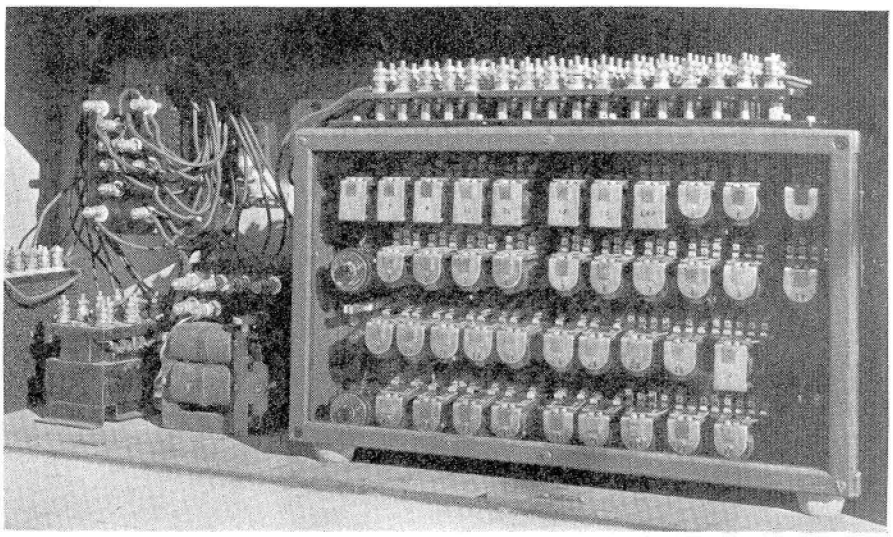
In this Seaboard installation, one oscillator-amplifier standard set, with the proper receiving filter, sending filter and relays is required at Savannah, and another such oscillator-amplifier set is located at Jones. In case of a failure of any part of one of these sets, a standby set can be cut into service quickly.

At the office, the code carrier set, which is in operation, is connected to the line through back contacts of an eight-point change-over relay, and the standby set can be placed in operation and connected to the line through the front contacts of this relay. If a failure occurs, the dispatcher can cut in the standby set by throwing a toggle switch on his desk which completes the circuit to energize the change-over relay. At Jones there is a change-over relay, associated with each oscillator-amplifier unit, which can be energized selectively by throwing a toggle switch on the control panel and pushing a button to send out a control code. Once each week the standby sets are cut into service as a test.

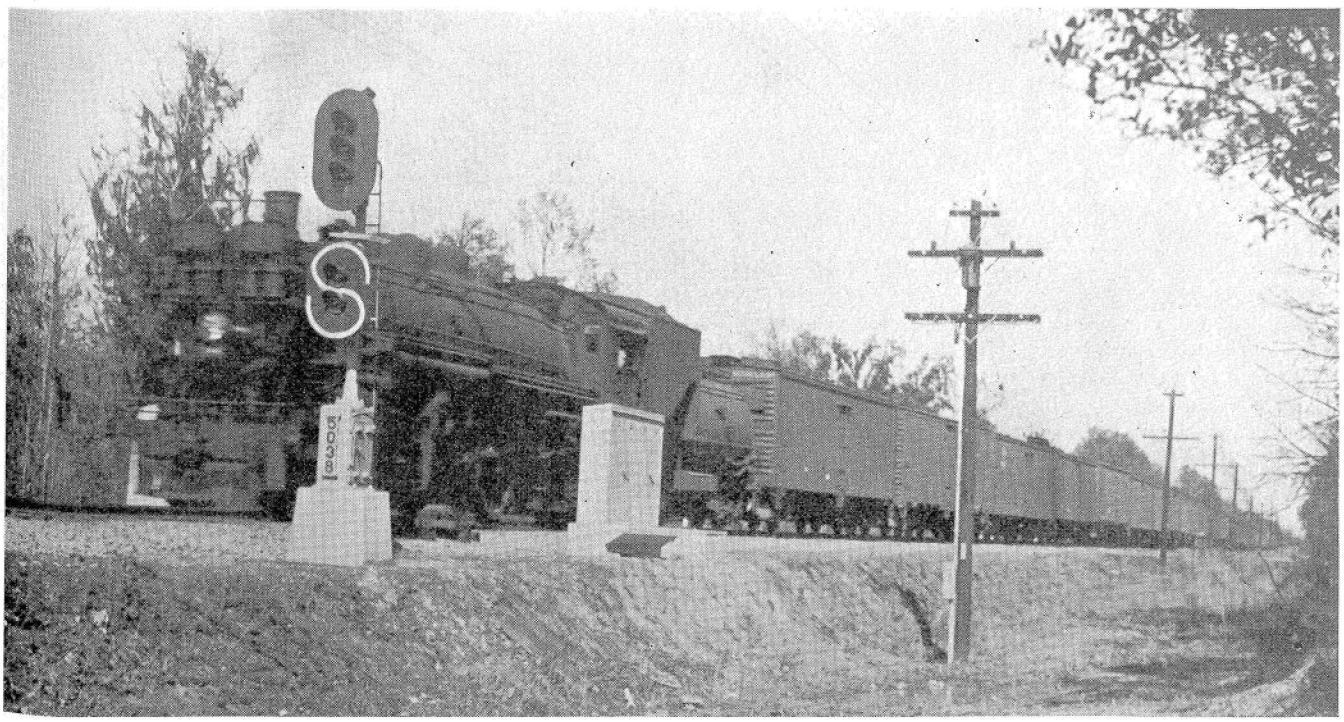
General Construction Features

The cabinet of the C.T.C. machine in this dispatcher's office, houses the line coding equipment. The line batteries, carrier current apparatus and relays required in connection with the Savannah office are mounted in a sheet-metal cabinet located in the signal supervisor's office in the same building. The battery for feeding the code line consists of 40 Type-N Edison cells, and a local low-voltage set includes 12 Type AH cells. At the various power switch layouts, the line coding equipment, relays and storage batteries are housed in large-sized sheet-metal cases.

New insulated wire and cable was installed at all the switch layouts and at many of the intermediate signal locations, that were relocated. The track connection cables are No. 9 copper with a 5/64-in. wall of insulation, a layer of tape and two layers of jute. The underground cables to signals are No. 14, with insulation, two layers of jute, a bronze tape, and two layers of jute. The cable run to each switch machine includes four No. 9 and six No. 14 conductors. The insulated wire and cable on this project is of Kerite manufacture. All signal apparatus was furnished by the Union Switch & Signal Company. This change-over from automatic block to centralized traffic control was planned and constructed by signal forces of the Seaboard Air Line, under the direction of J. R. DePriest, Superintendent Telegraph and Signals.



Line coding equipment at a field station



Southbound train makes a non-stop meet with no rthbound train which is going through the siding