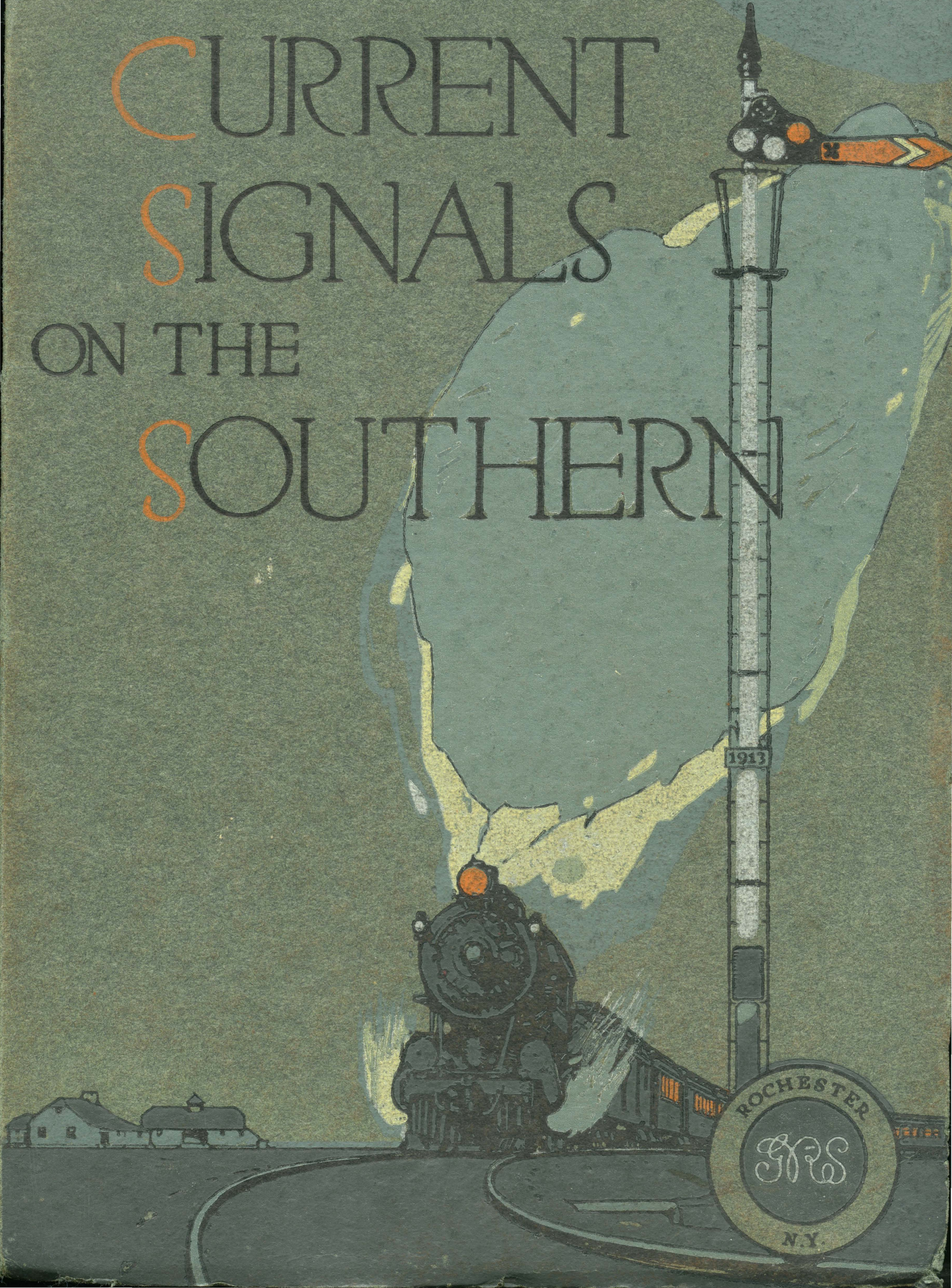
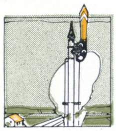
ALTERNATING CURRENT SIGNALS ON THE SOUTHERN



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Alternating Current *Block Signals* on the SOUTHERN RAILWAY

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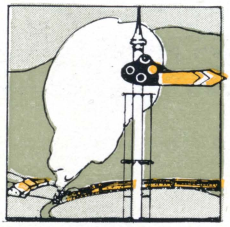

GENERAL RAILWAY SIGNAL COMPANY
ROCHESTER, QUALITY N.Y.

NEW YORK
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Peoples Gas Building
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SAN FRANCISCO
Monadnock Building
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CANADIAN AGENCY
General Railway Signal Company
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Lachine, P. Q. Winnipeg, M.

AUSTRALASIAN AGENCY
R. W. Cameron & Company
Sydney, N. S W. Australia
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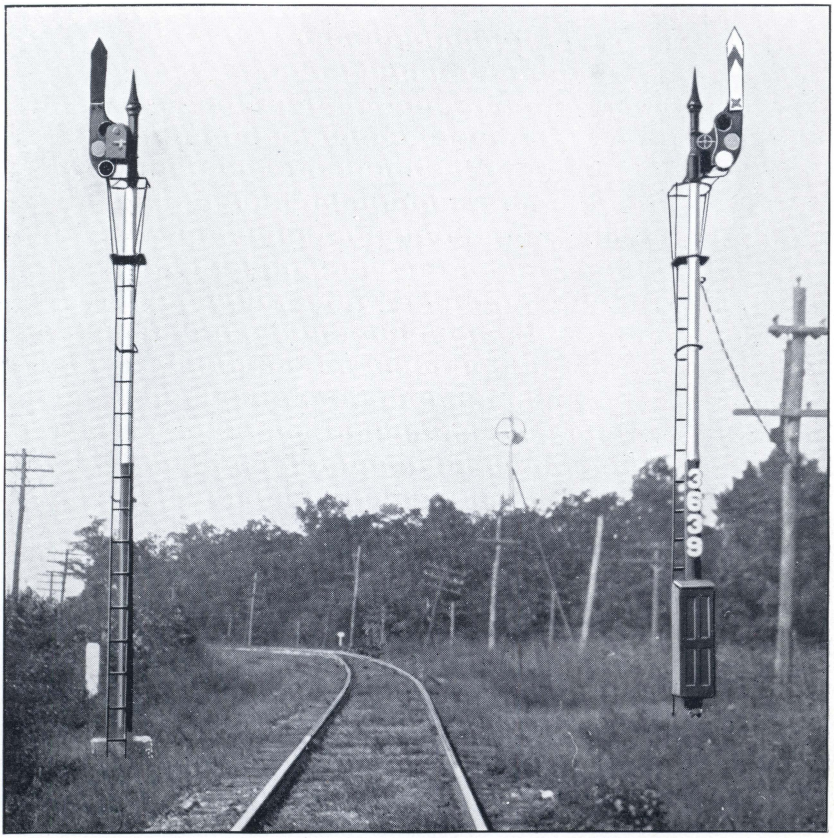
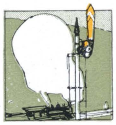
Bulletin 126
December
1913



A Signal Location on Single Track



INTRODUCTION

THE Automatic Block Signal installation, described in the following pages, presents some interesting features of the construction, operation and maintenance of a modern signaling system. Although direct current automatic block signaling has been developed to a point of high efficiency, signal engineers have been diligently seeking a means to secure even greater efficiency and to reduce the cost of maintenance and operation.

Alternating current seemed to have desirable characteristics for an automatic block signal system and several alternating current systems have been installed, during the past few years, the results of which have thoroughly demonstrated the practicability, higher efficiency and greater economy of the alternating current system.

The relative merits of the direct and alternative current systems are stated in the following parallel columns:

I. COST OF MAINTENANCE AND OPERATION

Direct Current System

This system is operated by current from various types of batteries, which is the most expensive manner of supplying electrical energy, and may be compared to a large machine shop in which there is a boiler and engine to operate each machine.

The cost of energy from batteries is estimated, by a competent authority, at from $5.00 to $8.00 per kilowatt hour.

Batteries require frequent attention and renewals; they sometimes freeze in extremely cold weather, and the jars sometimes crack or break, causing the display of stop signals until renewed or replaced.

Alternating Current System

This system is operated by current developed at a central station, which is the most economical manner of supplying electrical energy and may be compared to a modern machine shop in which all machines are operated electrically from the same source of power.

The cost of energy supplied in this manner is estimated, by a competent authority, at from $0.02 to $0.04 per kilowatt hour.

The A. C. System requires approximately 30 times as much energy as the D. C. System so that the approximate relative cost of D. C. current is about 8 times that of A. C. current.

No batteries are used in the A. C. System. Current from the Transmission line is stepped down to the proper voltage by transformers. The transformer is a substantial device contained in a cast iron case and requires no maintenance.

D. C. System	A. C. System
	The cost of maintaining an A. C. system is from 25 to 40 per cent. less than the cost of maintaining a similar D. C. system. Less than one-half of the maintenance force is required; there are no batteries to renew and A. C. devices require little attention.

II. RELIABILITY

D. C. System	A. C. System
The D. C. system is subject to the interference of foreign currents from adjacent electric railways, power houses and other sources, which sometimes cause improper signal indications.	The A. C. system is practically free from the interference of foreign currents, resulting in greater safety.
The moving parts of D. C. relays, being constructed to operate on small currents, are necessarily light and delicately adjusted and failures sometimes occur on account of poor contacts.	The moving parts of A. C. relays, being constructed to operate on heavier currents, are substantial and contacts are made with sufficient pressure to insure a path of low resistance through the contacts.

III. LENGTH OF TRACK CIRCUITS

D. C. System	A. C. System
Automatic signals are frequently located two or three miles apart and as the practical limit of a track circuit, operated by a battery of gravity cells, is about 3,000 feet, it is necessary to employ cut sections. A block 2 miles in length would be divided into 3 or 4 sections, the latter requiring 4 track relays, 4 sets of gravity cells with trunking, stakes and rubber covered wire, also 8 insulated joints.	In the A. C. system, a track circuit is the same length as the block, which eliminates the expense of additional relays, trunking, wire and insulated joints. A block 2 miles in length would require 1 track relay, with trunking stakes, wire and 2 insulated joints.

IV. SIGNAL LIGHTING

D. C. System	A. C. System
Oil lamps are used in the D. C. system which, even when provided with long time burners, require frequent attention, in addition to the oil that they burn.	Low candle-power incandescent lights are used in the A. C. system and as these lamps will burn efficiently for a year or more without attention, the cost of maintenance is negligible.

V. ADDITIONAL FACILITIES

D. C. System	A. C. System
	The A. C. system provides an efficient and economical means for lighting stations, and other railroad buildings; supplies power to operate coal and water stations, turntables, air compressors and other machines, crossing bells and for many other uses.

PRINCIPAL APPARATUS REQUIRED IN AN A. C. SYSTEM AND D. C. SYSTEM

The column on the right, headed A. C. System, shows the apparatus and equipment as installed on the Southern Railway; the column on the left, headed D. C. System, shows the appliances that would have been required if D. C. operation had been adopted.

POWER EQUIPMENT

D. C. System	A. C. System
1532 Cells Potash Battery	One Main Power Station
95 Concrete Battery Wells	Two Substations
1170 Cells Gravity Battery	Transmission Line
390 Cast Iron Battery Chutes	146 Track Transformers
	105 Line Transformers

APPLIANCES

116 Model 2A Signals	116 Model 2A Signals
415 Track Relays	142 Track Relays (Model 2 Form A)
12 Line Relays	12 Line Relays (Model 2 Form B)
411 Relay Boxes	138 Relay Boxes
326 Switch Boxes	326 Switch Boxes
1746 Insulated Joints	1200 Insulated Joints

GENERAL RAILWAY SIGNAL COMPANY

December, 1913

ROCHESTER, NEW YORK

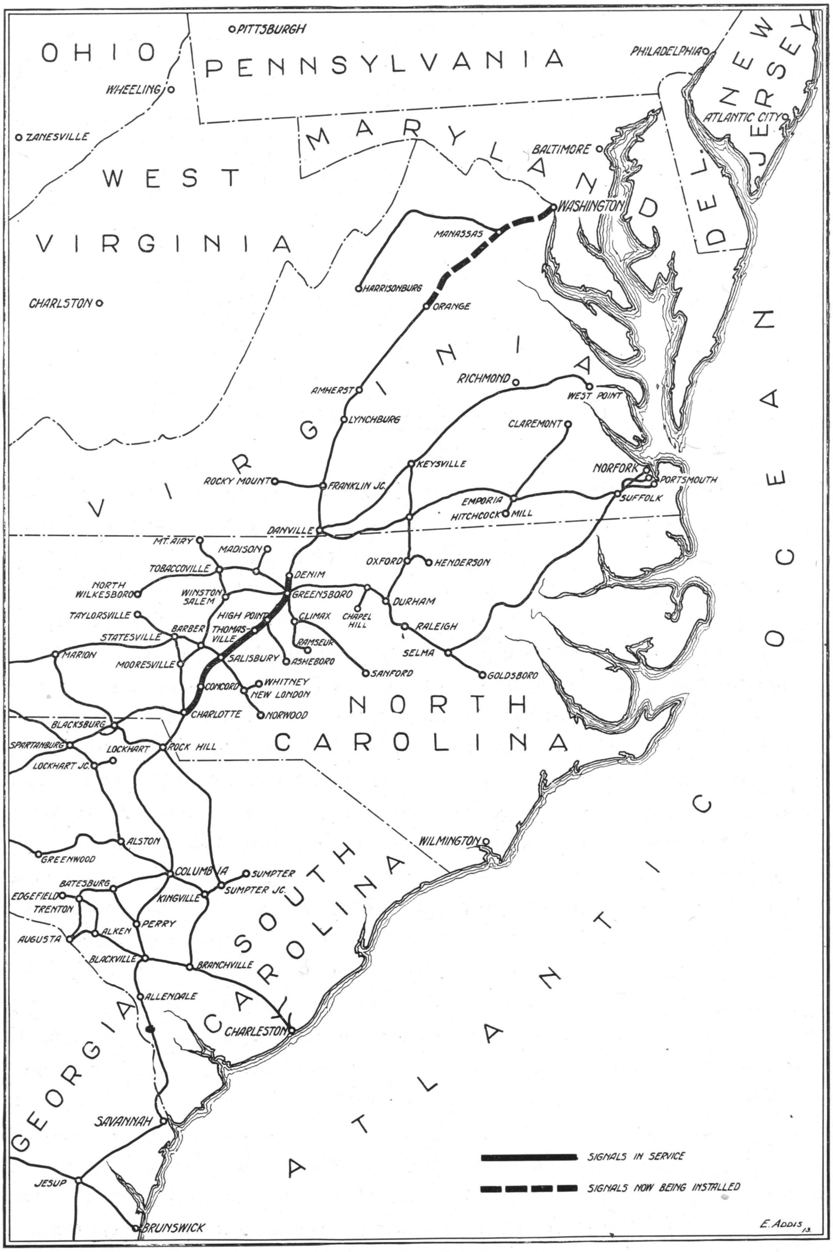


Fig. 1

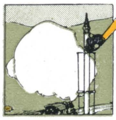
Alternating Current Signals on the Southern

ALTERNATING CURRENT BLOCK SIGNALS

ON THE

SOUTHERN

DESCRIBING THE NEW AUTOMATIC BLOCK
INSTALLATION OF ONE HUNDRED
MILES IN NORTH
CAROLINA



BY W. J. ECK
Signal and Electrical Engineer
Southern Railway

THE main line of the Southern Railway between Washington and Atlanta traverses an exceedingly fertile and prosperous section of the South. The territory in central North Carolina between Greensboro on the north and Charlotte on the south probably surpasses in fertility of soil and extent of manufacturing any other of equal length in the country. It is said that from some point on every mile of the lines of the Southern Railway, between Danville, Va., and Atlanta, Ga., one or more cotton mills can be seen. The city of High Point is second only to Grand Rapids, Mich., in the production of furniture. Other industries are as flourishing, so that the local and through railway traffic is very large and is constantly growing.

To safeguard and facilitate this traffic the management of the Southern Railway has installed and recently placed in service an automatic block signal system from Denim, N. C., 1½ miles north of Greensboro, to Charlotte, N. C., a distance of 100 miles, with 92 miles of double and eight miles of single track.

For many years this line has been operated under the manual block system with 19 block stations. The installation of the automatic signals closed these offices as block stations and 15 operators were transferred to other sections of the road.

The manual block system, while offering a very large measure of safety over the time interval system of handling trains, does not permit the utilization of the full capacity of the tracks provided. The traffic on this section consists of some 42 passenger and freight trains per day, and it is of such a character that, at certain times of the day, there are many trains in the same direction at very close intervals. Several of the passenger trains are run in two or more sections

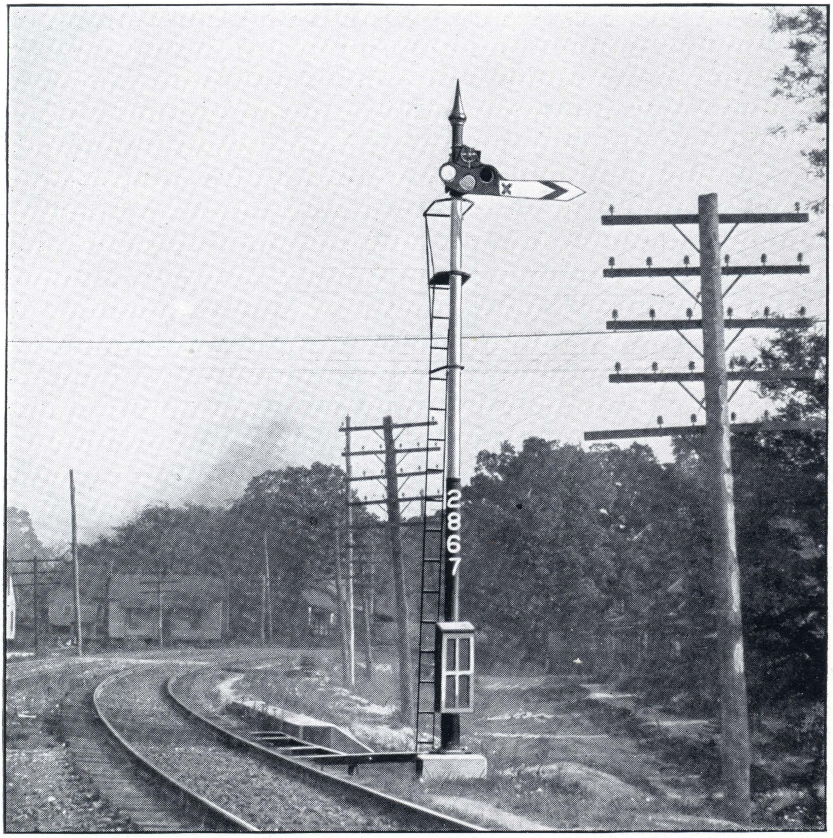


Fig. 2

Stop Signal

regularly. The handling of large quantities of fruit, vegetables and perishable freight, at certain seasons of the year, add so many additional trains that the manual block system could not handle the traffic without serious delays. After a careful consideration of the entire subject by the management of the road, it was decided that the use of automatic signals would at a less annual cost add much more to the capacity of the existing track facilities than could be obtained by any re-arrangement or addition to the existing manual block system, besides increasing largely the safety of train movement in this territory.

When the signal system was authorized a study was made of the traffic to be handled, the local conditions, and the first cost of an installation on the basis of one, two and three-mile blocks. Three-mile blocks were rejected as not offering the facility of train movement desired. One-mile blocks were rejected on account of increased cost and the giving of shorter blocks than is necessary at the present time, and two-mile blocks were decided upon as permitting a large increase in the capacity of present trackage at a reasonable cost. It was realized that blocks of this length require, in three-position signaling, the giving of the distant indication farther from the home signal than is generally thought desirable, but no practical difficulties have resulted.

When in the future, traffic has increased to such a point that this spacing of signals will not adequately take care of the train movements, additional signals may be installed between the present signals without disturbing the installation, thus cutting down the length of the block so that the maximum traffic capacity may be obtained from the present tracks.

LOCATION OF SIGNALS

A scale plan showing switches, grade, and alignment was prepared and a tentative location of the signals made on this plan. Keeping in mind the block length of approximately two miles, the signals were located with reference to the switches, curves and grades in the best apparent location. The locations were then checked by riding over the territory a number of times on trains. Where a good view of the signal in the proposed location could not be obtained, it was shifted to secure the best possible view. A motor car was used when marking the precise locations on the ground, the locations thus determined being shifted later in some cases so that a minimum amount of trunking and wire would be required.

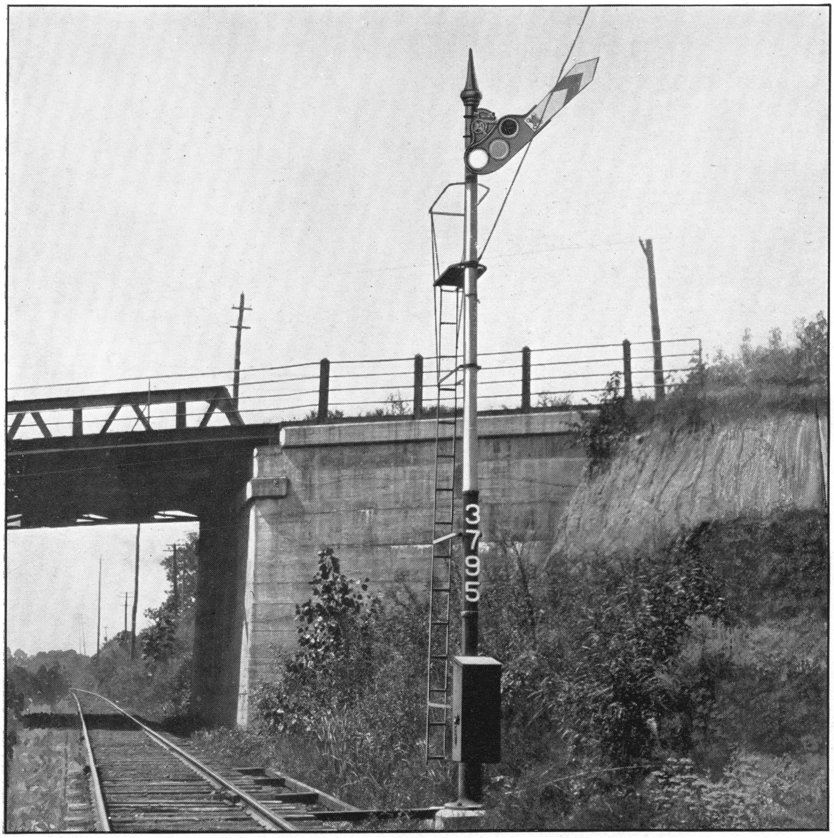


FIG. 3

CAUTION SIGNAL

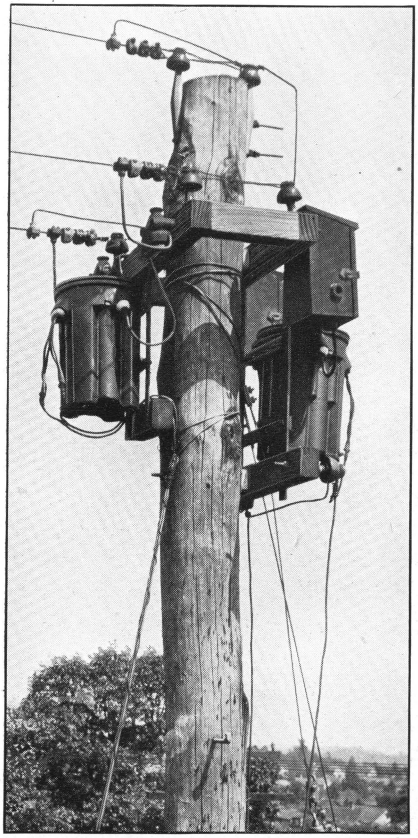


Fig. 4

Transformer for Signal Operation and Station Lighting

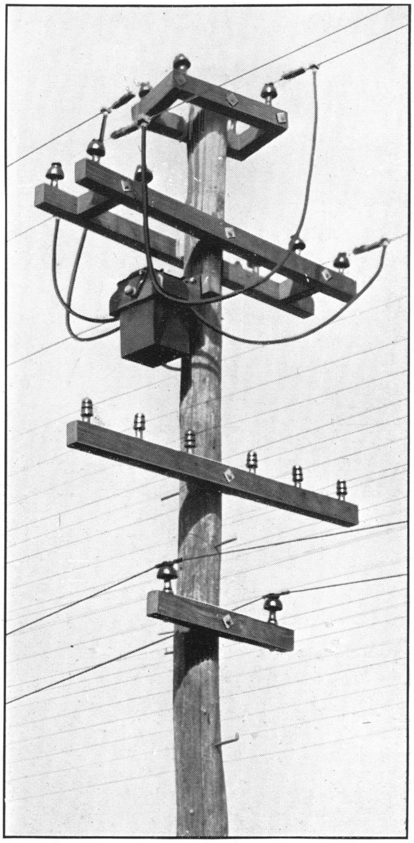


Fig. 5

Sectionalizing Switch on Transmission Line

The location of the signals was marked for the construction force by nailing a tin disc to the nearest cross tie. This method proved unsatisfactory on account of the disc rusting, and white paint on the tie will be used in future installations.

In general, the signals were placed to secure protection for trains standing at stations without greatly delaying following trains; at facing point switches, about 500 ft. in the rear; at lap sidings, at the home signal location if the ends of the sidings and crossover are ever interlocked; on grades, at points where tonnage trains can start if stopped by the signal; and at ends of tangents when track is curved, and on single track the signal locations are in each case "double."

Fig. 6

Clear Signal

It was necessary to vary from these general principles in only a very few instances.

CHOICE OF SYSTEM

After the length of block had been determined, a comparison of the various methods of supplying power for the signals was made, and alternating current was decided upon as possessing numerous advantages over direct current for this installation. Briefly, these advantages are—(1) it is free from the adverse influence of foreign current; (2) the track circuits can be made equal to the length of the block; (3) very much less apparatus is required, not only for the installation, but also to be maintained; (4) the signals and the railway company's buildings along the right-of-way can be lighted from the signal line; (5) there is more reliable working in all kinds of weather on account of the amount of power available to operate the signals; (6) the railroad company already had a power plant approximately in the center of the signal installation; and (7), the number of maintainers required could be reduced from 10 to 4.

The disadvantages were—(1) that a separate pole line would be required; (2) the breaking of the transmission line would put the entire system beyond the break out of order; and (3) the cost of the A. C. system was about 30 per cent. greater than a D. C. system with wires on the telegraph poles.

The advantages, however, so greatly outweighed the disadvantages that the alternating current system was decided upon.

TRANSMISSION LINE

Alternating current having been chosen, it became necessary to determine the proper voltage for the transmission, the material to be used for, and the details of, the pole line.

On account of the relatively large lighting load, and having in view the probable future extension of the system, the calculations showed a three-phase 4,400-volt current to be the most economical, this voltage enabling the amount of power required to be transmitted without undue loss and still not being high enough to require expensive protective devices and insulations.

This voltage required that the line of wires have a conductivity of about a No. 6 B. & S. gauge hard-drawn copper wire. The ease with which hard-drawn copper breaks when it has been injured in erecting led to an investigation of aluminum, which has been used in a number of high-voltage transmission lines. The wire finally selected is composed of six strands of aluminum about a plow steel core,

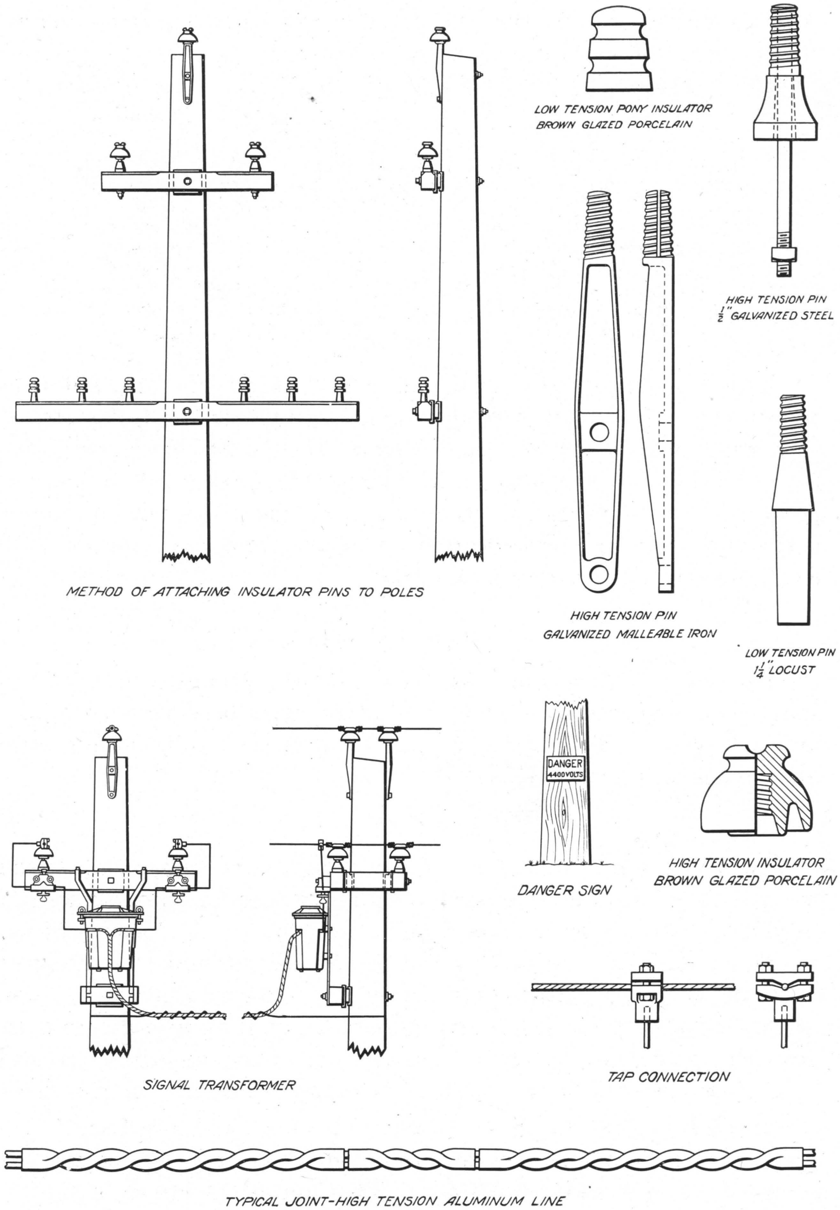


FIG. 7

CONSTRUCTION DETAILS—TRANSMISSION LINE

and is manufactured by the Aluminum Company of America. Following is a comparison with hard-drawn copper of equal conductivity:

	Hard-Drawn Copper	Stranded Aluminum
Size B. & S. gauge	6	4
Resistance, ohms per 1,000 ft.	0.40332	0.40013
Resistance, ohms per mile	2.1295	2.1193
Total area in C. M.	26,250	48,696
Total area aluminum C. M.		41,712
Total area steel core C. M.		6,954
Weight, lbs., per 1,000 ft.	79.46	57.3
Weight, lbs., per mile	419.55	302.55
Total ultimate strength, lbs.	1,237	1,694
Cost, dollars, per 1,000 ft.	13.70	12.70

It will be noted that the aluminum strand has the following advantages: (1) It is slightly greater in conductivity; (2) has greater strength; (3) is much lighter in weight; (4) is easier to erect; and (5) is cheaper in first cost. The increase in strength is practically greater than indicated on account of the fact that the aluminum is stranded and not easily injured, while the copper is solid and very easily nicked and broken in erecting.

LENGTH OF SPAN

The use of aluminum, and its superior strength, enabled the span to be increased over what would have been possible with copper, and a length of 200 ft. in the open country and 150 through cities and towns was employed.

JOINTS

Owing to the difficulty of soldering aluminum, some other method of joining the line wire and taps had to be used. The joint used in the transmission line is shown in Fig. 7. It consists of two 10-in. and one 5-in. aluminum sleeves. It will be noted in the figure that the short middle sleeve is twisted in a direction opposite to that of the end sleeves. This construction was adopted in order that the strength of the joint would be equal to the full strength of the steel core of the wire. The wire will break before the joint will give away.

Tap-offs from the high-tension line for the transformer and lightning arrester connections were made with the special cast aluminum clamp shown in Fig. 7. The lug on the larger of the two parts of the clamp was drilled in the factory for the tap-off wires and filled with a special solder and flux so that it was only necessary to apply heat and insert the tap wire to attach the clamp to the tap wires. These were attached to the transformers, lightning arresters

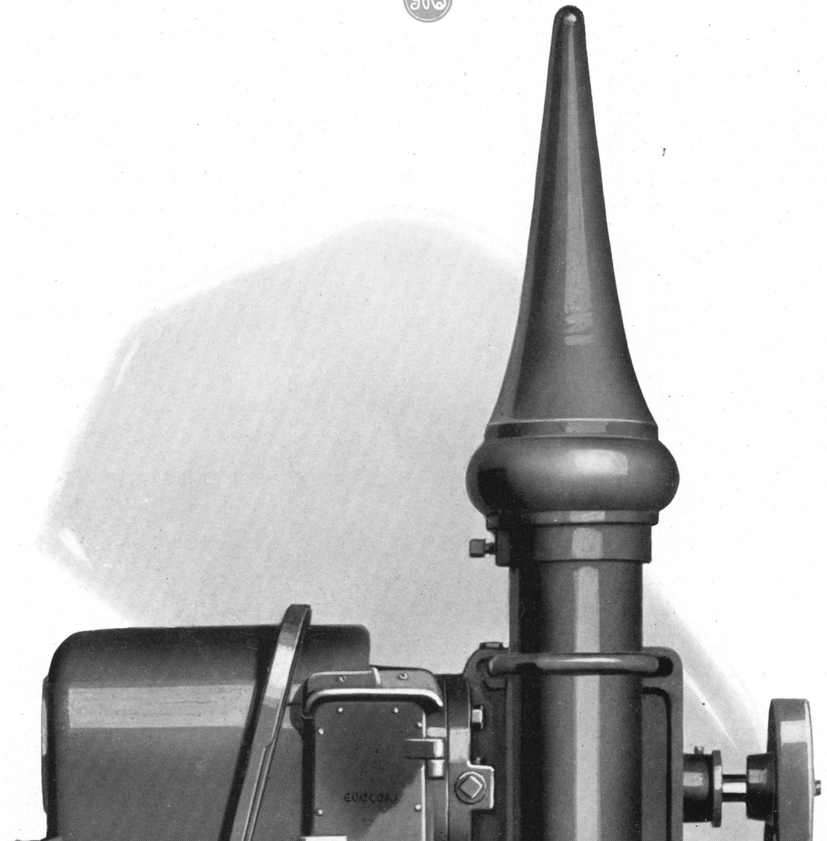


FIG. 8

MODEL 2A SIGNAL—SIDE VIEW

and other apparatus before they were distributed so that all the work necessary in the field was to attach the clamp to the transmission line. This was readily done by means of the bolts holding the two parts of the clamp together. Spring lock washers were provided to prevent the bolts from coming loose. A very reliable, easily applied and good contact was thus obtained.

At dead ends on the aluminum wire, special aluminum-faced clamps were used to prevent injury to the aluminum strands and to develop the entire strength of the wire.

Joints in the Copper Clad steel wire used for the low-tension circuits were made with ordinary copper sleeves in the usual manner, and branch wires were soldered to the line wire.

On the single-track section and in the vicinity of Pomona interlocking it was necessary to string some low-tension lines. No. 12, 40 per cent, Copper Clad steel wire furnished by the Duplex Metals Company was used for this purpose.

POLES

Chestnut wood poles were used, as they could be obtained upon the railway's lines and are relatively long-lived. The poles have a 7-in. top and vary in length from 25 to 60 ft. Very few of the higher poles are used, the average height being 30 ft., with 25 ft. above the surface. The tops of the poles were graded for height so that the wire line is approximately level, though no additional expense was incurred to make it exactly so. On highways a height of poles was chosen so that the wires clear a minimum of 22 ft., and over railways 30 ft. Crossings over the railway tracks were made at an angle of 45 deg. whenever it was feasible.

The transmission line wires were, wherever possible, carried above all other wires and structures crossing the railway. Where this was impossible $3/8$-in. Circular Loom was placed on the transmission line wires directly below the crossing wires to prevent possible contact in case of a broken wire falling on the transmission line. On curves, poles were set on chords of the curve to obtain as much straight line as possible. This made a much stronger line than following the curve of the track, and is more sightly, as each pole does not require a guy wire and anchor.

The tops of the poles were sawed off smooth to an angle of 1 in 7, and the top painted with Avenarious Carbolineum. The minimum depth of the hole in the soil was 5 ft. for 25-ft. poles, increasing to 7 ft. 6 in. for 60-ft. poles. In solid rock where it was

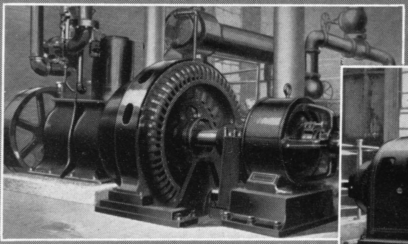


Fig. 9
Steam Driven A. C. Set

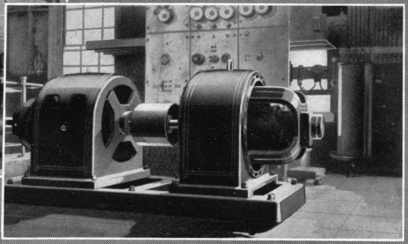


Fig. 10
Generator Set and Signal-Motor Switchboard

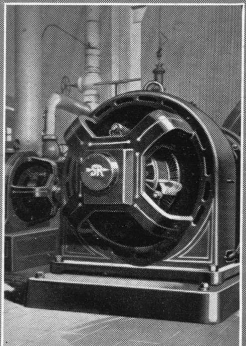


Fig. 11
End View Motor-Generator

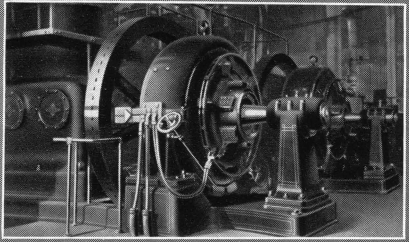


Fig. 12
Power Equipment
Main Power Station, Spencer, N. C.

Power Equipment

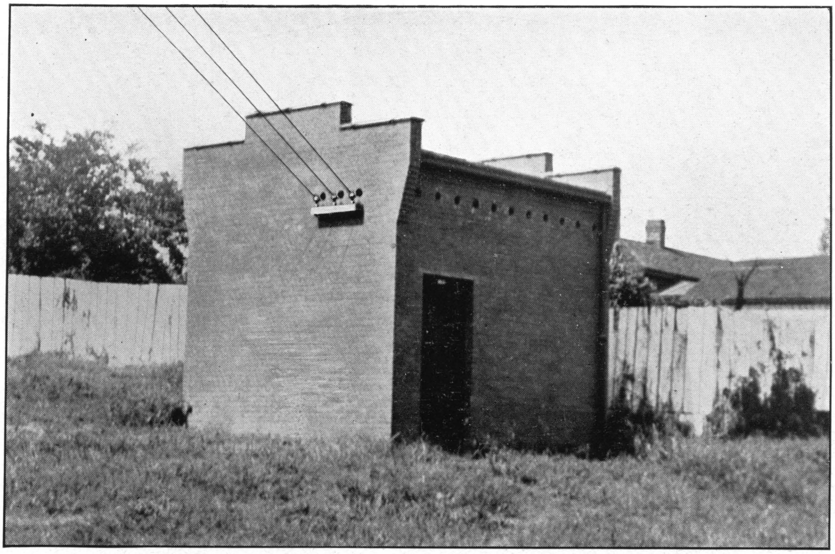


FIG. 13
CHARLOTTE SUB-STATION

necessary to use dynamite, the holes were somewhat shallower, but no poles were set less than 4 ft. even in rock. In filling the holes only one man was allowed to shovel in the dirt to three men tamping. This, with the requirement that the fine earth or sand be used at the bottom of the hole and the coarse soil or gravel at the top, secured a very firm foundation for each pole. In the solid rock, broken fragments of rock were tightly wedged about the pole.

All hardware used was galvanized, and was required to meet the specifications of the American Telephone & Telegraph Company. Transformer, lightning arrester, and sectionalizing switch poles were provided with steps.

All of the details of the pole line and the methods of construction used were selected with a view to obtaining a strong substantial line with a minimum of skilled labor.

CROSS-ARMS

Two sizes of cross-arms were used. One size, 3 in. x 4 in. x 36 in., bored for two ½-in. steel pins on 28-in. centers, was employed for the bottom phase of the transmission line, and one 3 in. x 4 in. by 6 ft. 0 in., bored for six 1¼-in. wood pins, was used for the low-tension wires. The location of the arms on the pole is shown in Fig. 7. The longer arm is used only where there are low-tension wires, as on the

FIG. 14

SIGNAL TRANSFORMER

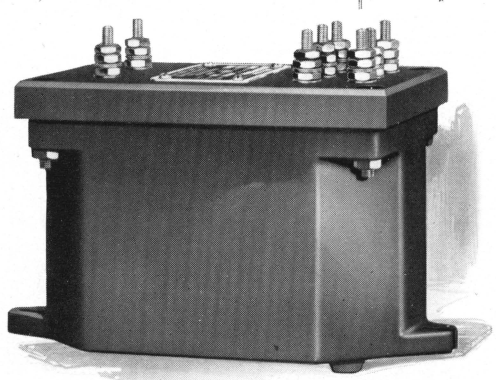


FIG. 15

TRACK TRANSFORMER

single track section and in the vicinity of Pomona interlocking. The arms are unpainted and are of cypress, this wood having been chosen on account of its very long life.

GAINS

To preserve the strength of the pole and to reduce the labor to a minimum, gains were not cut into the poles, but steel gains were employed. The use of these devices also obviated the necessity for cross-arm braces, and cost of the pole line hardware was thus materially lessened.

The gain consists of two steel stampings fastened between the cross-arm and pole by a 5/8-in. bolt. Two tongues are cut from the back of the gain and inserted in slots. The tongues are forced into the pole when the through bolt is set up, which squares the cross-arm with the pole, fastening it securely in place.

GUYING

All curves, crossings, corners, terminals, transformer poles, and extra long spans were securely guyed with 1/4-in. galvanized guy strand. Storm guys were used on the transformer poles and head guys where necessary, but in no case more than one mile apart.

When guy wires were liable to be run into by employes or the public a guard consisting of about 6 ft. of 3-in. by 3-in. trunking was fastened about the guy wire, this passing down through the groove in the trunking, and the trunking resting on top of the anchor. This forms a neat and at the same time effective guard. A very large number of guys were used in proportion to the length of the line as it was believed they would add immensely to its stability.

ANCHORS

Crouse-Hinds ungalvanized butterfly pattern drive anchor rods were used throughout. They were very easily and quickly installed even where the soil contained considerable quantities of rock. There was a very material saving in labor by their use over what would have been required if parts of poles or "deadmen" had been employed, as there were no holes to dig. These anchors were inserted, wherever possible, at least one-third of the height of the pole away from the ground line of the pole.

INSULATORS

All line insulators used were of brown glazed porcelain, a brown color having been chosen as being inconspicuous and not liable to

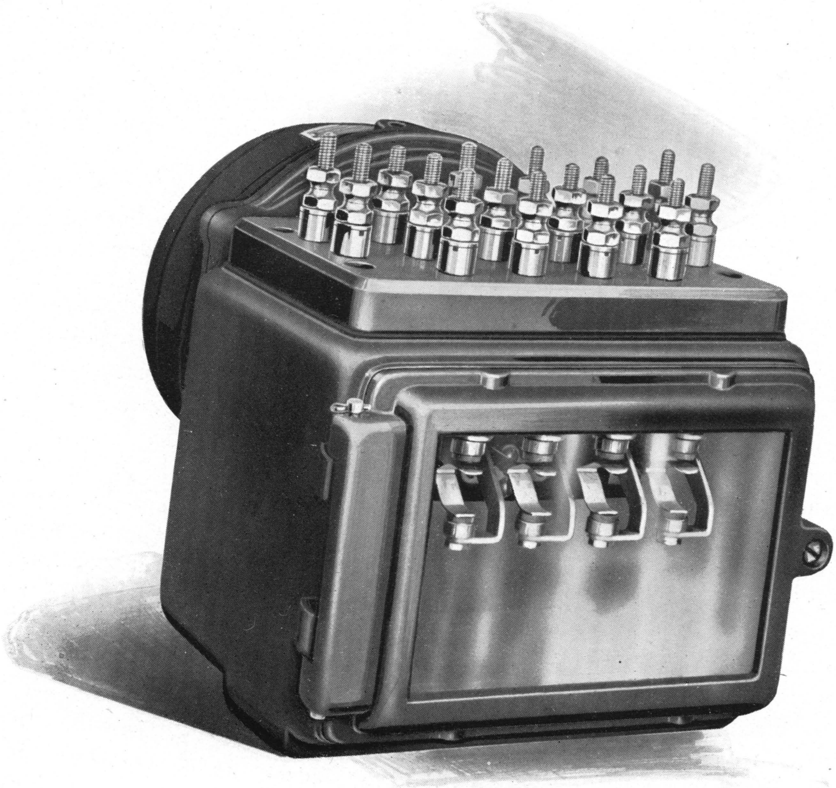


Fig. 16

Model 2 Form A Relay

be used as a target by thoughtless persons with guns. The high and low-tension insulators are shown in Fig. 7. The former is a standard 6,600-volt insulator weighing about 1.75 lbs. and tested with 12,000 volts wet and 20,000 volts dry. A soft-drawn aluminum wire 18 in. long, of No. 4 B. & S. gauge, was used for tying the transmission line to the insulator.

Strain insulators were installed in all guy lines to prevent grounding the line and to avoid danger of shock due to touching a guy wire in case of an accidental contact between a phase and a guy wire.

INSULATOR PINS

The pole-top pin used was of galvanized malleable iron. A detail is shown in Fig. 7. The high-tension insulators were cemented on to the pin with thin Portland cement before being distributed, care being taken to screw the insulator on as firmly as possible and still have the top groove of the insulator perpendicular to the back of the pin. The groove is thus parallel to the line and the wire can be tightly, and easily, tied in. The pole-top pin is attached to the pole by a ½-in. by 9-in. bolt and a ½-in. by 6-in. lag screw. Where double pins are required, two bolts are used. This construction is easily erected and is believed to be much stronger and cheaper than the method sometimes used where the top of the pole is bored out and the top pin mounted directly on top of the pole.

The other high-tension insulator pins are shown in Fig. 7. This is a ½-in. steel pin with wood cap and brown porcelain base. The wood cap is paraffined, and this, with the porcelain base, gives a pin the insulation resistance of which is very high. This construction obviates all danger of burning of the insulator pins.

The insulator pin used on the low-tension lines is a standard 1¼-in. locust wood pin, unpainted, and is practically immune to decay.

DANGER SIGNS

Enameled steel signs bearing the words, "DANGER, 4,400 VOLTS," were attached to poles in the vicinity of stations and road crossings where it was thought there was any liability of employes or others climbing the poles or coming in contact with the high-voltage wires. These signs are shown in Fig. 7.

SECTIONALIZING SWITCHES

To provide means whereby repairs could be made to the transmission line without putting the entire signal system out of service, sectionalizing switches, Fig. 5, were installed at convenient intervals,

FIG. 17

MODEL 2 FORM B RELAY

averaging eight miles apart. These switches enable the current to be cut off the transmission line in emergencies at practically any point and yet keep nearly all of the signals working. The switches are mounted in a cast-iron box and the contacts are immersed in oil. All three wires are disconnected at one movement of the switch handle, which indicates by its position whether the current is on or off. The switches are the General Electric Company's Type "F," Form "P." The connecting wires from the line to the switch are provided with extra heavy insulation guaranteed to stand a potential of 6,600 volts, which is 50 per cent. greater than the line voltage.

HOOK SWITCHES

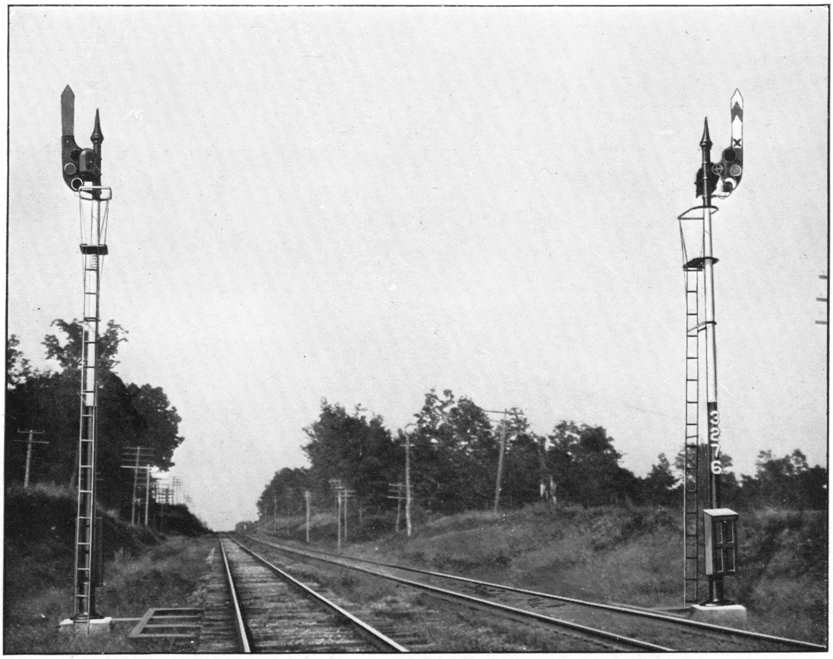
To entirely disconnect the lines from the sub-stations and power-house, Westinghouse Type "M" hook switches are provided in each line. These permit of the cleaning and inspecting of the apparatus with entire safety. These switches consists of a copper bar mounted upon vitrified porcelain attached to a cast-iron pedestal. The porcelain supports are designed to withstand the voltage of the circuit without breaking down or puncturing. The switches are operated by means of a hook mounted upon a wooden pole which engages in a hole in the switch blade. This enables the switches to be opened when the circuit is alive, if necessary.

THE MAIN POWER STATION

The railway company has at Spencer, N. C., a very large shop where 240-volt direct current, steam power, and the services of an engineer are always available. As this is also approximately in the center of the installation provision was made for obtaining the current for operating the system from this point.

The apparatus installed included a Westinghouse high-speed single-acting standard engine, direct-connected to a 75 K. V. A. three-phase 60-cycle 440-volt generator with a direct-connected 7½-K. W. 125-volt exciter. This set is used when the direct current dynamos are fully loaded and is shown in Fig. 9. The General Railway Signal Company furnished a 75 K. W. motor generator set, taking direct current at 250 volts and delivering three-phase 60 cycle current at 440 volts. This set is shown in Figs. 10 and 11. It is used when the direct-current dynamos are running with less than full load.

Four 25 K. V. A. transformers are installed upon a raised concrete platform back of the switchboard and are used to step up the 440-volt alternating current generated, to 4,400 volts for the transmission



Double Track Signals

line, three of the transformers being connected in delta and one held in reserve.

A three-panel marble switchboard carries the necessary instruments and controlling apparatus. This switchboard was made up to match the existing d. c. switchboard.

An electrolytic lightning arrester was installed and arranged to protect the apparatus in the power-house from lightning and high potential surges on the transmission line.

Six wires are carried into the switchboard so that the transmission line running north can be separated from that running south. The entire installation was designed to secure as far as possible uninterrupted service.

ENERGY REQUIRED

The total energy required for 118 signals, all track circuits, and the signal lightning, is now slightly less than 10 K. W., and it is expected that even this low energy consumption will be further reduced.

SUB-STATIONS

To insure an uninterrupted service in case of a failure of the power plant at Spencer, arrangements were made to secure current from the Southern Power Company at Charlotte and Thomasville. A more desirable location for the emergency supply for the north end would have been at Greensboro at the end of the system instead of at Thomasville, but current was not available at that point. A very substantial pressed brick building, to match the architecture of the adjacent station buildings, was erected for the sub-stations. The sub-stations are each equipped with a switchboard, electrolytic lightning arresters, measuring instruments, transformers and switches. The transformers are 12½ K. W. each, and they step the Southern Power Company's current up from 2,300 volts to 4,400 volts. Four transformers are provided at each station, three of which are connected in delta, with one spare. The spare transformer is mounted directly under the bus bars, to which the working transformers are connected, and is provided with terminals of the proper length for connecting without delay in case of trouble.

The board is drilled for the reception of the Power Company's wattmeter.

The alarm bell is mounted in an adjacent telegraph office and indicates to the operator that current is off the line. When this bell rings he goes at once to the sub-station and takes the necessary

Fig. 20

Model 2A Signal—A. C. Mechanism with Cover Removed steps to restore current to the line. Printed instructions are posted under glass in both the sub-stations and the telegraph office.

CHOKE COILS

To prevent high potential discharges due to lightning or other causes reaching the transformers at the sub-stations and the power-house, choke coils are inserted on each wire entering from the transmission line. These coils do not act as a lightning arrester, but they offer such resistance as to force the discharge through the arrester. The coils are circular in shape, heavily insulated, and are mounted on brackets on the wall to protect the apparatus in the power-house from lightning and high potential surges on the transmission line.

SIGNALS

The signals used are provided with the R. S. A. type "A" spectacle, and are 25 ft. high from the base to the center of the spectacle bearing. They are the General Railway Signal Company's Model 2 A top-post three-position type, giving the indications in the upper right-hand quadrant. These signals are operated by a 110-volt series commutator motor, having a high starting torque and a low operating current. This motor is so designed that it will operate the signal arm from 0 to 90 deg. in seven seconds, with a 20 per cent. reduction in the normal operating voltage. The motors are equipped with a star-wheel hold clear device, neither slot nor dash pot being necessary or being used. The signal is held in the several positions by means of a stator winding with a laminated iron core, mounted on the armature shaft of the motor. When the mechanism is assuming the proceed position, the core, through the medium of a simple clutch, remains stationary when its stator winding is energized. The moment the reverse movement starts the clutch clamps this core to the armature shaft and holds the signal blade in the position to which it has been moved. The holding of the blade in the proceed position is not dependent on mechanical contact in any way, but is due entirely to the torque produced by lines of flux flowing between the pole surfaces, separated by a large air gap. When the retaining current is cut off the torque existing between the core and stator pole pieces ceases, and the signal arm returns to the stop or caution position, as the case may be. Instead of using a dash pot, the signal is prevented from going with shock to the stop position, by means of a buffer spring which absorbs the energy developed by the mechanism and motor by backward motion.

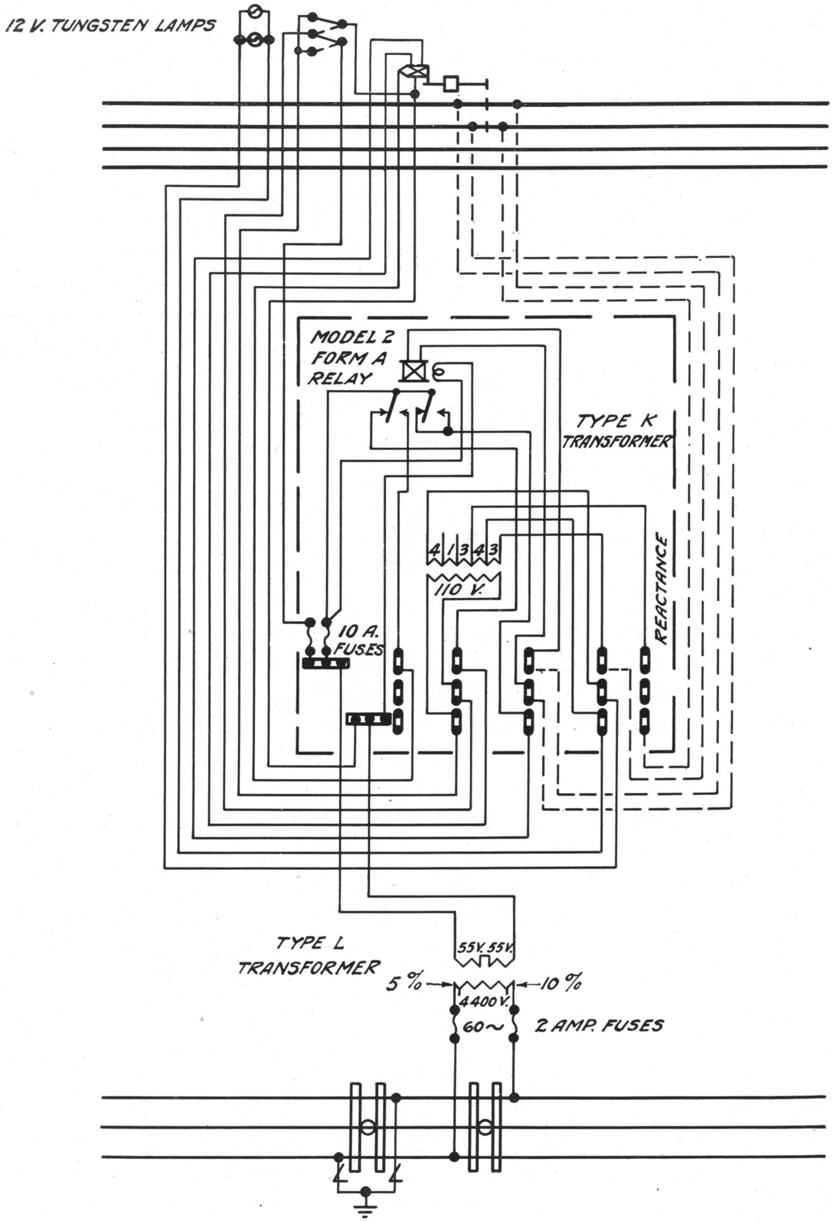


Fig. 21

Typical Wiring Diagram, Single Signal Location

Quick and accurate movement of the semaphore arm is obtained by the use of a centrifugal governor on the end of the armature shaft for controlling the speed of the motor and preventing the signal from overrunning its position. This insures the arm coming to the proceed position rapidly and without shock under various conditions of load, voltage and line resistance.

No slow-acting relays are required in the 45 deg. to 90 deg. operation of the signal, as it will return to the full proceed position without first going to the stop position. It has been found that this feature is a valuable one, as it obviates the necessity of synchronizing the power house generators with the line voltage. This simplifies the changing of power on the line from the power house to the sub-station, or vice-versa, very materially. A view of the signal mechanism and motor is shown in Fig. 20. Signals to the number of 116 are used on the entire installation.

On account of local conditions, a number of special signals were required. Fig. 23 shows one of the bracket signals.

Two-arm signals, as shown in Fig. 22, are located just south and north of the Salisbury passenger station. All passenger trains leave the main tracks about 300 ft. in advance of this signal to enter upon one of the tracks into the station. These station tracks are long enough to hold two trains, and many times a day it is necessary to move the entering train upon an occupied track. To prevent stopping practically every train, the lower arm was added to these signals to govern trains entering the station. This arm works from 0 deg. to 45 deg. only and is controlled by the position of the switches leading to the station tracks, the upper arm being a regular three-position arm and governing straight through on the main track.

Veeder counters reading to five figures are provided with each signal to record the movements of the signal arm from 0 deg. to 45 deg. and from 45 deg. to 90 deg. separately. This will enable a very accurate record to be kept of each signal performance.

SIGNAL BLADES

The signal blades follow the recommended practice of the R. S. A. as to shape, bolt holes, spacing and striping. They are of steel, heavily enameled; face red with white stripe, and back all black with no stripe. They present a handsome appearance and are easily kept clean.

SIGNAL NUMBERS

All of the signals are numbered to represent not only their location, but also the direction of traffic they govern. That is, south-

Fig. 22

Two-Arm Signal, Salisbury

bound signals are numbered to the nearest odd tenth of the mile and northbound to the nearest even tenth of the mile. Thus signal 3306 is located between mile post 330 and 331 from Washington and is for northbound trains, northbound trains having even numbers and southbound odd numbers on the Southern Railway.

These numbers are of cast iron, 8 in. high, and are attached to each signal. They are mounted upon a 1½-in. wrought iron strip by means of small bolts, the strip being fastened to the pole by clamps. The numbers are painted white, and as the signal mast behind the number is painted black, the numbers are very plain and distinct. No skill is required to paint them, and they are free from any chipping or flaking that enamel numbers would possibly be subjected to.

SIGNAL LIGHTING

Each of the signals is provided with two 12-volt 5-watt Mazda lamps in multiple. These lamps are mounted in porcelain receptacles in a small cast-iron lamp box, provided with a sliding cover and guides so that it slips on to a standard R. S. A. oil lamp bracket.

The lamps are kept burning continuously on the 8-volt tap of the secondary transformer. On account of the very white character of the light given by a tungsten filament lamp, they can be burned very much under their normal operating voltage and thus enormously increase their life. In spite of the decrease of candle power due to the reduced voltage the light on the signals is much superior to any oil light which we have been able to obtain. It is expected that the 12-volt lamps burned on the 8-volt circuit will last at least a year and probably much longer. The total current consumed by the two lamps is approximately eight watts per signal.

LINE RELAYS

The few line relays that are used in the installation are of the General Railway Signal Company's Model 2 Form "B" type. This is a two-position polyphase relay operating on the same general principle as the polyphase track relay. It is designed for mounting on the walls of the relay boxes, and the glass case protecting the contacts can be removed by unscrewing the retaining nut at the bottom. The relay is approximately the same size as a D. C. relay of the same number of contacts.

LINE TRANSFORMERS

Separate line transformers are used for each signal except at double signal locations. They are the General Railway Signal

Fig. 23

Bracket Signal

Company's Type "L" oil-cooled, 600 volt-ampere, single-phase, 60-cycle, 4,400-volt primary, 110-55-volt secondary. The transformer is provided with a primary terminal block with binding posts for 5 and 10 per cent primary taps. Each transformer is provided with high-tension fuses and the mounted transformers are shown in Fig. 4, which shows a signal line transformer and a station lighting transformer mounted on the same pole.

RELAY BOXES

Relays, track transformers and impedances are housed in wooden boxes secured to the signal mast. The box in each case is made of 1½-in. clear pine lumber, and the top is covered with galvanized iron. Shelves in the box are loose so as to permit free access to the apparatus. All relay boxes are wired as nearly as possible alike to simplify testing.

At single signal locations, where the signal is on the opposite side of the track from the pole line, the relay box is mounted on the signal mast. The 110-volt lines from the signal transformer are brought to an iron cable post set upon a concrete foundation, and thence to the relay box through trunking. This reduces very greatly the amount of wire required, and makes all the wiring of the relay boxes uniform.

TRUNKING

All trunking used was yellow pine 3 in. by 4 in. in section, and before being installed was treated with two brush coats of Avenarious Carbolineum preservative compound in lieu of paint. This compound gives a very pleasing brown finish to the trunking, and as tests have shown that it has no deteriorating effect upon the rubber insulation of the enclosed wires, it is believed that it will materially prolong the life of the trunking and prove more economical than painting. All trunking is supported by a short length of capping upon cedar stakes not over 5 feet apart. As the trunking is not buried beneath the ballast, particular care was taken with the carpenter work, in fitting, so as to make as neat an installation as possible.

WIRE

All insulated wire used was manufactured by the National India Rubber Company in accordance with the specifications of the R. S. A., and was inspected by the Wire Inspection Bureau of New York before shipment.

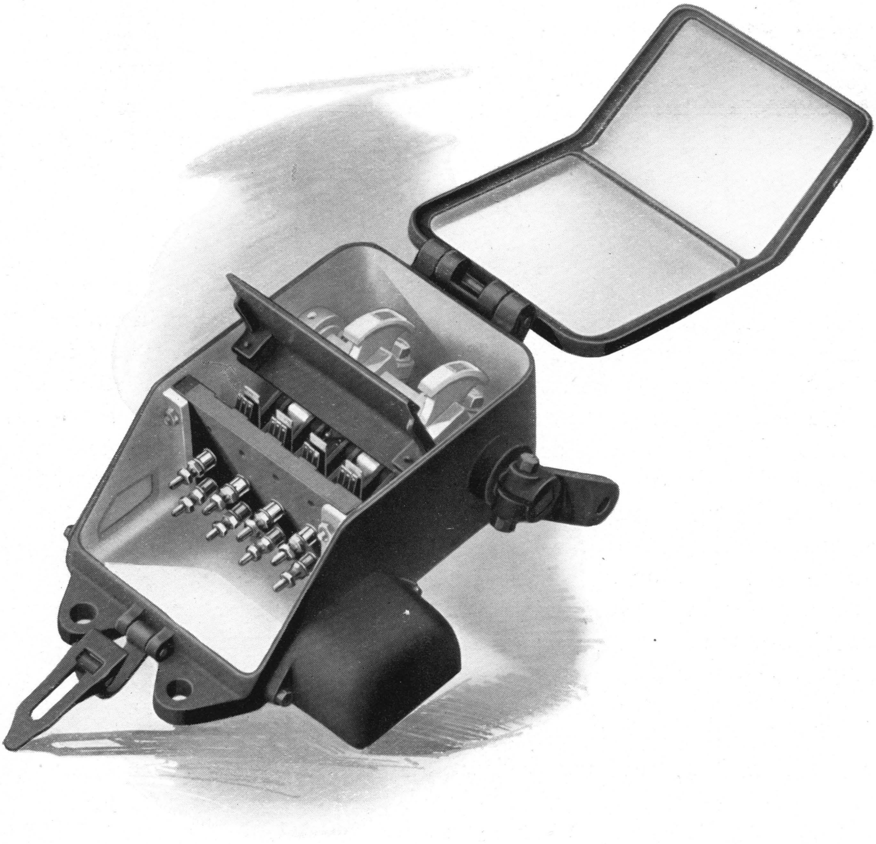


Fig. 24

Model 5 Form A
Switch Circuit Controller

SIGNAL WIRING

Wires from the relay boxes to the signal mechanisms are carried through iron conduit into the mast in each case, then up the interior of the mast and out to the mechanism case through a length of steel-armored flexible Sprague conduit, making a very neat and permanent construction.

TRACK TRANSFORMERS

To make the installation as simple as possible and to minimize danger to the maintenance force, the various voltages required for lighting, track circuits, etc., are not obtained from the main transformer, but from a track transformer with a voltage of 110 on the primary side. This arrangement requires but two wires from the pole line to the relay box, and the maintainer is not required to work in close proximity to the high-voltage line when making adjustments and inspecting apparatus. This additional safety and simplicity is believed to more than offset any loss that might be due to the use of two transformers. The transformer operates upon 110-volt primary, and any voltage from one volt to 22 volts may be obtained on the secondary. It is small and compact, and is provided with standard and easily accessible binding posts so that any charge of voltage required can be quickly made. The capacity of the transformers is 200 V. A. It is the Form "K" made by the General Railway Signal Company, and is shown in Fig. 15.

TRACK RELAYS

The track relays are the General Railway Signal Company's Model 2 Form "A" three-position, shown in Fig. 16, especially designed for very long track circuits.

The relay is operated by a polyphase motor, which consists of a non-magnetic shell or rotor and fixed inner and outer cores, the outer core being the stator on which the windings are placed. These windings are designed and connected so as to produce (with alternating current applied) a rotating magnetic field, which in turn will induce currents in the non-magnetic rotor, causing it to operate. Direct currents cannot produce this rotary field and cannot, therefore, operate the relay. The rotor is connected to the contacts by means of a pinion and selector arrangement, thereby multiplying the torque of the rotor and permitting the operation of a large number of contacts with a very small amount of energy applied. Furthermore, as most of the energy for the operation of the stator is obtained from

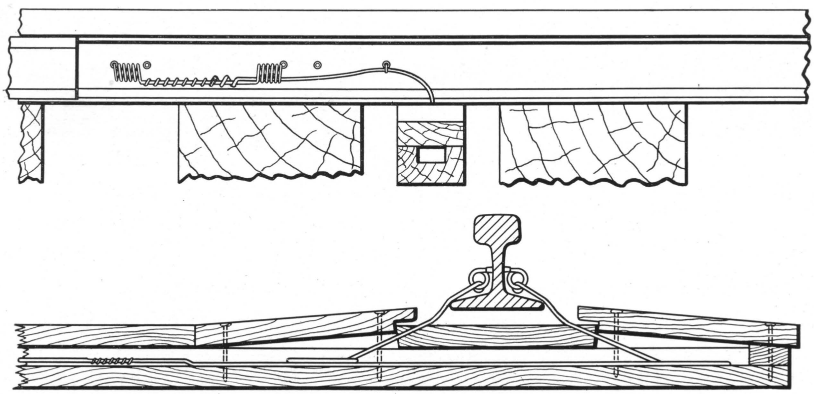


FIG. 25 – RAIL CONNECTION

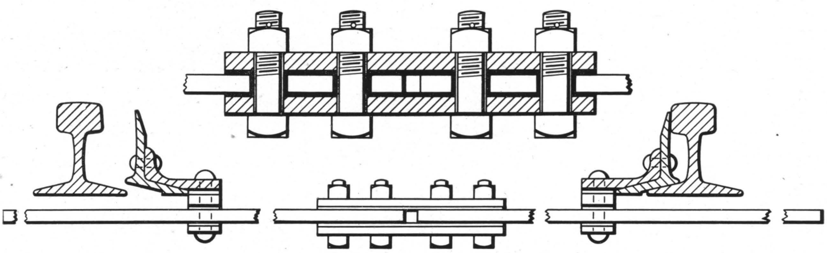


FIG. 26 – INSULATED SWITCH ROD

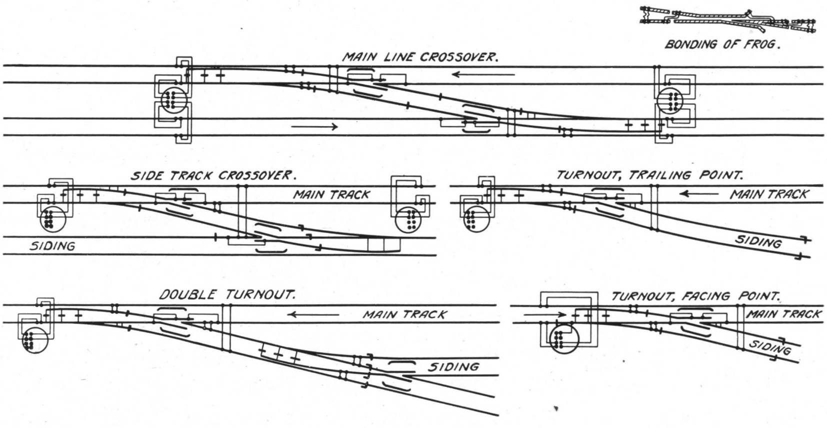


FIG. 27 – TRACK WIRING

a local transformer only a small amount of energy is required from the rails to operate the relay.

These features permit the operation of very long track circuits without the use of cut sections or a prohibitive amount of energy. The contacts are unusually heavy in construction, having a wide opening; and by rubbing through the last $\frac{1}{16}$-in. of their stroke in closing, they maintain a clean, low-resistance contact. Any combination of front, back or front and back contacts can be secured, and these changes can be made on the ground if desired.

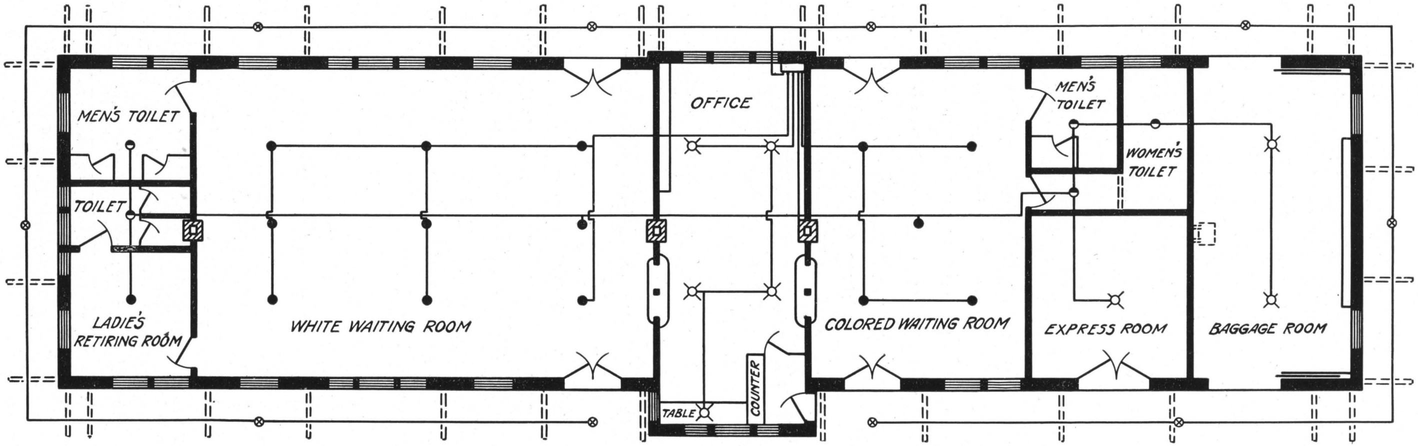
SWITCH BOXES

Circuit controllers, or switch boxes, shown in Fig. 24, are attached by means of $\frac{5}{8}$-in. adjustable rods to the normally closed points of all non-interlocked switches. They are also used on all side track derails not pipe-connected to main track switch stands. The box is designed so that all parts are accessible and readily adjusted. Four normal and four reverse contacts are provided in a separate compartment, which is furnished with supplemental cover. They are thus protected from frost and condensation and, when the main cover is open, from rain. The contacts are arranged so that they will make or break when the switch points are moved from the closed position $\frac{3}{16}$ of an inch. The contacts are mounted on slate, so that they can be removed without changing the contact adjustment. They are forced open or closed without reliance upon spring action. The binding posts are in a separate compartment and are R. S. A. standard. Of these boxes 326 were used.

TRACK INSULATION

Joints. Compared with a D. C. system of signals there was a considerable less number of insulated rail joints used. The majority of joints used were of the Weber one-end type although joints of several other makes were installed for trial and comparison as to efficiency, cost and durability.

Switch Rods. The work of insulating the switch rods, gage plates, etc., was done by the railway company's forces under Andrew Dellemont, interlocking foreman. The force being moved from place to place and the work performed in the field. The type of switch rod insulation is shown in Fig. 26. This type permits the use of the ordinary switch rod without any special parts other than the plates, bolts and fibre parts.



ALL WIRING CONCEALED EXCEPT FOR OUTSIDE LIGHTS.
PANEL BOX LOCATED IN OFFICE AT MOST CONVENIENT POINT.
DEEP CONE TIN SHADES IN OFFICE.
WIRE GUARDS IN BAGGAGE AND EXPRESS ROOMS.

● = A.B. UNIT FIXTURE #G25—40 WATT MAZDA LAMP.
⊖ = CEILING RECEPTACLE FLAT TIN SHADE, 25 WATT MAZDA LAMP.
⌑ = DROP LIGHT, 50 WATT GEM LAMP.
⊗ = WEATHER-PROOF SOCKET—50 WATT GEM LAMP.

Fig. 28

Typical Arrangement for Electric Lighting of Passenger Stations

Gage Plates. No insulation was used upon the gage plates, instead, about 6 inches was cut out of the middle of the plate and the ends of the plate securely fastened to the tie with lag screws.

Boot Legs. Standard boot legs or rail connections were made as shown in Fig. 25. This consists of a short piece of the bottom of the standard trunking cut to shape and the wires arranged as shown. It will be noted that there is an independent connection to both sides of the rail and that the parts are very low so that there is practically no chance for these connections to be broken by dragging equipment.

TRACK WIRING

Fig. 27 shows the track wiring used for all switches. It will be noted that the signal control wires are not carried through the switch circuit controller, but the signal is controlled by the switch through the track circuit entirely. Trailing point switches, shunt and facing point switches both break and shunt the track circuit. On single track the switch control of the signals is secured by carrying the control wires of the signal through the switch circuit controller. The track circuit is not shunted.

BONDING

Two 46-in. No. 8 E. B. B. galvanized wires were used on the gauge side of the rail for bonding rail joints. Through platforms and road crossings four No. 6 Copper Clad steel wires are used, two on either side of the joint outside of the angle bars. Tin-coated channel pins were employed throughout.

The use of iron bound wires for alternating current track circuits has heretofore been considered inadvisable, but the efficiency of the relay used is such that the extra conductivity of copper or Copper Clad bond wires is not required. The use of iron resulted in a large saving in the cost of this installation.

STATION LIGHTING

For lighting the smaller stations a regular 600 V. A. transformer, identical with the signal transformers, is used. For each of the larger stations a General Electric Type "H" single-phase transformer of the proper capacity is employed. These vary from three to ten kilowatts. All transformers used are designed in accordance with the requirements of the A. I. E. E. as regards heating, insulating, etc.

All of the stations not already wired for electric lights were wired by the railway company forces. Two different methods were used in carrying the low tension wire from the transformer to the buildings. Where the transmission line was on the same side of the track as the station the wires were carried directly through the air from the transformer to the station, no messenger wire being used as in the case of the signals.

At Concord, where the transmission line is on the opposite side of the track from the station the lighting wires are carried through 1½-in. Sheridized conduit under the tracks into the station. The wiring installed was open cleat work in the small stations and buildings and concealed work in the larger stations. Rubber covered copper was used for mains and branches and heavy reinforced cord for the drop lights. Waiting rooms were equipped with ceiling fixtures and holophane reflectors. All work being done in compliance with the rules and regulations of the National Board of Fire Underwriters. Practically all of the buildings of the railway company along the right-of-way were equipped with electric lights, such as gate houses, stations, interlocking towers, etc. The lamp used ranged from 25 to 150-watt Mazda, the latter being used to replace enclosed arc lamps. The smaller lamps being used in the majority of the outlets. The cost of wiring the stations was small and in a number of instances the transformer provided for the operation of a signal adjacent to the station is also used for lighting the station. No special transformer being required. A typical wiring plan for one of the stations is shown as Fig. 28. The total saving over the use of oil lamps and the difference in the cost of electricity at the stations where it was previously purchased from the local electric light companies is amounting to about $1,800.00 per year.

LIGHTNING PROTECTION

To protect the apparatus from the effects of atmospheric electrical discharges, three types of lightning arresters were installed. For low-voltage circuits the Brach type 20 arresters were used. These were mounted in special wood boxes on iron terminal poles, one arrester being provided between aerial and trunking lines for each wire.

For transformer protection on the transmission line, the General Electric graded shunt resistance multigap arrester was used. This arrester is designed to prevent an excessive rise in potential between the phase wires to the ground, to restrain the flow of dynamic current, and to extinguish the arc of discharge, as well as to discharge high potentials covering a wide range of frequency. It consists of a number of cylinders mounted upon porcelain and spaced with a small air gap between them. Some of the cylinders are shunted with resistance rods which tend to extinguish any arc formed.

To make the installation as simple as possible and to reduce the danger to maintainers in case of broken down arresters, the arresters are installed on the poles adjacent to the transformer poles. Each of the transformers is protected with arresters except where there are transformers less than one-half mile apart, in which case a single set of arresters protects both transformers. In future installations, arresters will be mounted on the same pole with the transformers.

For protection of the apparatus at the power-house at Spencer and the sub-stations at Thomasville and Charlotte, Type A electrolytic lightning arresters, made by the Westinghouse Electric & Manufacturing Company, were installed. This type of arrester was chosen on account of its ability to automatically offer a very low resistance to current flow at abnormal voltages, and, also, its high resistance to the flow of current of low frequency and its low resistance to current of high frequencies.

This arrester consists of a series of cone-shaped aluminum trays. These trays are stacked one on top of another, and each tray is insulated from the adjoining one. The number of trays required is determined by the normal operating voltage, there being one tray for each 275 volts (effective) for alternating current. After assembly, each tray is partly filled with a suitable electrolyte, and the stack of trays is placed in a steel tank. The tank is then filled with transformer oil, which completely submerges the trays. The oil is used to improve the insulation between the trays, to prevent the evaporation of the electrolyte, and to absorb the heat of discharge. The arresters are connected to the line through horn gaps that dissipate any dynamic arc that might be formed during discharge. The action of the arrester depends upon the formation of a film of hydroxide of Aluminum by electrolytic action. This film is formed by bridging the horn gaps at regular intervals. This connects the line potential to the arrester and builds up a film of a thickness proportional to the normal voltage of the line. This is called charging.

Grounds for lightning arresters are obtained by driving 1-inch galvanized iron rods 8 feet into the ground. At the sub-stations and power-house four of these rods are connected together in multiple. At transformer locations only one is used. This type of ground is very quickly installed, is cheap, and, it is believed, is as efficient as more elaborate grounds consisting of copper plates.

Fig. 29

A View of the Pomona Interlocking

POMONA INTERLOCKING

Fig. 29 of Pomona interlocking shows the only interlocking included within the limits of the automatic signals. This is a junction of the main line and a branch line leading to Winston-Salem and Taylorsville, N. C. The layout of signals and tracks are shown in Fig. 30.

The machine is a 24-lever S. & F. mechanical type, and the signal indications were given in the lower quadrant. All of the high signals have been changed to three-position upper quadrant power operated, and approach and route locking with time releases installed.

Annunciators were also provided which indicate the arrival of a train at the second automatic signal from the plant in each direction.

The circuits installed include six electric lights in the tower, supplied with current from the signal transformer.

TRACK AND SIGNAL CIRCUITS

Track circuits on double track are end fed and are continuous from one signal to the other. The track circuits vary in length from 300 to 14,000 ft. long. The voltage used upon all but the very short track circuits is 8 volts, and the longest circuits have worked perfectly not only in fine weather, but also when it was wet and rainy.

The 45 deg. to 90 deg. movement of the signal is secured by a reversal of the track transformer leads by the signal in advance.

The circuit for a single signal location is shown in Fig. 21.

Track circuits for single track are center fed with the transformer in the middle and relays at each end of the circuit. As in double track circuits extend the length of the block, no cut sections being used. These signals are arranged upon the "A. P." Block system which provides for head-on protection from one end of the single track to the other, thus preventing two opposing trains entering upon the single track. It also provides for following protection from signal to signal, so that trains may follow each other on the single track as on double track. At Rocky River, the south end of the single track, an over-lap is provided on the double track, which is only effective when the cross-over switch is set for a northbound train, northbound trains having timetable right over southbound trains on this division. This over-lap prevents two opposing trains from ever entering the single track under clear signals at the same time.

CONSTRUCTION

The transmission line was built by the railway company's forces. This force was provided with two motor cars, a large gang car, and a

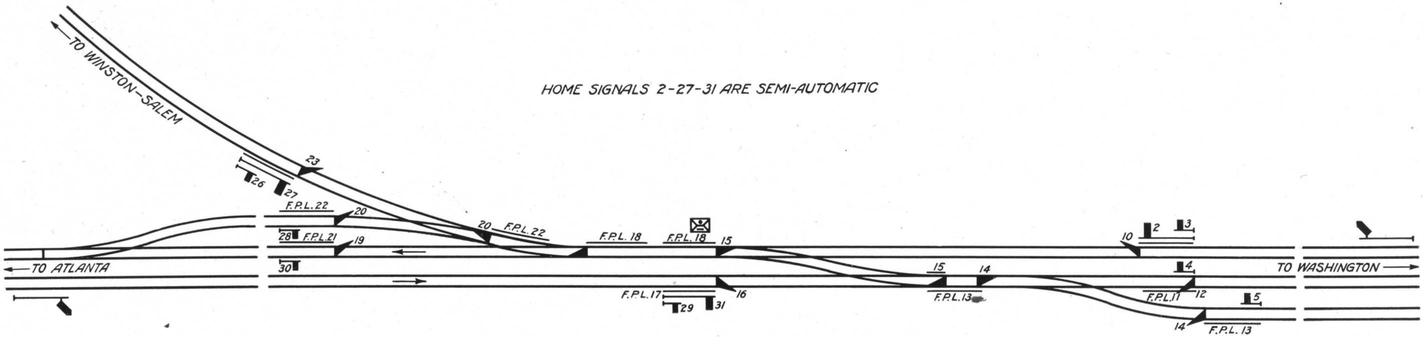


Fig. 30

Track Plan—Pomona Interlocking

small three-man car. The cars were of great assistance, the large car in transporting men and material, and the small car in enabling the foreman to oversee all parts of the work, the men in the gang being often spread out over four or five miles of territory. Cross-arms, pins and insulators were applied to the poles before erection, the poles having previously been dropped from a work train at the location marked. All poles were erected and guyed before any wire was strung. The stringing of the wire was done at a very rapid rate on account of the light weight of the aluminum strand and the ease with which it could be handled. The ¾-mile coils of wire were placed on the large motor car and all three-phase wires erected at the same time. Switch rods, pipe line insulations and electric wiring for all depots, towers and buildings on the railway's right-of-way was done by the railway company's own forces. The General Railway Signal Company furnished all of the signals, relays, switch boxes, signal transformers and signal material and the necessary labor for their installation.

A simple form of graphical progress report was devised, and upon this was shown the various details of the work and divisions corresponding to the mile posts. A very few moments' work enabled the general foreman to indicate upon this form all of the details of work done the previous week and just where it was performed. It saved an immense amount of letter writing and the state of the work on all sections could be seen at a glance.

The general foremen in the field were C. C. Strupe for the railway company and E. B. Fairbanks and Wm. Lowenthal for the General Railway Signal Company.

PLACING IN SERVICE

About two weeks before the signals were placed in service a bulletin plan as shown in Fig. 31 was prepared and posted upon all bulletin boards on all divisions concerned. In addition to the plan, a printed set of rules, as shown on page 51, based on the Standard Code was issued to all trainmen.

After a study of the plan and printed rules had enabled the trainmen to become familiar with the location of the signals and the governing rules, meetings were held by the superintendent with the employes affected by the signals to insure that all understood the indication of the signals and the rules. Twenty-four hours before the signals were placed in service a 31 order was issued to all trains notifying them that after a certain hour trains would be governed by the signals. Fifty miles of signals, from Greensboro to Salisbury, N. C., were put in operation at one time without trouble of any kind.

MAINTENANCE FORCES

Two maintainers and two assistants are required for the 100 miles of signaling. These men are so located that they can be reached quickly by the dispatcher and one of them will always be able to reach quickly the site of any trouble. These men will also look after the electric lighting of the stations and all electric work on their section except telephone and telegraph lines and instruments, these being under the jurisdiction of the telegraph department.

The maintainers and assistants have been provided with motor cars and the results so far indicate that they will successfully handle the amount of territory assigned them. This, it will be noted, is more than double what can well be handled with signals operated by direct current.

As the railway company has a large shop at Spencer, approximately in the center of the system, it was considered unnecessary to provide the maintainers with a very elaborate set of tools for repairing purposes. A full line of tools for ordinary maintenance was, however, provided.

RECORDS

A set of forms similar to those standard with the R. S. A. was adopted to keep a close check upon the performance of the signals. An engineer finding a signal at stop fills out a post-card form and leaves it at the first open telegraph office. The information on the card is sent to the dispatcher and the card forwarded by train mail to the signal engineer. The dispatcher notifies the maintainer, who forwards a report to the signal engineer, covering the occurrence and what was done. These reports, together with the monthly reading of the signals counters, are consolidated into a performance report of the signals each month in the signal engineer's office. The records are not elaborate, yet they are full and sufficient.

NOTE—This article is a revision of the articles which first appeared in the April, June and July, 1913, issues of the Signal Engineer Magazine.

Southern Railway Company

DANVILLE DIVISION.

OFFICE OF SUPERINTENDENT

Automatic Block Signal Rules

GREENSBORO, N. C., February 15, 1913.

Rules herein set forth govern the operation of automatic block signals on this division between Monroe and Montview via new line and between Denim and Salisbury, effective 12:01 p. m., February 23, 1913.

Failure to understand the rules or neglect to examine bulletins will not be accepted as an excuse for any violation thereof

RULES

501. The normal indication of the automatic block signal is PROCEED

AUTOMATIC BLOCK SIGNALS.

Signal	Occasion for use.	Indication	Name
Color	The signal will be displayed when	For enginemen and trainmen.	As used in rules.
(a) Red	Block is not clear	Stop.	Stop-signal.
(b) Green.	Block is clear. Second block in advance is not clear	Approach next signal prepared to stop.	Caution-signal
(c) White.	Block is clear.	Proceed.	Clear-signal.

The signals used are of the semaphore pattern, the governing arm is displayed to the right of the signal mast as seen from an approaching train

A permissive automatic signal has an arm with a pointed end.

Absolute automatic and home interlocking signals have an arm with a square end. They must not be passed when in the Stop position without authority, either by special order, caution or clearance card

The signal indications are given by three positions of the arm and in addition, at night by lights of prescribed color

Horizontal as the equivalent of (a)

Diagonal 45° above the horizontal as the equivalent of (b).

Vertical as the equivalent of (c)

Signals are placed where practicable, on masts to the right of, and adjacent to the track they control.

When the space between tracks is not sufficient for a mast adjacent to the track controlled, bracket posts to the right of such track will support the signal mast together with dummy or "doll" masts, representing—one for each track—the tracks intervening between the bracket post and the track controlled by the signal. These "doll" masts will each display a blue light by night and will be located to the right of the signal mast.

Automatic block signals are designated by numbers indicating the established direction of the running track for which the signal is given.

Signals governing north and east bound movements have even numbers and signals governing south and west bound movements have odd numbers.

502 Automatic block signals control the use of the blocks, but unless otherwise provided, do not supersede the superiority of trains, nor dispense with the use or the observance of other signals whenever and wherever they may be required.

503. Automatic block signals for a track apply only to trains running with the current of traffic on that track

504. (a) When a train is stopped by a permissive automatic block signal it may proceed when a Caution or Clear signal is displayed. If a Caution or Clear signal is not immediately displayed the train may proceed at once under control, expecting to find the block occupied, a switch open or the track broken or obstructed.

(Permission to pass an automatic block signal at Stop does not apply to absolute automatic block signals [Rule 504-b] or interlocking home signals [Rule 603])

(b) When a train is stopped by an absolute automatic block signal, authority to pass same must be obtained from the dispatcher If operator is not on duty and the dispatcher cannot be communicated with, the train may proceed under protection of flag to the next block signal in proceed or caution position.

505. When an automatic block signal is out of service, the fact will be indicated by special instructions.

Trains finding an automatic block signal out of service must, unless otherwise directed, proceed with caution to the next block signal

506. When an automatic block signal is out of order and not so indicated, the fact must be reported to the Chief Dispatcher

Reports of detentions to trains by signals must be made by enginemen to the Chief Dispatcher from the next regular stopping place at which there is an open telegraph office, upon Form S. D. 1, giving the signal number

Before reporting cause of stop as "unknown" enginemen must, if possible, ascertain if stop was caused by a train in the block, an open switch or closed side track derail, a broken rail or some other obstruction

507. Lights must be used upon all automatic block signals from sunset to sunrise and whenever the signal indications cannot be clearly seen without them.

When lights are not burning on automatic block signals, trains must be governed by the indication displayed by the signal arm. Enginemen finding a light out shall report same upon Form S. D. 1, giving the signal number from the next regular stopping place at which there is an open telegraph office.

508. Enginemen must not allow engine cinders to be dropped upon conduits containing automatic block signal wires.

509. Cars placed on sidings must be set back of derailing switches and insulated joints, and the derailing switches open. The siding end of side track cross-over switches must be set for the siding.

510. A train desiring to come out on a main track through any switch or cross-over in the territory controlled by these signals shall:

First: Open all switches to be used, which will place the signals protecting the switches in STOP position.

Second: Wait two minutes before proceeding.

Third: Be prepared to close the switches to protect a train which may have passed the signal before the switches were opened.

These instructions do not relieve trainmen from strict compliance with Rule No. 99.

511. On double track, where automatic block signals are in use, lights will not be maintained on trailing point switches; nor, on facing point switches which are within a distance of 500 feet beyond the signal protecting the block.

603. When the home signal of an interlocking plant cannot be cleared trains will proceed **only** on Caution or Clearance card.

Interlocking home signals are in service at Pomona, Pomona Yard and Montview.

Signal No. 3363, just north of the Passenger station at Salisbury, is provided with two arms. The upper arm governing south bound through movements on south bound main track. The lower arm when in the 45° or Caution position indicates that the main line switches are set for one of the diverging tracks into the station. Enginemen will proceed with CAUTION, prepared to stop within limits of their vision.

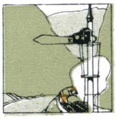
Particular attention is called to the necessity of setting the side track end of side track cross-overs for the side track when leaving same, as this switch is connected with the automatic signal system and the signal protecting the cross-over will be held at Stop unless switch is set for siding. (Rule 509.)

Approved·

H. E. HUTCHENS,
General Superintendent.

A. D. SHELTON,
Superintendent.

G. W. TAYLOR,
Gen'l Sup't Transportation.



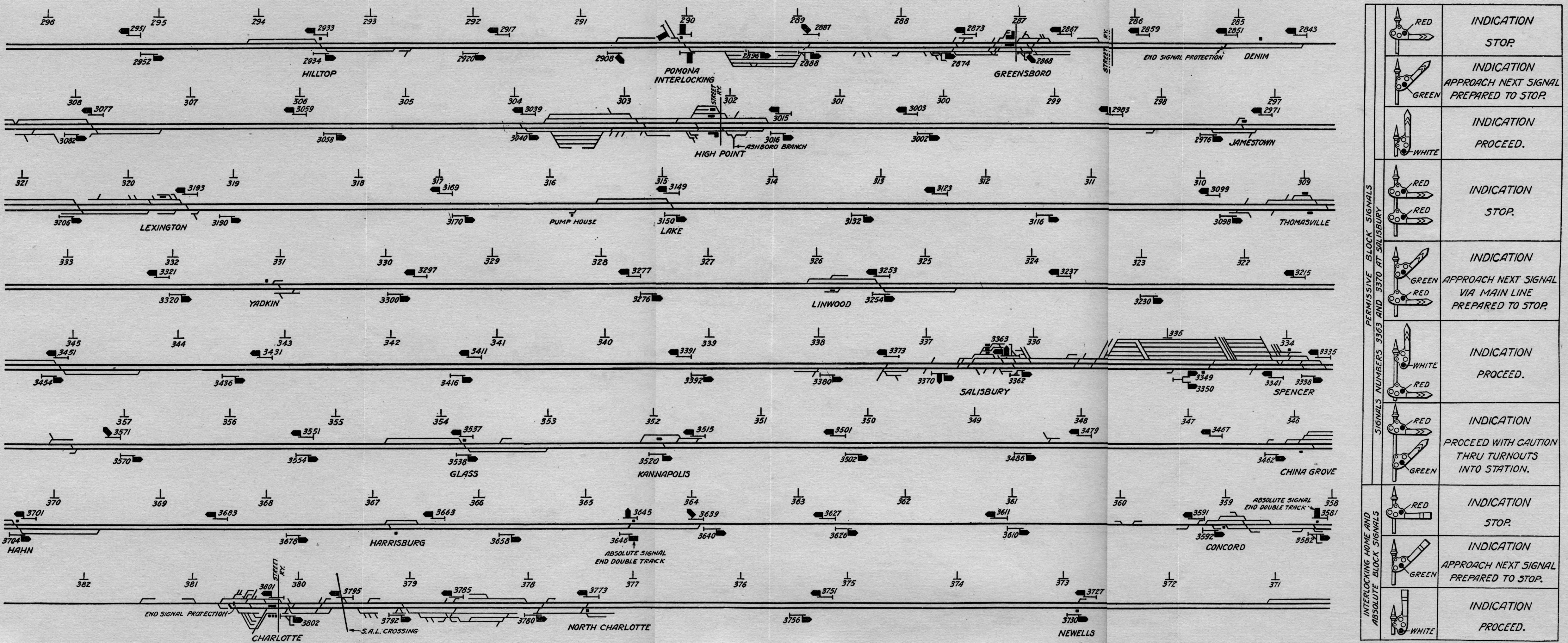


Fig. 31
Bulletin Plan