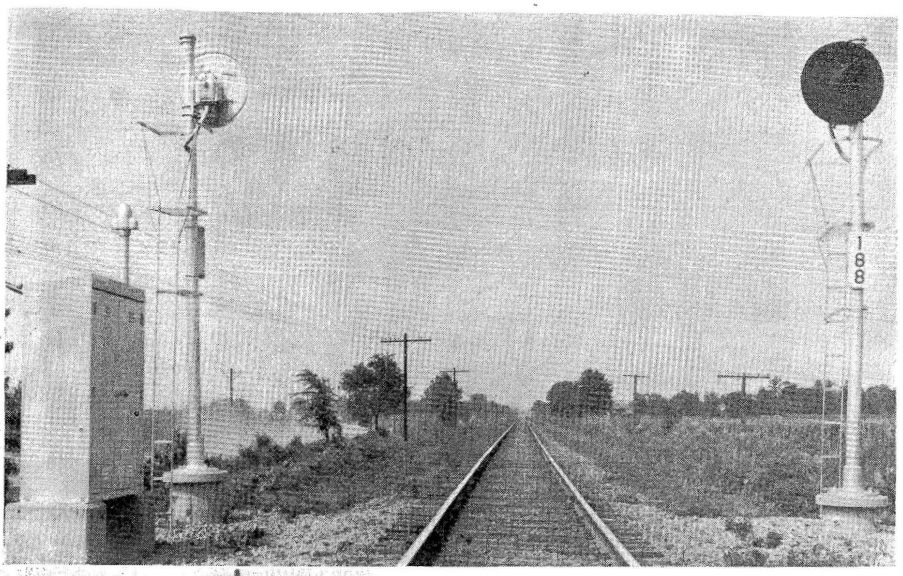


Right—View of typical intermediate automatic block signaling on single track. Below —Eastbound Missouri Pacific freight train entering the St. Louis Southwestern tracks at Dexter Junction showing automatic signal 502

Project includes three power switches and six spring switches with signals at passing tracks located properly for future change-over to centralized traffic control—Equipment includes coded track circuits

Signaling on 47 Miles

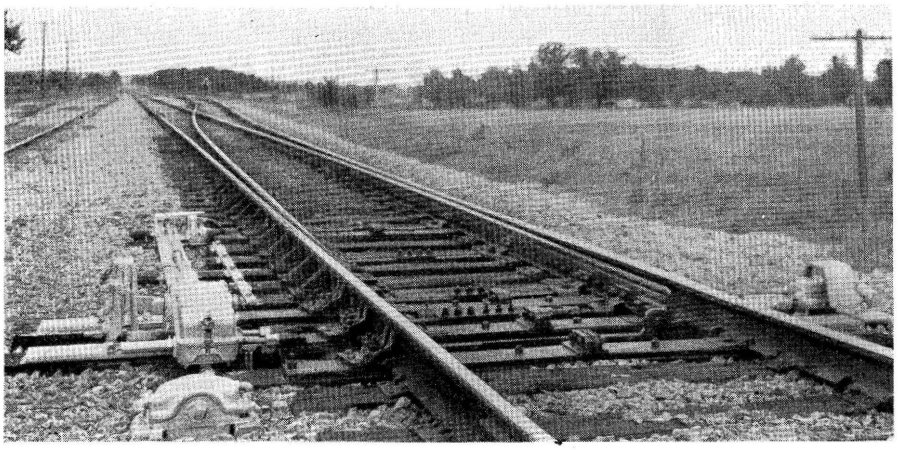
Of St. Louis Southwestern

BETWEEN Illmo, Mo., and Dexter Junction, the St. Louis Southwestern has installed automatic block signaling on 32 miles of single track and 15 miles of double track, and the project includes remotely-controlled power switch machines and signals for a crossover and a turnout of the yard switch at Ancell, the south end of the Illmo yards. Also, spring switch mechanisms have been installed at two of the ends of double track as well as at the departing switches of two lap-siding layouts. A feature of the automatic signaling is that the signals at turnouts are located so that no signals need be moved or added when centralized traffic control is superimposed on the installation at a later date. Modern searchlight color-light signals, with coded track circuits, are used throughout. This is the first installation of automatic block signaling on the St. L. S. W., a railroad which has 1,706 miles of main line.

Between East St. Louis, Ill., and Thebes, 135 mi., the St. Louis Southwestern and the Missouri Pacific operate jointly over tracks of the Missouri Pacific. The bridge across the Mississippi river at Thebes, and the tracks between Thebes and Illmo, 3 mi., are owned jointly by the St. Louis Southwestern, the Missouri Pacific and the Chicago & Eastern Illinois. Between Illmo and Dexter Junction, the St. Louis Southwestern and the Missouri Pacific operate jointly over tracks of the St. L. S. W. The main line of the St. L. S. W. extends south from Dexter Junction through Paragould, Ark., and Texarkana, Ark., to Dallas, Tex., Ft. Worth, Tyler, Waco and other principal points in Texas. Throughout the territory between Paragould and Illmo, the St. Louis Southwestern line is located in comparatively flat territory in the Mississippi River valley, the maximum ruling grade being only 0.3 per cent. None of the curves are more than 4 deg., and, therefore, do not limit the maximum permissible speed of trains. The track is constructed with 112-lb. rail, treated ties and rock ballast, except on some sections.

Train Movements Bunched

From Dexter Junction, the Missouri Pacific has a single-track line extending 25 mi. westward to Poplar Bluff, Mo., where connections are made to the main line of the M. P. between Texarkana, Ark., and St. Louis, Mo. Also at Paragould, Ark., the M. P. has lines extending to various points in Louisiana. In order to avoid heavy grades through the Ozark mountains on the direct line between Poplar Bluff and St. Louis, much of the freight traffic of the Missouri Pacific is routed via the St. L. S. W. between Paragould and Illmo, as well as on the route via Poplar Bluff, Dexter Junction and Illmo. Furthermore, the Missouri Pacific line in Illinois between Thebes and East St. Louis is at river grade, thus being an



Each of the spring switch lay-outs includes a spring and oil buffer arrangement as well as a stand including an automatic mechanical facing-point lock

advantage to trains of both the Missouri Pacific and the St. Louis Southwestern.

A total of 34 to 36 trains are operated daily between Illmo and Dexter Junction. The St. Louis Southwestern has one through passenger train each way daily known as the "Cotton Belter." This train southbound is scheduled at 2:45 a.m. at Illmo, and northbound the schedule is 12:20 a.m. at Dexter Junction. A special high-speed southbound freight train known as the "Blue Streak" leaves East St. Louis at 7:10 p.m., sets out cars of l.c.l. at various points for delivery the next morning by trucks. This train is scheduled for the 47 miles between Illmo and Dexter Junction in 1 hr. and 9 min., including a scheduled meet at Quarry. In addition to the trains mentioned above, the St. Louis Southwestern has three scheduled freight trains northward and two southward daily, and the M. P. has three such trains scheduled each way daily. A local freight train of the St. L. S. W. is operated northward daily, except Sunday, and one of the southbound through freight trains is used to set out or pick up cars as may be required to give prompt service to shippers. Extra trains are operated as required. The Chicago & Eastern Illinois operates a mixed train daily except Sunday on 7.3 miles of the St. L. S. W. between Illmo and Frisco Junction.

A large percentage of the through scheduled and extra freight trains are bunched. Southbound trains departing from East St. Louis in the afternoon and early evening are handled over the Illmo-Dexter Junction territory between midnight and early morning hours. Trains scheduled for early morning delivery and connections at East St. Louis are handled over the Dexter Junction-Illmo section during the late afternoon and up to midnight or later. When the tail ends of northward "parade" meets a part of the southward "bunch" on the single-track section, and the two through passenger trains must also be handled, every minute saved contributes to the success of making meets with minimum delays to train operation.

As traffic increased gradually during the past few years, a decision was made to install signaling as well as power switches and spring switches at certain locations, not only as a means of reducing train delays but also to improve the safety of train operation.

Yard Switch and Crossover

At Illmo, the Missouri Pacific freight trains hold the main track for movements northbound to the bridge or southbound from the bridge territory. On the other hand, at Illmo the St. L. S. W. northbound trains enter the yard via a crossover between the main tracks and a turnout to the yard. Likewise, all southbound St. L. S. W. trains depart from the yard lead turnout to the southward main track. When these switches were handled by trainmen, train stops and delays were incurred, and in some instances other trains also were delayed.

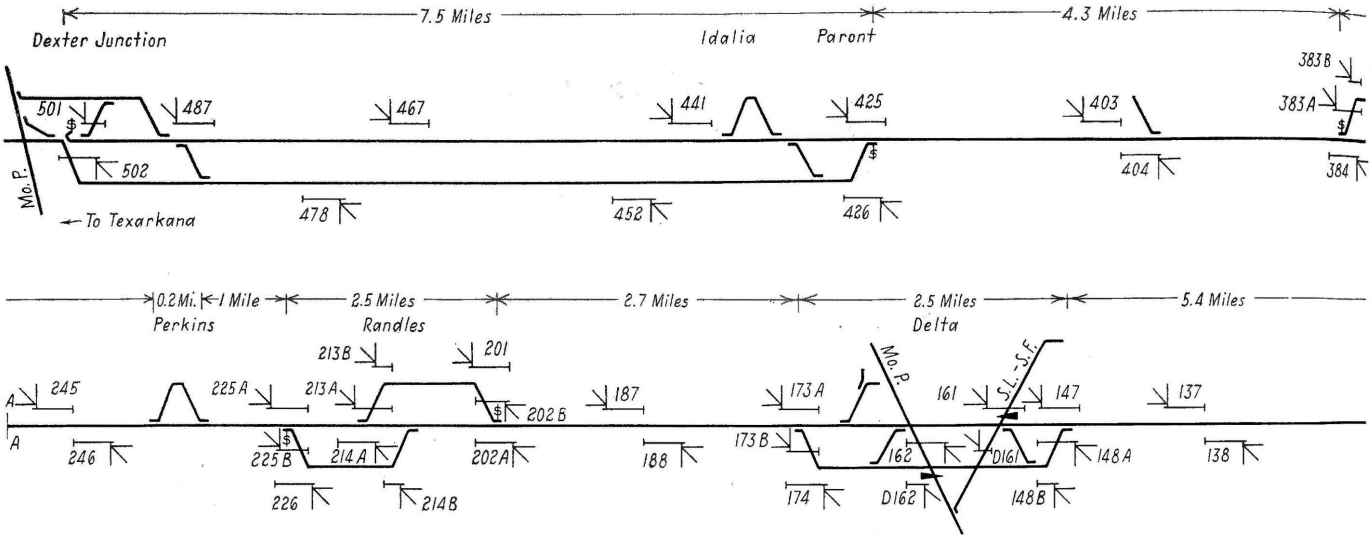


Diagram of the tracks and the signals

An important part of the signaling project, therefore, was to install power machines at this crossover and turnout, and to arrange for these facilities to be controlled by a machine on the dispatcher's desk at Illmo. As compared with hand-operation of this yard switch and crossover by trainmen, the new power switch machines and signaling save about five minutes for each southbound train, and from eight to ten minutes for each northbound train.

The bridge territory from Thebes, Ill., to Illmo, Mo., is double track, and double track extends southward

from Illmo, 7.5 miles to Rockview, the-end-of-double-track switch being included in a mechanical interlocking which also protects a crossing with a single-track line of the St. Louis-San Francisco. From Rockview, single track of the St. L. S. W. extends 32 miles to Paront, from which point double track extends 7.5 miles to Dexter Junction. The end-of-double-track switches at Paront and Dexter Junction are equipped with spring operating mechanisms including oil buffers and automatic mechanical facing-point locks, so that trains operating normal right-hand running need not stop for the operation of these switches.

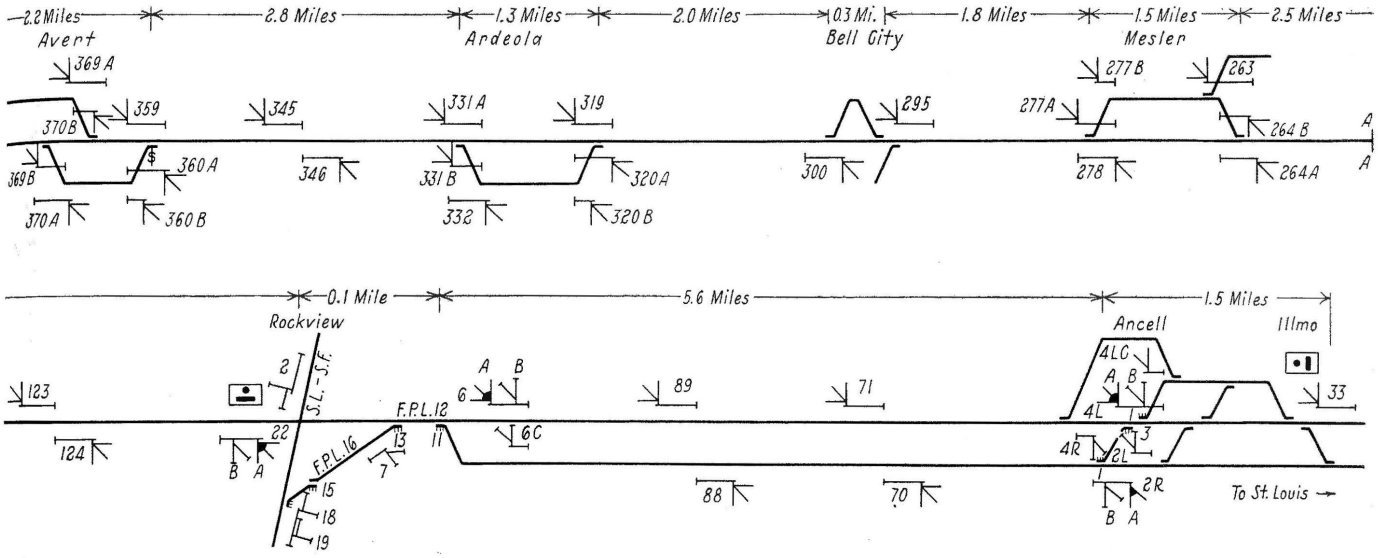
On the section of single track between Rockview and Paront, lap-siding layouts are located at Randles and at Avert. As a general rule, practically all of the meets between through freight trains are made at these two layouts. As a part of the signaling program, spring switch machines with automatic mechanical facing-point locks were installed at the outlying switches, i. e., the departure switches of these lap-siding layouts. An operator located at the lap of each layout, lines the head-in switches when trains are to take siding for meets. Thus trains are not required to stop for the handling of switches either when entering or departing from the lap-siding layouts. At Mesler there is a single passing track, and at Delta there is a long passing track with two crossovers between the main track and the passing track near the center so that this layout can be used as two separate passing tracks. The passing tracks at Mesler and Delta are not used by through freight trains to make meets except under unusual circumstances and, therefore, the hand-throw switch stands were continued in service.

The junction switch between the St. L. S. W. and the M. P. line from Dexter Junction to Poplar Bluff is hand thrown and is lined by the operator on duty at Dexter Junction.

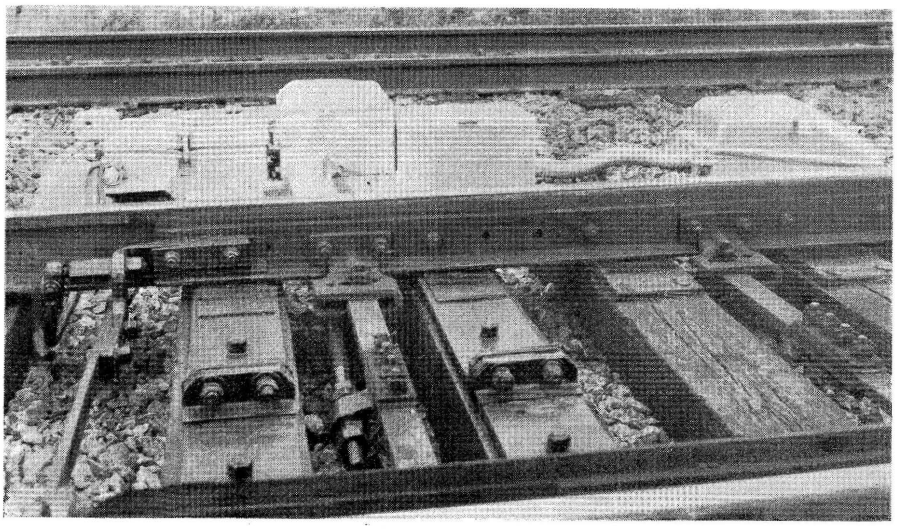
Delays Reduced at Delta

At Delta, two single-track branch lines, one the M. P. and the other the St. L.-S. F., cross the St. L. S. W. at grade. Each of these branch lines handles one mixed train each way daily except Sunday. Each crossing is protected by a gate which is normally set for St. L. S. W. trains to pass without stopping. Heretofore, however, all trains on the St. L. S. W. were required, for safety, to operate at reduced speed throughout the entire layout at Delta, thus losing several minutes time. As a part of the improvements, each of the crossing gates was equipped with an electric lock and circuit controllers, such that after a St. L. S. W. train approaches and accepts the indication of a signal, a gate cannot be unlocked until the St. L. S. W. train passes the crossing. Furthermore, when the engineman of a St. L. S. W. train gets a proceed aspect on a signal, he knows that the gates are in proper position and locked, and also he knows that the switches throughout Delta are all in the normal position. With this protection, trains can operate safely at higher speeds through Delta.

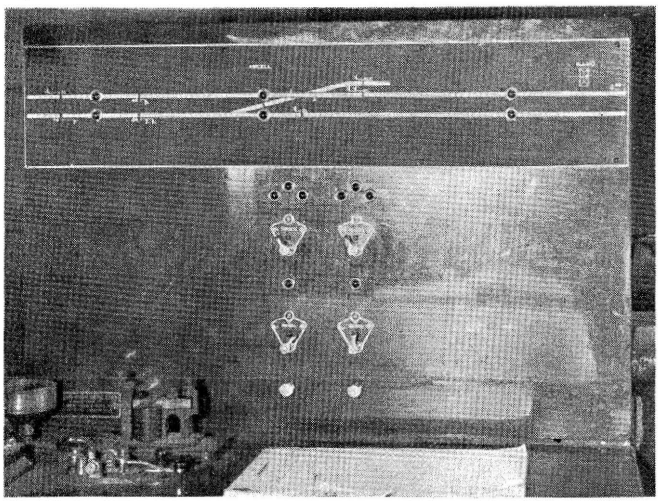
Train movements are authorized by time-table and train orders. The dispatcher is located in the office at Illmo. Train-order offices, open three tricks daily, are in service at Rockview, Delta, Randles and Dexter Junction; the office at Bell City and Paront are open days, and the offices



between Illmo and Dexter Junction



Power switches at Ancell are operated by electric switch machines, and insulated gage plates and rail braces are used on two ties of each switch



The control machine, located at Illmo, is the miniature lever type with a track model and indications

at Mesler and Avert are open nights. Semaphore train-order signals are used. At some locations, the lamp of a train-order signal might possibly be mistaken for the lamp of an automatic signal as viewed by the engineman of an approaching train. At such offices, equipment has been installed to flash the electric lamp in the train-order signal, thus providing a means of distinguishing between the aspects as displayed by the automatic and the train-order signals.

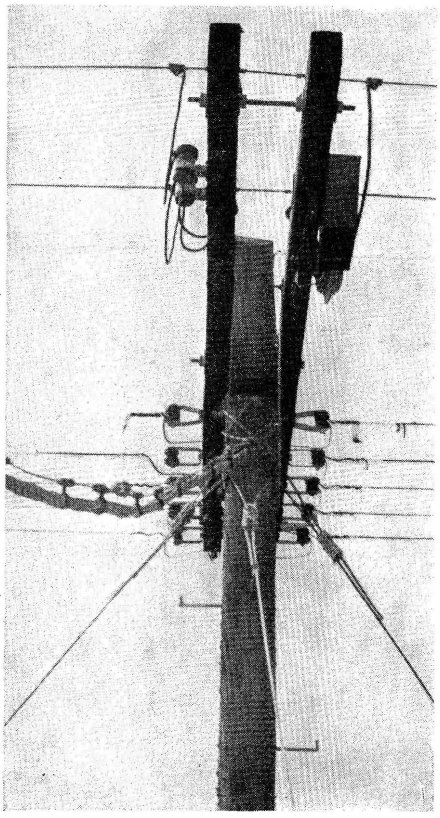
Next Step Was Signaling

With the power machines at the switch and crossover at the south end of Illmo yard; with the end-of-double-track switch at Rockview in an interlocking; and the two remaining end-of-double-track switches as well as the lap-siding switches equipped with spring mechanisms; and operators on duty at the laps as well as the Dexter Junction, a very large percentage of the moves to and from the main tracks can be made without trains being required to stop to permit trainmen to operate hand-thrown switch stands.

The next requirement was automatic signaling to permit following trains to be operated at maximum permissible speed with safety at all times when unoccupied track is available. With the two-block, three-aspect signaling as used on this territory, two blocks ahead of a given signal must be unoccupied, in order for that signal to display a green, Clear, aspect. The block lengths vary, depending on the length of passing tracks and the distance between two consecutive passing tracks. For example, the block through the passing track at Ardeola is 6,965 ft. long. The overall distance between the passing tracks at Avert and Paront is divided into two automatic blocks each 11,285 ft. long and the overall distance between Rockview and Delta is divided into three automatic blocks, 7,450 ft., 7,102 ft. and 6,452 ft. in length, respectively. Thus two consecutive blocks may total about 14,000 ft., or as much as 22,570 ft., and the spacing of following trains operated at normal speeds must total the length of any two consecutive blocks in order to run on Clear aspects throughout.

Trains Are Fleeted

When trains in the same direction are being "fleeted," as during the north and the south "parades" as previously mentioned, following moves are being made at a headway of about six minutes from the time



Each air-cooled line transformer is protected by lightning arresters and cut-outs

the rear of one train passes a given point until the head-end of the next train arrives. Obviously such close spacing and efficient utilization of track capacity at maximum permissible speeds would not be practicable without signaling.

A second important advantage of the signaling is to permit trains to make meets on close timing. For example, if the schedule or train orders call for a certain train to take siding or to get off of single track on to double track ahead of the arrival of a second train, and the first train encounters some unexpected minor delays, the move can be completed with safety, because the second train will be stopped at the signal. The facility of thus advancing a train on close timing with perfect safety may save 20 to 30 min. in a certain instance, which, combined with train interference as a whole, may save an hour or more total train time.

Signals at Passing Tracks

A special feature of this project is that signals are located opposite the fouling point on the turnouts, this applying not only at the ends of double track but also at the passing track layouts. With this arrangement no signals need be moved when converting this signaling to centralized traffic control at a later date. Furthermore, in the meantime, the signals as located afford several advantages in protecting and facilitating train movements. In the first instance, each switch is protected locally by a signal for each direction in approach to the switch, as shown in the illustration. When a train is entering a passing track for a meet, the second train, holding the main line, can pull on down to the signal directly in approach to the switch rather than being held at the signal at the far end of the passing track. A few minutes train time is thus saved in each of numerous instances.

The controls of the automatic signals at the end of a siding, for example at Randles, are interconnected to provide protection in the nature of an automatic interlocking. Normally the controls are set for the display of a green aspect on high main line signals 201 and 202A, and a red aspect on the leave-siding dwarf 202B. The lamps in the signals are normally extinguished, but are lighted automatically when a train approaches. A short approach track circuit 200 ft. long is located on the passing track in approach to dwarf signal 202B. When a northbound train on the passing track enters this clearing section, dwarf signal 202B will display a red aspect if a train on the main line is

approaching within the limits of braking distance beyond the second signal in each direction. As, for example, if a southbound train has passed signal 173A or 173B, the northward leave-siding dwarf signal 202B will continue to display the red aspect. On the other hand, if no train is approaching on the main line from either direction within the specified limits, then leave-siding dwarf signal 202B will display a proceed aspect when the locomotive of a northbound train enters the track circuit in approach to that signal. Also when the front trucks pass signal 202B, the controls are set to display the Stop aspect on signals 201, 187, 173A and 173B, as well as the Stop aspect on signal 202A and the Approach aspect on signals 214A and 214B. The northbound train can then pull out of the passing track through the spring switch without stopping, and proceed with complete protection against other trains.

Signals at the end of passing tracks are located opposite the fouling point of the turnout so that no signals will need to be added or moved when changing over to centralized traffic control

Operation at Hand-Throw Switches

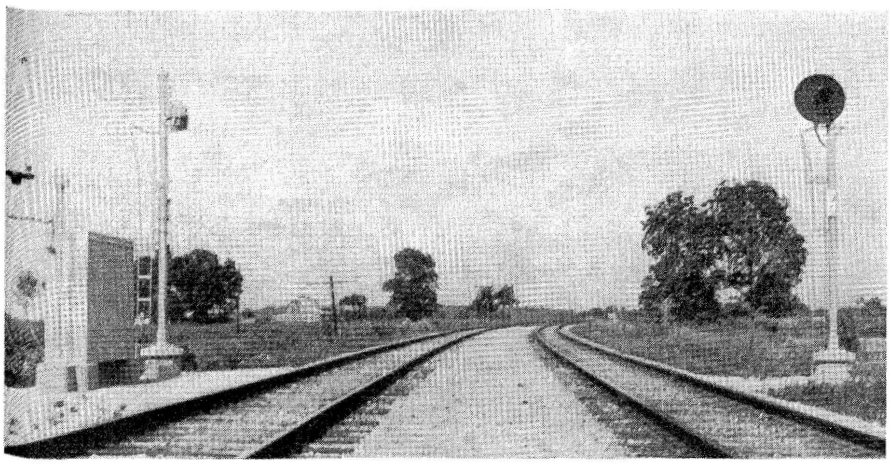
At passing tracks such as that at Mesler, where hand-thrown stands are used, operation of the switch to the reverse position by a trainman actuates the controls to set the main line signals 278 and 277A at the Stop aspect and signals 263 at the Approach aspect, and causes a proceed aspect to be displayed by the leave-siding dwarf signal. If one automatic block is unoccupied, a yellow aspect will be displayed, but if two blocks are unoccupied the aspect will be green. This use of the yellow or green aspect on the leave-siding dwarfs as compared with only the yellow as a proceed aspect, allows an engineman, when he gets a green aspect, to pull out promptly and then accelerate to maximum permissible speed because he is informed that a yellow aspect or better is being displayed on the next signal, and, therefore, he need not run at reduced speed prepared to stop at the next signal. Thus the three-aspect dwarfs save a few minutes time for each train making a move out of a passing track.

Coded Track Circuits

All of the longer track circuits are equipped for code operations using 75 codes per minute. This code equipment permits the use of track circuits up to 11,500 ft. long, thus obviating the cutting of such lengths into two or more track circuits if conventional d-c. circuits were used. On the short track circuits at switches, conventional d-c. neutral relays are used.

On the double track the automatic block signaling is for single-direction train operation, right-hand running, in the normal direction of traffic, no provisions being made for automatic block protection for reverse running. On the double track, therefore, the automatic signals are controlled by coded track circuits without line wire circuits, the code being fed at the leaving end of each track circuit toward a relay at the entering end. In each of these coded track circuit arrangements of double track, the feed from the battery to the track is interrupted either 75 or 180 times each minute by code transmitters which are in operation continuously. At the train entrance end of the track circuit, i.e., at the signal controlling entrance to the block, a Type P-4, code-following track relay is energized and released to follow each code pulsation. Circuits through contacts of the code-following relay are arranged to cause the signal to display the yellow aspect when 75 code is being received, or the green aspect when 180 code is being received. Absence of energy or steady flowing energy either a-c. or d-c. will result in the display of the red aspect. With this arrangement no line wires are required for the control of automatic signals.

The sections of single track are, of course, signaled for train movements in either direction. As the coded track circuits on this single track are arranged to feed in only one direction, the signals are not controlled to different aspects by different rates of coding. The code is at the rate of 180 per minute and when a circuit is not occupied, the P-4 code-following relay causes a code-controlled d-c. repeater relay to be picked up and remain in the energized position. Line circuits using one wire and common extend through contacts of these code-con-



Double automatic signal location on double track

trolled track repeater relays in the usual manner to complete regular absolute permissive block contral arrangements for this single track automatic block signaling.

The lamps in the signals are of the double-filament type rated at 13 + 3.5 watts at 10 volts, and are normally fed at about 8.5 volts in order to increase the life of the filaments. The lamps in the automatic signals on double track and the intermediate signals on single track are normally extinguished, being lighted when trains approach. Where coded track circuits are used, a train entering at the battery end causes the track relay to be released, and a circuit through a back contact of the TPR relay lights the signal lamp.

When an approaching train enters at the relay end of a coded track circuit, the code transmitter continues to send coded energy down the rails toward the approaching train. In such instances approach control of the signal lamp is accomplished by an ATR relay which is in parallel with the feed to the track. When the train approaching gets within about 4,000 ft. of the signal, the shunting of the circuit by the train causes a sufficient decrease in the flow of current to the ATR track relay which in turn causes the ATPR relay to drop. The signal lamp is fed by a circuit through back contacts of this ATPR relay.

Power-Operated Switches

The three electric power switch machines used on the crossover and turnout switches at the south end of Illmo yard, are the Model M-22-A equipped with dual control levers, so that they can be operated by trainmen if necessary when making special switching moves. The usual arrangement of lock rods and facing-point locks, as well as point detectors, are used. A special feature is the use of three 1-in. by 7-in. insulated gage plates, one on each of the first two ties under the points and a third on the tie ahead of the points. These plates are held in place by ¾-in. bolts which extend through the ties, rather than using lag screws and spikes. Adjustable rail braces are used on these ties. On the first two ties under the points, the plates extend and are attached to the switch machine, thus preventing any chances for lost motion to develop. With this type of heavy plate and brace construction, the switches can be held in proper position with minimum attention and with very few train stops caused by loosened switch parts which might prevent proper locking of the switch machine.

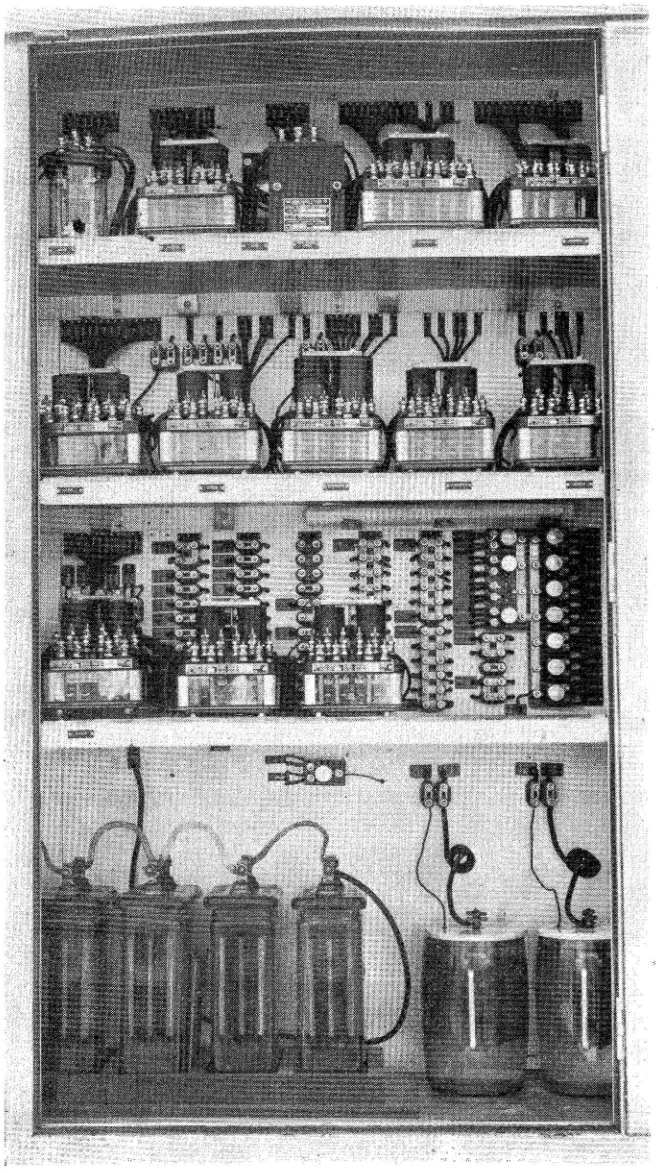
These three power switches and two high signals and three dwarfs for directing train movements over this track layout are controlled remotely from a miniature lever type machine at the dispatcher's desk in the Illmo office. The distance between the office and the switch layout is 2 miles, and, therefore, direct-wire line circuits rather than coded were used.

At each of six switches, two at the ends of double track and four at the outer switches at lap sidings, a spring switch mechanism, with an oil buffer and an automatic mechanical facing-point lock was installed, this complete equipment being known as the U. S. & S. Co. Model S-20. At these switches heavy plates and braces were installed the same as at the power-operated switches.

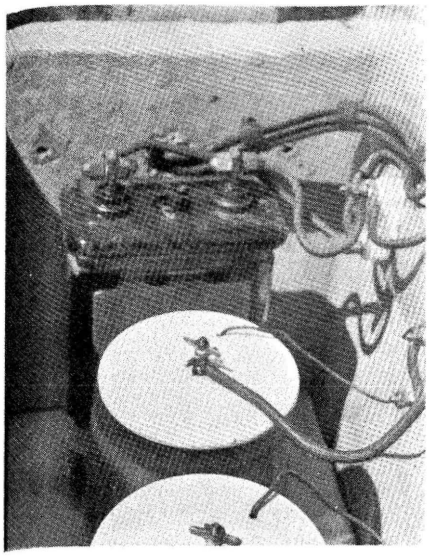
The power switch machines as well as the spring switch lock cases include circuit controllers which check the positions of the switch points to within 3/16 in. of the closed positions. At each of the main-line switches which is operated by a regular hand-throw stand, a Type U-5 switch circuit controller was installed, the controller case being held in place by three ¾-in. bolts through the tie, which prevents lost motion over a longer period as compared with the use of lag screws.

The signals on this installation are all the U. S. & S. Co. Type H-2 searchlight signals, each capable of displaying a red, a yellow or a green light. A second "arm" is used on each of two high signals at the south end of Illmo yard, and on two high signals at Rockview. All high signals are mounted on masts, with the center of the lens 186 in. above the level of the top of the rail. All signals are at the right of the track governed, and, where necessary to get clearance, passing tracks were thrown over, thus obviating the need for signal bridges.

Pre-cast concrete foundations, made by the Railroad Concrete Products Company, St. Louis, Mo., were used throughout. Each signal foundation consists of three sections, a bottom base, a hollow cylindrical body, and a top, all held together by hook anchor



Interior of typical case at an automatic signal showing the arrangement of relays, rectifiers and batteries



At track battery locations the batteries are housed in concrete battery boxes

bolts. The instrument case foundations are cast in one piece. The holes were dug down to the proper depth with the bottom level on solid earth, and the foundations were set in place with a power derrick on a work train. Up to the present time, only one of the signals has settled out of line.

A feature of this installation is that all the instruments, and for the most part the batteries also, are housed in sheet-metal instrument cases mounted on precast concrete foundations, independent of the signal masts. This practice not only concentrates the instruments at one point to facilitate construction as well as maintenance, but also obviates the use of smaller cases at the three separate signal locations at the end of a passing track.

Each instrument case has two hinged doors at the front, and two removable panels at the rear to give access to a wiring space 6½ in. deep. The back boards, on which the terminals and arresters are mounted, are made of plywood. The shelves are made of steel and are covered with a corrugated rubber matting. The relays are the shelf type, and are equipped with spring mounting bases which are attached to the shelves with machine bolts. The cables are brought up through the foundations and into the wiring space at the rear where they are pot-headed, and each insulated conductor extended through an individual hole in the panel to its terminal or arrester. At the switch and crossover layout at the south end of Illmo yard, a sheet-metal house 6 ft. by 9 ft. includes all the instruments and battery for this remotely-controlled installation. The instrument house and the various cases were wired completely with terminals in place before being distributed.

The circuits from the instrument house and cases to the signals, switches and rails are all in underground cables of the Okosheath type furnished by the Okonite Company. A seven-conductor cable runs from the case under the track and to a cast-iron junction box on the mast of a signal on the other side of the track. From this box, single-conductor No. 14 insulated wires run up inside the mast and out through a flexible conduit to the searchlight mechanism. For each track connection, a single-conductor cable of No. 9 stranded wire runs from the case to a Union bootleg outlet from which a stranded Copperweld conductor extends to a ⅜-in. pin in the rail. The cable to each switch machine or spring switch mechanism terminates in a cast-iron terminal box from which flexible insulated conductors extend in a flexible conduit to the machine. This practice minimizes the breakage of wires which might be caused by vibration of the track. At each switch circuit controller, the cable comes up through a cast-iron riser, then through a section of rubber hose and to the case of the controller.

View of interior of a sheet-metal instrument house at Ancell, showing the rectifiers, relays and a portion of the storage batteries for operating the electric switch machines

New Pole Line Constructed

As a part of this signaling project, a new pole line was constructed throughout the 47-mile territory. Except at crossings where higher poles are required, the poles are 25 ft. and are set 176 ft. apart, which is 30 poles to the mile. The poles are Class-6, with approximately 17½ in. circumference at the top. These poles are Southern Pine and are treated full length with creosote, 16 lb. to the cubic foot, with a final retention of at least 8 lb. per cu. ft. These poles were produced in the territory adjacent to the St. Louis Southwestern and were furnished by the Wood Processing Company at Texarkana, Ark., and the Lincoln Creosote Company, Shreveport, La. The 25-ft. poles were set 4½ ft. in the ground, and the soil conditions are such that these holes were dug with hand-operated augur type hole diggers.

The 10-pin crossarms are creosoted Southern Pine. Steel pins and Ohio Brass Company porcelain insulators are used. The two conductors for the 575-volt single-phase, 60-cycle power distribution, each consist of six strands of aluminum with one inner steel strand, the total resistance of which is equal to that of No. 6 solid copper. The signal control line circuits are on No. 10 weatherproof Copperweld wire. The 575-volt line is fed at Idalia and Delta. The longest feed section is 15 miles in length and the normal 110-volt circuit at this point is not less than 107 volts. The power bills for the entire 47-mile territory average about $60 per month.

Air-cooled, General Electric line transformers are used, the ones at ends of passing tracks being rated at 250 watts and those at single signal locations are rated at 150 watts. Each line transformer is protected by lightning arresters and fused cut-outs, mounted on the crossarms. The rectifiers for charging the batteries operate on 110-volts from the line transformers. At each signal location there

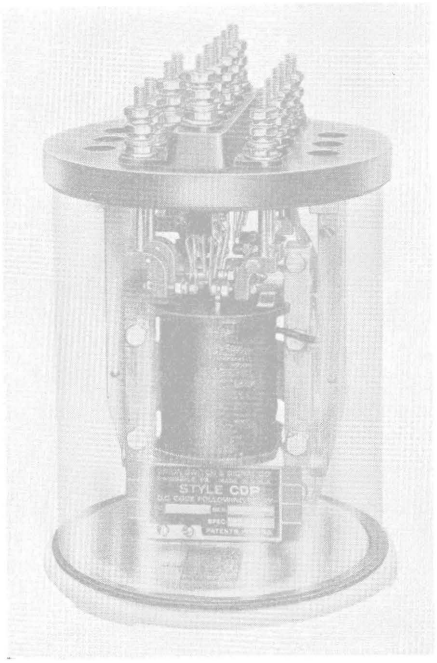
(Continued on page 572)

of the energy required to operate earlier types of centralized traffic control polar relays.

Code-Following Polar Stick Track Circuit Relay

THE Style CDP code-following polar stick relay has been developed by the Union Switch & Signal Company, Swissvale, Pa., for use for approach control in coded track circuit signaling or for coded line systems. This relay is similar in design to the Style CD polar neutral relay used in standard line and track coded circuits, except that the magnetic and contact structure has been modified so that the armature and contacts will remain in the position in which they were last energized. In order to operate this relay on code it is, therefore, necessary to reverse the energizing current at each "on" and "off" interval of the code.

The armature and contacts of this relay are supported on flexible strips of phosphor bronze in which the stresses are so low that fatigue failures are said never to occur. Core pins and pole pieces are plated with a heavy layer of chromium, which, because of its hardness, prevents wear. This relay has a maximum contact capacity of four normal and four reverse non-independent contacts, of an alloy of silver and platinum for low-voltage d-c. circuits, or a fine-grain tungsten for the high-voltage a-c. circuits. The contacts are designed for ease of adjustment and simplicity of replacement.

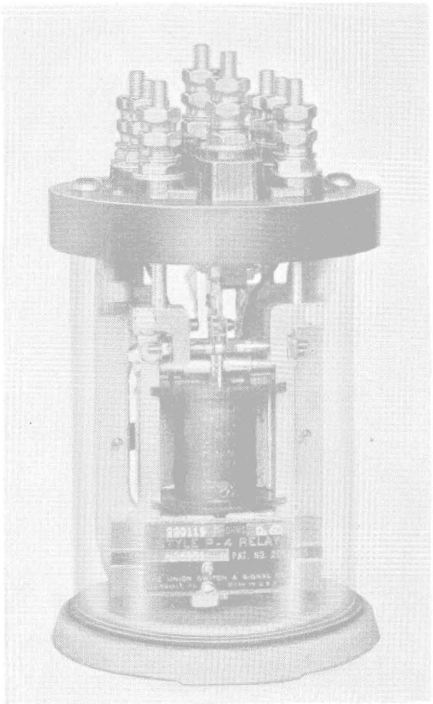


Code-following polar stick relay

P-4 Code-Following Relay

THE Union Switch & Signal Company, Swissvale, Pa., developed its Style P-4 code-following track relay for continuous operation at the usual code speeds with its system of coded track circuit control. Because of the unique design of this relay, it operates on a very small amount of track circuit energy. This relay is furnished with one front and one back contact or with two front and two back contacts. The single-point relay has been called a pilot track relay because it is used to operate a Style CD code-following repeater relay which controls the decoding circuits. The use of this relay makes possible the operation of 11,000 ft. track circuits from a single cell of primary battery, with proper ballast and rail resistance. As the 2-point P-4 relay requires slightly more power, a track circuit of approximately 7,500 ft. can be operated from a single cell of primary battery. This relay, however, can be operated on the longer track circuits with two cells of primary connected in series or on one cell of storage battery.

The single-point P-4 Relay requires a type "CD" repeater relay for control of the usual decoding circuits, while the two-point relay can be used without a repeater relay.



Two-point code-following relay

The P-4 relay is similar in design to the "CD" code-following relay in that the armature and contact bar are supported on hinge springs to eliminate the use of trunnions, and the engaging parts are heavily chromium-plated to provide exceptionally long life. The contacts regularly furnished for this relay are of 3/16-in. diameter, silver-platinum alloy. Both the single point and two-point P-4 code-following relays are, of course, adaptable to shorter track circuits than the 11,000-ft. circuit.

These relays are available in either the polar neutral type, for normal track circuit operation, or in the polar bias type, frequently used in reverse code operation in coded track circuits. The polar neutral relay is normally biased to the back contact position, and operation of the front contact is obtained only when direct current of the proper polarity is applied. This feature makes it possible to secure broken joint protection in d-c. track circuit territory by applying the proper polarity to adjacent track circuits. The polar bias relay is so designed that the armature will stay in either the normal or reverse position, depending upon the polarity of the energy last received. Therefore, in order to obtain code operation, it is necessary to reverse the direction of the applied current to provide operation.

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is a set of five Exide lead storage cells rated at 40 a.h. on an 8-hr. rate. Each of the longer track circuits is fed by a cell of the same type. Each of the shorter track circuits is fed by one cell of Edison 500 a.h. primary battery with a rectifier connected to take practically all of the normal load.

The rail joints throughout the signaled territory are bonded with mechanically applied rail-head bonds, three different types being used, the Ohio Brass Company, Hammerhead, the American Steel & Wire Company PA-2 Type, and the Railroad Accessories Corporation Raco Type.

This signaling installation, including the construction of a new pole line, was made by forces of the St. Louis Southwestern, under the jurisdiction of W. S. Hanley, chief engineer, and under the supervision of B. J. Alford, signal foreman, with G. A. Davis in charge of the field forces. The major items were furnished by the Union Switch & Signal Company.