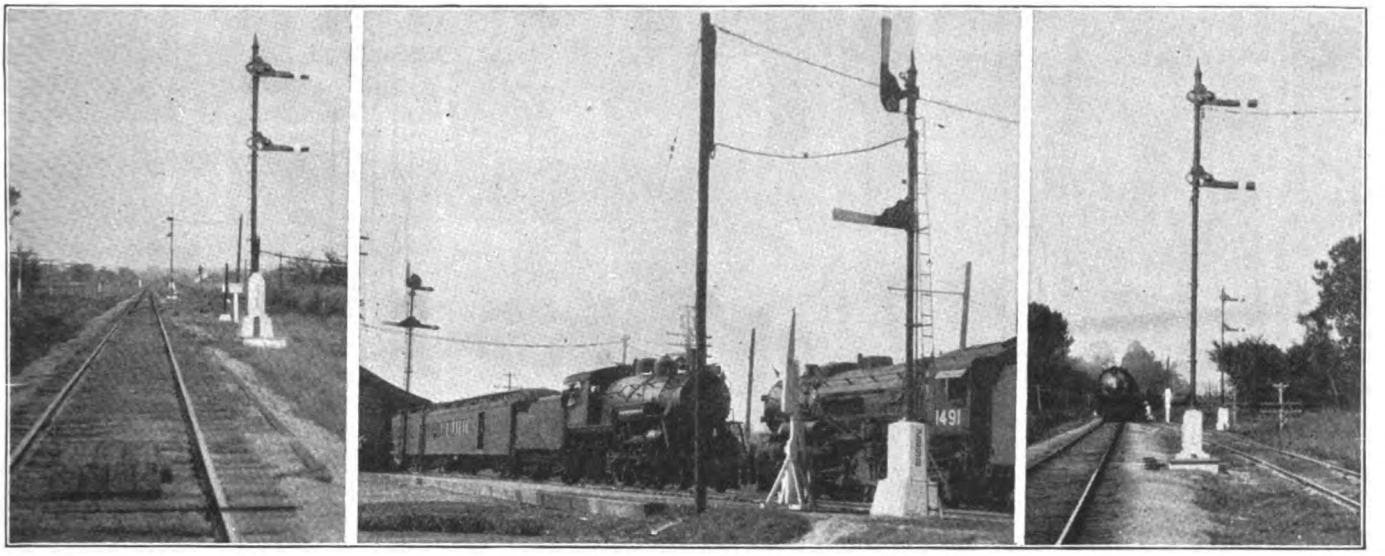
# Controlled Manual Block Signaling With Train Control

## Missouri Pacific Eliminates Train Orders by Directing Train Movements With Signal Indications

THE Missouri Pacific is installing a system of controlled manual block signaling on 50 miles of single track between Leeds, Mo. (Kansas City) and Osawatomie, Kan. Superimposed on this block signaling is an automatic train control system, which is being installed in compliance with the order of the Interstate Commerce Commission. The intermittent inductive train control of the National Safety Appliance Company was installed as a part of the wayside equipment, while 19 freight and 10 passenger locomotives have been equipped with the engine apparatus. Following the completion of the installation on the first 25 miles between Leeds and Kenneth a representative of the Interstate Commerce Commission made an official inspection between September 1 and 12.



West End of Martin City Passing Track

Passenger on Main Line Passing Dodson with Both Train-Order Signal and Block Signal 2998 Clear

East End of Kenneth Passing Track

The complete signaling system provides for the direction of trains by signal indication, thereby reducing considerably the number of written train orders with the ultimate purpose of eliminating orders entirely. The directional control of train movements between stations on this single track is provided by electric locking of the controlled manual levers in the stations. All of the signals are associated with the stations and passing tracks, no intermediate signals being used although distant signals are provided in some cases.

The controlled manual block has been superimposed on the previous manual block system without any addition or rearrangement of the men manning the manual block offices. The spacing of the sidings will be rearranged in accordance with the actual performance of an average train in a peak load period.

### Operating Problems to Be Considered

This single track division between Kansas City, Mo., and Osawatomie, Kan., handles a total of from 38 to 51 trains a day, which includes 10 scheduled passenger trains, the remainder being freight trains. A ruling grade of about 1 per cent in each direction in this 50-mile district limits the train load. The draw bar pull of the Mikado 1,400 class locomotives used in this territory is approximately 70,000 lb. In the direction of heavy traffic, the maximum grade is located within 20 miles of the initial terminal (Osawatomie), therefore full tonnage can be handled with the assistance of a helper which is cut off at Wagstaff. The line has numerous sharp curves that will necessitate heavy reconstruction when a second track is necessary.

The results desired by the present installation of signaling were: (1) to provide a section of automatic train control as required by the order of the Interstate Commerce Commission; (2) to increase the track capacity of this section of single track by rearranging the sidings and relocating the water stations and signals accordingly; (3) to direct the movement of trains by signal indication, thereby reducing the use of written train orders.

### Requirements for Train Control and Signaling

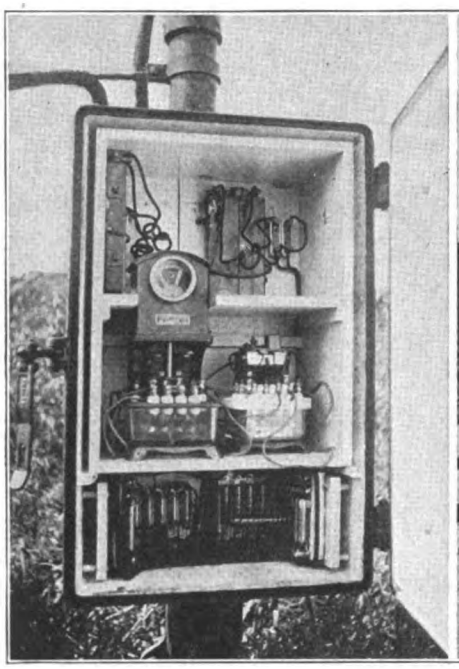
In the section now being signaled there are four passing tracks and the end of double track. Operators are located at Leeds, the end of double track on the Kansas City Terminal, at Dodson, and at Kenneth. Train movements between Leeds and Dodson are directed by signal indication exclusively, the signals being cleared by the co-operative action of the operators at the separate offices. Train movements into and out of Hytex passing track are likewise directed by signals which are under joint control from Leeds and Dodson. A similar system is used between Dodson and Kenneth. The wayside track magnets of the train control system are located at the signals. Therefore unless an attempt is made to pass a signal in the stop position, a train in a routine trip will not encounter an operation of the train control system,

except at the two non-interlocked railroad crossings.

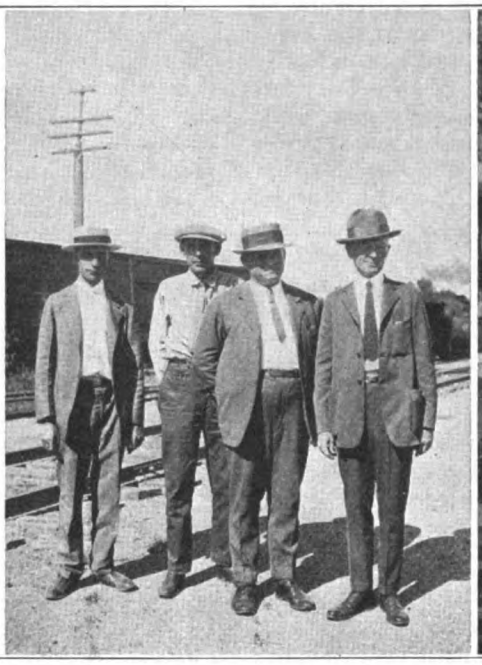
The Interstate Commerce Commission requisites for train control require either that a train must be stopped before reaching the home or stop signal when the latter is in the stop position, or else a stopping distance must be provided in the space covered after the train passes the signal. Without the forestalling device (paragraph 1-b) a stopping distance must be provided at a single track meeting point, which condition can be met in two ways: (1) by extending the overlap on the main track inside the switch at which the inferior train takes the siding, or (2) by interlocking the switches at the inner end of a lap siding to give parallel moves, requiring trains to enter the sidings at the inner ends of the laps.

When a train is approaching a meeting point an indication is given of the line-up at the lap switch by means of the distant signal at the outlying switch. This signal also governs the movement of an approaching train, if it should be desired that the train enter the siding at the outlying end, which case would occur if more than one train in the same direction was to meet a superior train.

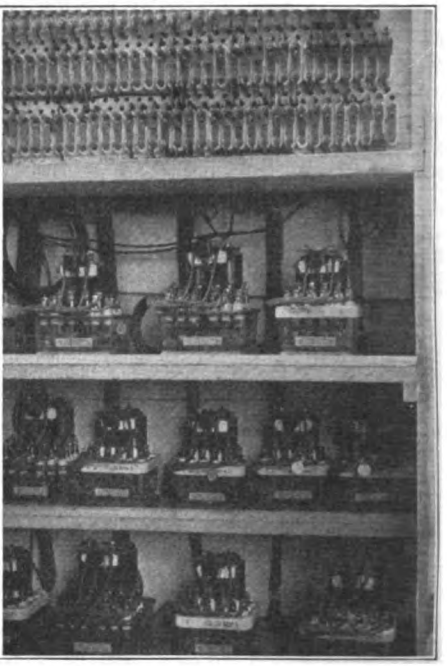
The lap siding with all switches handled by an operator provides a practical equivalent of an equal amount of double track. This has been proven to be the case by a circumstance in which, with four meeting points at one station, only one train out of eight was required to come to a stop. This result is, of course, brought about by the combination of the stretch of double track of a length



**Typical Relay Case Showing Single Cell of Edison Storage Used for Track Battery and Time Element Relay to Control Speed Limits**



**Left to Right: L. S. Werthmuller, assistant signal engineer; R. R. Ragland, train control examiner; O. R. Unger, signal inspector and T. W. Cheatham, division supt.**



**A Corner of the Relay Cabinet at Kenneth, Showing Track Repeat Relays, Control Relays, Terminal Arresters, etc.**

The forestalling device on the locomotive is not used on the Missouri Pacific, therefore either the overlap inside the inferior switches or the interlocking of the lap switches is used.

There are two non-interlocked crossings between Leeds and Dodson at which the track magnets are permanently set to stop all trains in order to enforce obedience to the STOP sign. When a train must pass a stop signal to enter a siding the train stop apparatus will not be in effect to stop the train, provided the train is within a few feet of the switch before the route is changed.

### Advantages of Lap Sidings and Method of Operation

At the single track meeting point for a lap siding the train enters the siding at the inner end of the lap. If the arrival of two opposing trains is separated by an appreciable interval of time so that the first train has had time to get in the clear, the other train is given the main line. If the trains arrive so closely together as to require it, both trains are diverted into their respective sidings. The switches at the near ends of the laps are handled by mechanical levers in the telegraph office. It is planned that the operator shall control the switches at the outer ends of all passing tracks by means of remote control, power-operated switch machines, therefore the trains can pass out to the main track without stopping, providing the block in advance is clear.

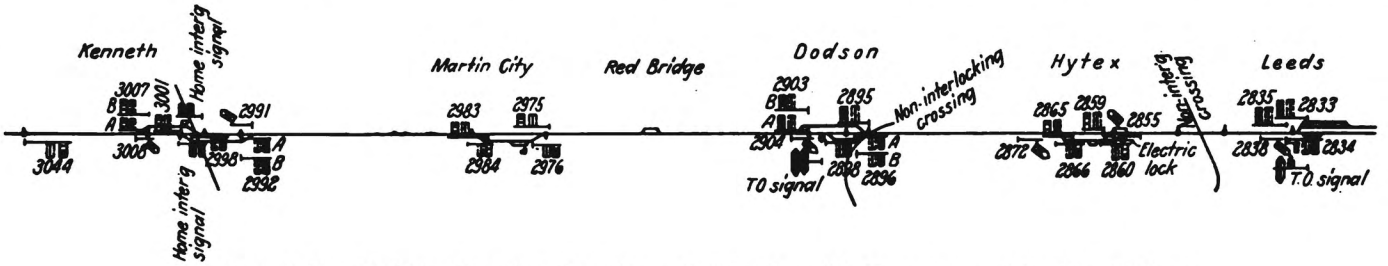
equal to twice each siding, with the fact that the inferiority of the trains at the meeting point is not established in advance by train order or time table as to right, class or direction. Instructions to take siding by direction of the train dispatcher are, on the one hand, as a rule, issued to the trains by signal indication at the block station where the meet or pass is to be made, and on the other hand at intermediate or blind sidings when the train is stopped by a stop signal, bell, telephone or other indication at the head-block of the hand-thrown entering switch. Through the method of diverting to the siding the train which first arrives at the meeting point, there is the possibility of avoiding a stop not only for the opposing train which holds the main line but also for the train on the siding, when the meeting point for both of the trains is a good one.

The control of the use of the sidings is in the hands of the block operator under the direction of the train dispatcher so that there need be no misunderstanding as to the arrangement of the meeting point insofar as the use of the siding is concerned. Superiority of the train from station to station is conferred by signal indication.

When a train is to take siding at the first switch, the stop signal is displayed. If the switch is hand-operated, the trainmen get in touch with the operator by telephone or by bell signal for instructions. If the switch is handled by the operator through a remote controlled low-

voltage movement, a slow speed indication by semaphore dwarf signal is displayed for the train to enter the siding after the switch has been properly lined up.

The operation of the signals is such that where the location of the block office is some distance beyond the first switch of the siding and the block ahead is occupied, the caution or 45-deg. position of the high semaphore signal is displayed to the approaching train at the near




**Track and Signal Plan Showing Location of Signals with Respect to Passing Sidings**

switch so as to bring the train up on the main line to the block office for further instructions.

A continuous track circuit is provided from station to station. On this account it is necessary to inform the crew at the rear of the train whether or not superiority is conferred on the train at the entrance to the block. In order to do this the existing manual block (train-order) signal is retained and its operating lever is locked into and controlled by the signal system.

Extending out of the Kansas City terminals on the Omaha division, this same form of controlled manual block system has been in service for over a year. Since this installation there has been a material increase in the traffic capacity of the single track covered and all necessity for double track appears to have been removed. The train movement approximates that of the train district between Kansas City and Osawatomie. The movement of trains on single track by direction of signal indications will now be explained by following through the instructions issued to the operator at Dodson.

## Instructions for Operating Control Apparatus in Dodson Station for Dodson-Kenneth Block

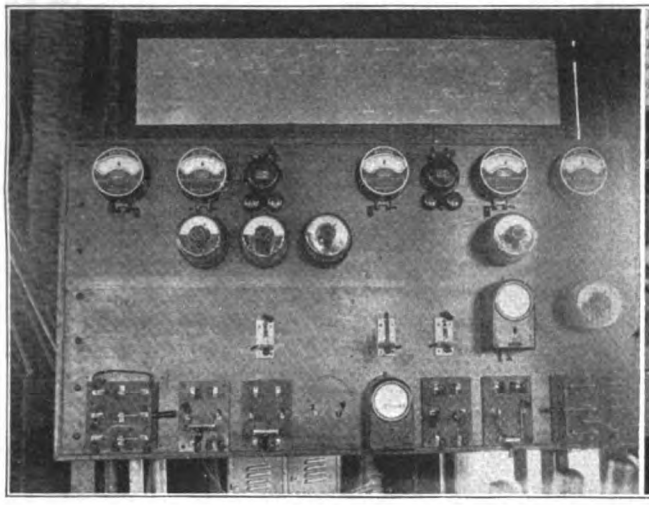
The knife switches must be open (normal position) and the lock and block instrument handle must be in the second position from the right.

### Lining Up for a West-Bound Movement

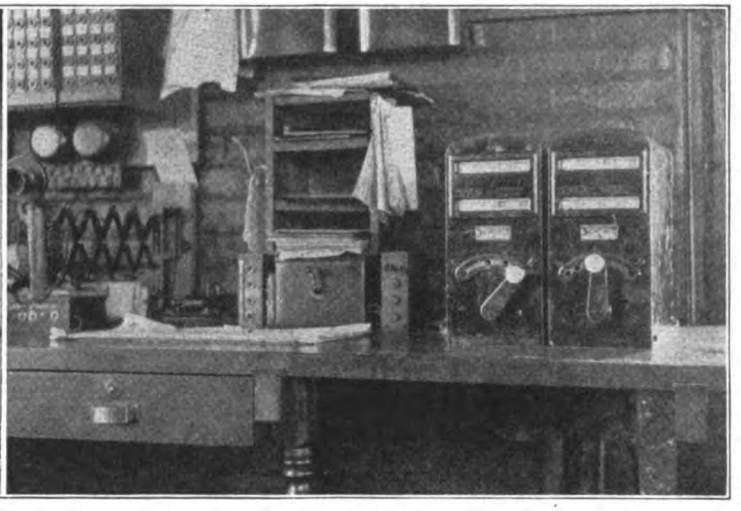
Move the handle of the machine in the direction traffic is to move. Close the three-pole switch in the direction traffic is to be moved, then ask Kenneth for an unlock connection (battery).

When the battery is received it will unlock the instrument, showing an unlock on the indicator. The handle is then to be moved to the extreme position to the left. If the train is to be moved on the main line, throw the two-pole, double-throw switch on the instrument board up. This will then clear signals 2895 and 2903-A. (See track and signal plan.) The train-order signal may then be cleared.

After the train has passed signal 2903-A and is in the block between Dodson and Martin City, the instrument handle should be moved one position to the right, which is as far as it will go. After the train has cleared the block at Martin City, which is indicated by the block indicator on the instrument at Dodson, the handle should be restored to its normal position, which is the second hole from the right. If the handle is not restored to its proper position while the train is in the block, it must be restored to its proper position and the clock-work time-



**Switch-board in Tower at Kenneth**



**Desk Type Controlled Levers at Kenneth**

release is operated in order to unlock the instrument. At Dodson, the hand-release is used only when locked up. It is not necessary for Kenneth to operate the hand-release. The knife-switches should be restored to normal position.

### Lining Up for a Following (or Caution) Movement or Meet At Martin City

Move the handle of the machine in the direction traffic is to go. Close the three-pole switch in the direction traffic is to be moved. Throw the two-pole, double-throw switch on the instrument board up. This will clear signals 2895 and 2903-A to the caution or 45-deg. position. The train-order signal cannot be cleared for this move.

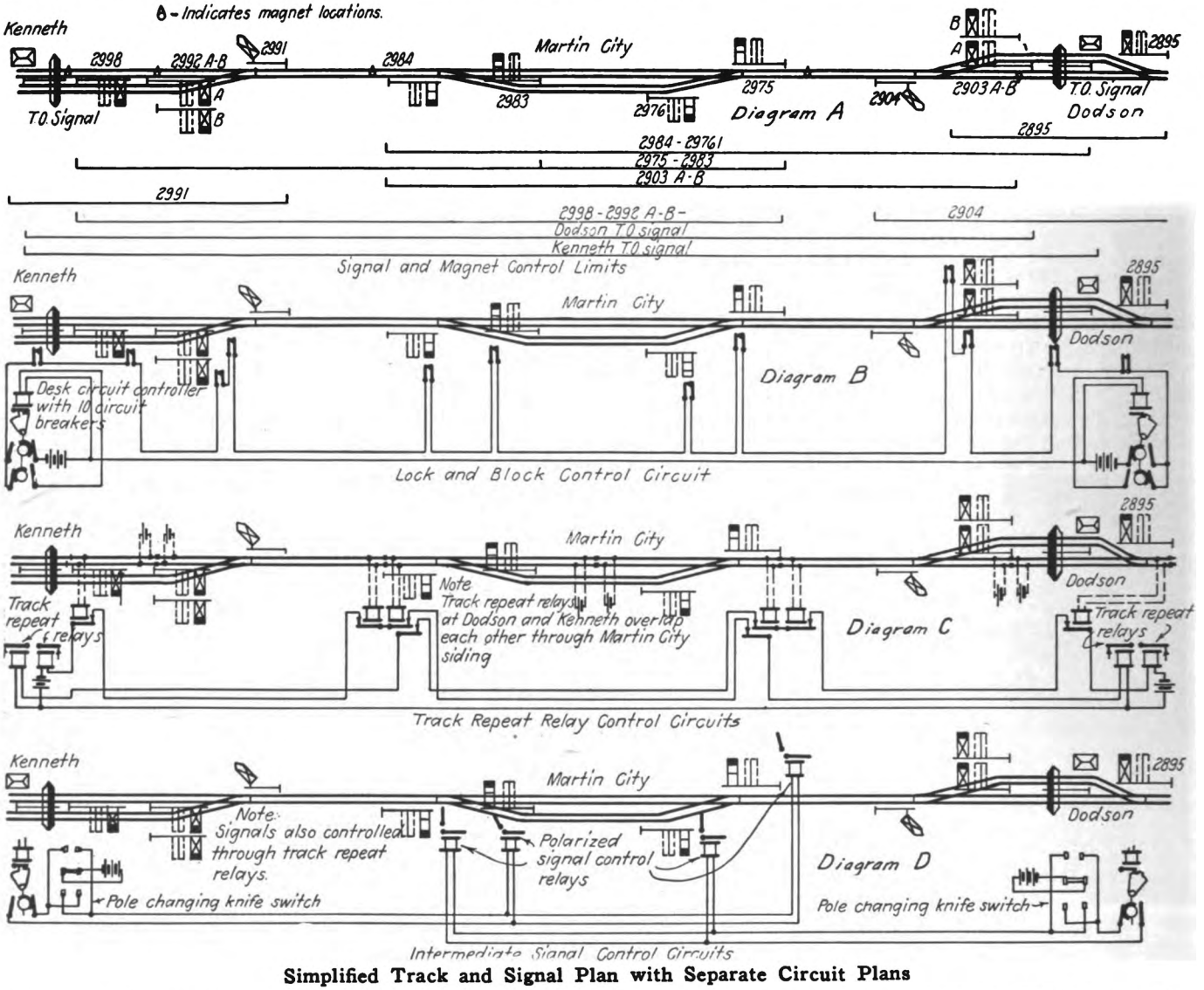
If a train is to be moved from the siding under either of the above conditions, the two-pole, double-throw switch on the instrument board should be thrown *down* instead of up. To restore the machine to normal, proceed as indicated above.

### Lining Up for East-Bound Movement

When Kenneth asks for "Unlock," place the handle of the instrument in the extreme right-hand position and throw the three-pole switch to the east or in the direction of traffic. When Kenneth receives battery, it will be indicated by the ammeter on the instrument board in Dodson station. After Kenneth has unlocked (indicated by the ammeter needle returning to zero), the two-pole, double-throw switch should be thrown down, which will clear signal 2984.

LINING UP FOR EAST-BOUND MOVEMENT FROM MARTIN CITY SIDING

Place the handle of the instrument in the extreme right-hand position and throw the three-pole switch to the east, which is the direction of traffic. Throw the two-pole switch up and operate the clock-work time-release which will set up the lineup so that signal 2976 will clear when the passing track switch is opened for the train to move out on the main line. Watch the ammeter needle, which will move up to the scale as the signal is clearing. The needle must drop back slightly when the movement of the signal arm is complete.




**Simplified Track and Signal Plan with Separate Circuit Plans**

## Special Locking and Signal Control Circuits

A simplified track and signaling plan of the layout from Dodson to Kenneth is shown in diagram A. All of the circuits from one block station to the next are electrically independent of the circuits in the adjacent block in either direction. The lock and block circuit, the track repeat control circuits and the intermediate signal control circuits are each shown on a separate diagram to prevent confusion.

As may be seen in diagram B, the control circuit for the lock of the desk circuit controller is carried through a circuit breaker on every signal concerned, made when the signal is at stop. Therefore, in order for Dodson to get an unlock, all signals must be at stop and the operator at Kenneth must operate his controller to give battery to the controller at Dodson. The traffic direction locking in the block operation, together with the indication in the various sections of the block occupied, is secured by General Railway Signal Company desk type circuit controllers. The train-order signals at Dodson are locked electrically by Type-F Hall locks, while at Kenneth the train-order signals are operated by levers in the interlocking machine, which are equipped with standard electric locks.

As may be seen in the photograph, the desk circuit controller has two separate indicators, one which shows when the section, Dodson to Martin City, is occupied and the other for the section Martin City to Kenneth. These indications as well as the locking features are controlled by track repeat relay control circuits that are shown in diagram C.

Diagram D, which shows the intermediate signal control circuits, indicates how the electrically locked desk circuit controller and the knife switches are used to control the operation of the signals. Signals 2984 and 2976 are controlled over one pair of wires by means of the pole changing switch. This combination is possible on account of the fact that in no case would these two signals be cleared at the same time and as they control the same direction of traffic no harm can be done if the switch is thrown the wrong way. A study of these circuits shows that an operator is at all times controlling signals to move trains towards his station, which keeps the movement under his control.

The track magnets are either 83 ft. in the rear of the home signal, or, where used for the two opposing signals of a double location not more than 350 ft. apart, the

magnets are located so as to bisect the distance between the signals. Such a magnet location can be used for a stop in both directions and for speed control in both directions. The magnet located at a distant signal is used solely for speed control, either in the rear or in advance of the signal and is set properly with reference to the measured length of this track circuit so as to provide a different speed limitation in one direction from that in the other.

### How the Train Control Fits Into the Signaling

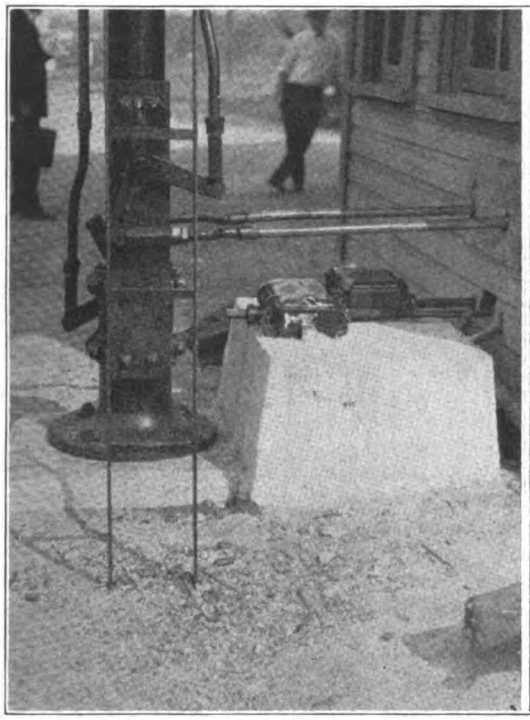
The relays for the speed control contain a clock-work mechanism operated electrically in combination with magnets controlling the fixed contacts. The speed control of the relay is effected by breaking an electric contact through the clock-work as the train enters its track circuit and making this contact again by the clock-work at the end of the selected time period. This time period, if greater than the time required by the train to move through the track circuit, will set in action a magnet to stop the train. The relay is set and sealed at its location for whatever speed is selected as the maximum to be permitted. The relays are specially designed to avoid the opening of the electric circuits through vibrations set up by passing trains or otherwise. Only two speed limits are provided, one of 35 m. p. h. approaching interlocked crossings or junctions to test whether the engineman is alert, and one of 25 m. p. h. approaching stop locations or points.

Where a magnet is located in advance of siding switch points, a special circuit is provided which will permit trains to enter the siding without automatic application of the brakes, providing the switch has been opened after the train is within 400 ft. of the signal. Otherwise, the magnet will function to stop the train. In this manner, open switch protection is provided.

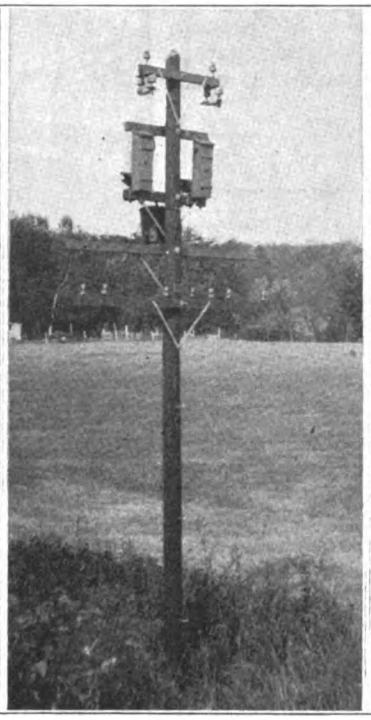
### Pole Line Construction

In constructing the pole line, creosoted pine poles, 25 to 40 ft. in length over-all were spaced 35 to the mile. A two-pin four-ft. top cross-arm carries the two, stranded aluminum conductors, which have a steel core, and seven strands of aluminum, making up a No. 4 aluminum cable. Second cross-arms 4 ft. long, when required, are spaced 4 ft. and carry two No. 10 B. & S. gage hard-drawn copper, or copper-clad wires for the 110-volt circuits. The third arm, spaced 2 ft. below the second, has 10 pins and carries the 7 wires of the system plus the local circuits at the stations when necessary. These wires are also No. 10 B. & S. copper or copper-clad.

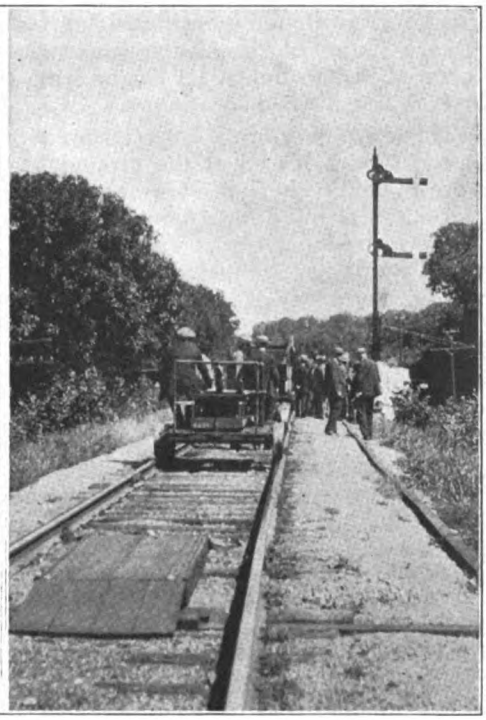
The Kansas City Light & Power Company furnishes the power at Leeds station, a 2,200 volt circuit being metered and raised to 4,400 volts for line transmission. At the meter source, overload and underload circuit breakers are installed to guard the line in case of grounds, crosses or breaks, caused by emergencies in railroad operation. It is so designed that a variation of 2 per cent, either way in the load, will cause the circuit breaker to open and ring a buzzer or bell to notify the operator in the Leeds station. If a break should occur, the circuit breaker will cut all power off the line immediately. This circuit breaker was designed for this particular operation by the Roller-Smith Company.



**Special Electric Lock for Train Order Signal at Dodson**



**Typical Transformer Pole Location**



**The Party Inspected Wayside Control Apparatus**

Where energy is required along the line for battery charging, 4,400 to 110-volt transformers of 1.5 k. v. a. capacity are installed. A 110-volt line is constructed where the distance from the transformer is less than 2,000 ft. In this way it is not necessary to use a separate transformer at each place power is required through station limits. The reduction from the 110-volt circuit to either the 8, 16, or 24 volt signal lines is made by the Leich rectifiers, both to reduce the voltage and to change from a. c. to d. c. for the trickle charge signal circuit battery. Signal lights are carried on the a. c. side of the circuit at 8 volts and are automatically cut over to the storage battery when the power fails. The 1.5 volt Leich rectifiers are used for charging the track batteries, which are Edison 18 a. h. type B. 1 H. batteries. The line batteries are Exide KXS, 7, 84 a. h. The line batteries were formerly in portable service, being transferred to the floating charge service when so reduced in capacity to be unfit for use in the portable service. The Edison

track batteries are placed in the relay boxes, no other shelter being required. By actual test the rectifiers will carry the load on the track for an indefinite time without connections to the storage cell.

### Lightning Protection and Sectional Switching

Lightning protection for the 4,400 volt circuit consists of multi-spark gap and choke coils. The choke coils are made up of No. 10 hard drawn rubber covered copper wire. The 110-volt and lower voltage circuits are protected by the Mann multi-shunt coil and spark gap arrester to which is added, to sift out the smaller surges, the G. E. vacuum arrester. Brach spark-gap arresters are used to protect all relay coils. Due to local conditions, one source of power feeds through from Kansas City to Osawatomie. Sectionalizing switches are located at each station block and the same type of switch manufactured by the Industrial Engineering Company is used at each transformer location.

The lead type storage batteries are mounted in concrete battery boxes placed at the ground level. These boxes were made on the job. On account of the frequent replacement of rail due to flange wear on curves, iron bond wires with channel pins are used. All insulated joints are Troy pattern, 90 lb. A. R. A., type B. Switch lights in this territory will be electrically lighted, using G. E. 110-8 volt transformers specially designed for switch lighting.

Western Electric Company's No. 1149 bell type insulators are used for dead ending. Where the Bureau of Standards circular requires, No. 6 B. & S. rubber covered wire is used for the 4,000 volt line. Pine lumber treated by the Rueping process, carefully inspected, is used for wire trunking. T. Geo. Stiles switch circuit controllers are used throughout. Resistance units are Missouri-Pacific standard, made by the Ward-Leonard Company. Okonite wire is used throughout the installation. The signals in use are G. R. S. 2-A, Union B and the Hall-L. The instrument shelters besides the signal mechanism cases are Chicago Railway Signal & Supply Company and Hanlan & Bock mechanism cases and open either in front or back. The relay boxes are Chicago type. The relays are the Ziegler type, made by the United Electric Apparatus Company.

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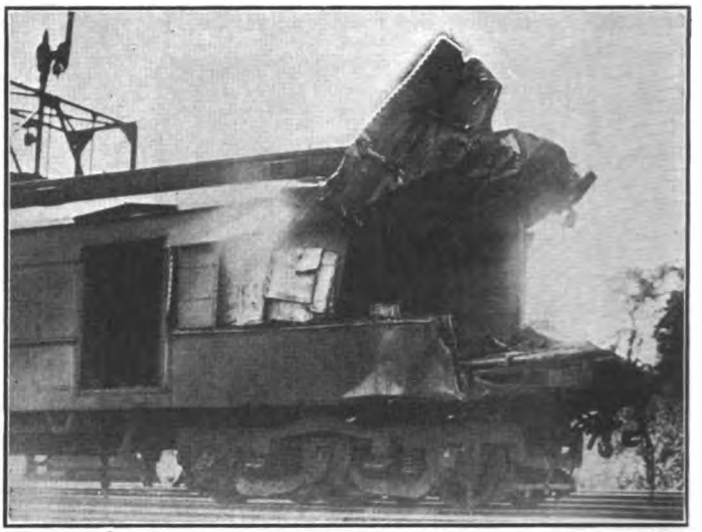
# N. Y. C. Collision at Savannah

THE Bureau of Safety of the Interstate Commerce Commission has issued a report, dated October 15, 1924, as a result of the investigation of the accident which occurred on the New York Central near Savannah, N. Y., on August 30, 1924, when 36 passengers, 5 employees and 2 Pullman porters were injured.

At the point of accident, which is nearly one mile west of Seneca river, on the Syracuse division, the road is a four-track line over which trains are operated by timetable, train orders and automatic block signals. The two south tracks handle the passenger traffic and are equipped with water pans about 1,800 ft. in length, located just west of the Seneca river, the west end of these pans is about 2,400 ft. east of the point of accident. The collision occurred on the westbound passenger track which at this point is a right curve, 2,295 ft. in length, on a practically level grade. Three-position, upper quadrant, normal danger, semaphore type, automatic block signals located on overhead bridges, provide signal protection on this line, but a slight fog at the time of the accident obstructed the view at this point. Westbound signal 32101 is located 221 ft. east of the point of accident, while 6,167 ft. farther east is located signal 31982. Following is the substance of the report:

Westbound passenger train No. 19 consisted of 1 express car, 1 buffet car, and 10 Pullman sleeping cars, all of steel construction. This train left Syracuse, 31.83 miles from Savannah, at 12:42 a. m., 17 min. late, and on reaching the west end of the water pan at Seneca river, the water scoop hose blew off the engine causing the air brakes to be applied, the train coming to a stop with its rear end 221 ft. west of signal 32101. While standing at this point it was struck by train No. 47.

Westbound passenger train No. 47 consisting of one buffet car and nine Pullman sleeping cars, all of steel construction, left Syracuse at 12:48 a. m., eight min. late,



**First Car of No. 47 Came to Rest Just West of Signal Bridge 321**

passed signal 31982, which was displaying a caution indication, passed the flagman of the preceding train, a lighted fusee and the stop indication of signal 32101, and collided with train No. 19 while traveling at a speed estimated to have been between 30 and 45 miles an hour. Train No. 19 was driven forward a distance of about 60 ft.; the vestibule of the rear car was crushed and the rear end was raised about 2 ft.

The investigation disclosed that the automatic block-signal system was in proper working order before and after the accident. A check of the train sheet indicated that train No. 47 traveled the distance between Syracuse and the point of accident, a distance of about 31.34 miles, in 35 minutes, or at an average speed of approximately 53 miles an hour; the distance from Warners to the point of accident, about 14.30 miles, was traveled in about 12 minutes, or at an average speed of 71.30 miles an hour.

### Conclusions

This accident was caused by the failure of Engineman Gibbons of train 47, properly to observe and obey automatic block signal indications. The book of rules of this railroad specifically cover the caution indication as displayed by signal 31982 and place the following interpretation upon such indication:

"Proceed at a speed, reduced to not exceeding one-half the maximum authorized at the point involved (not exceeding thirty miles per hour), prepared to stop at the next signal."

Although Engineman Gibbons emphatically stated that the air brakes did not work properly just prior to the accident, the weight of evidence is to the effect that the air brakes were in proper working order both before and after the accident, and it is believed that Engineman Gibbons misjudged the speed of his train in the fog and did not definitely realize it was excessive, in view of the caution indication displayed at signal 31982, until it was too late to avert the accident.