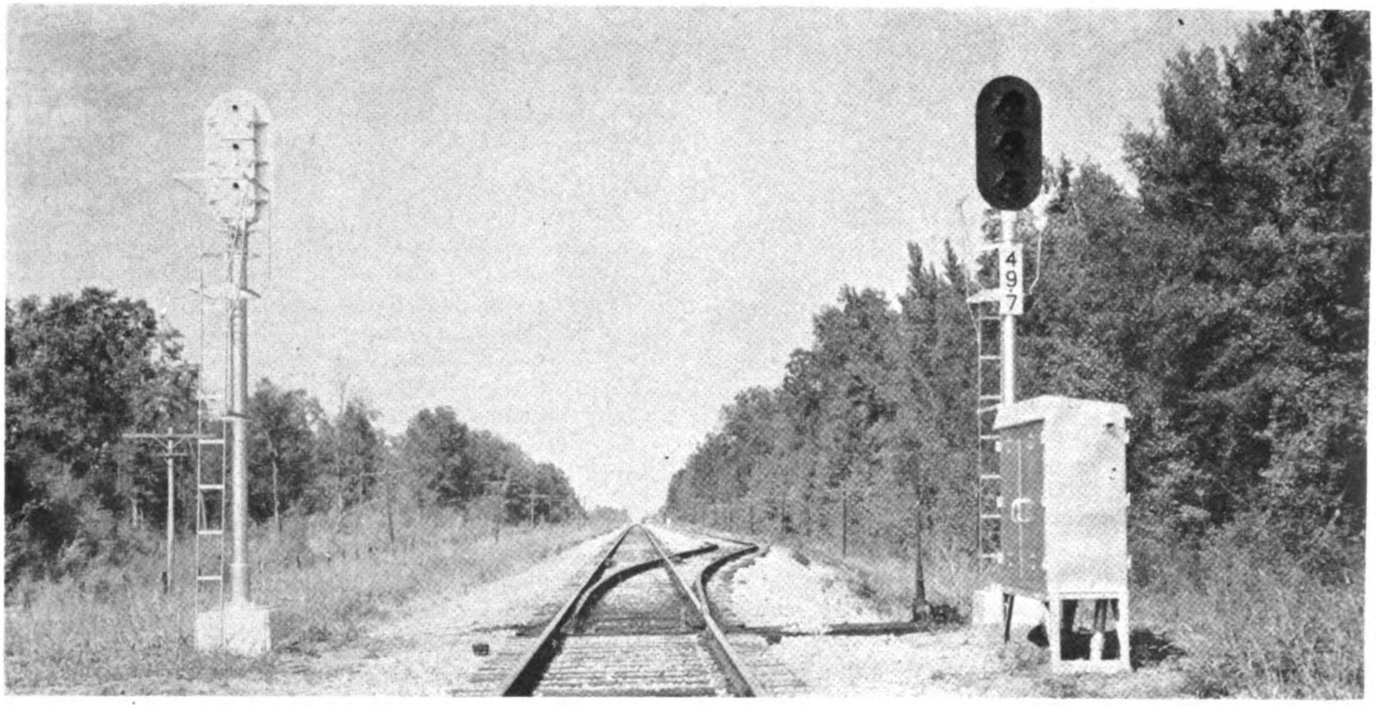


Signal Controls by Track Circuit Only

Slow codes, on the rails, first one direction and then the other, from siding to siding—are coordinated to accomplish controls without line wire circuits

THE TEXAS & PACIFIC has some very good reasons for installing automatic block signaling—rather than centralized traffic control—on 112 miles of single track between Lucas, La., and Texmo Junction, which is near Shreveport, La. This was the only remaining section that was without automatic block or CTC on the Texas & Pacific main route 1,142 miles from New Orleans through Dallas to El Paso.

Some of the reasons for leaving this Lucas-Texmo Jct. section until last are: (1) track is practically level, and is tangent except for a few long curves, therefore sighting distance is good; (2) train movements were a minimum, because local trains are operated in one direction on an alternate line for more than one-half the distance between Lucas and Texmo Jct. Another factor is that the direct line between Texmo Jct. and Lucas has been improved within recent years so that trains could be operated safely at higher speeds. A conclusion was that some form of track-circuit controlled signaling was desirable, so that train speeds could be increased, to 79 m.p.h. for passenger trains and 60 m.p.h. for freights, and thus save time, thereby giving better service to shippers and passengers.

Why Automatic Block

The Texas & Pacific now has centralized traffic control on 244 miles of single track and 35 miles of double track. Therefore this railroad has adequate information concerning the benefits of this form of signaling. Investigation showed, however, that the train operations on the Lucas-Texmo Jct. section would justify only the absolute minimum expense for the most simple automatic signaling.

The daily traffic on this territory includes two passenger trains each way, a manifest freight train each way, and one local freight each way, making a total of eight trains. Under normal conditions, the local freight has only the two day-time passenger trains to clear while working in the territory. There were no continuous day-and-night train order stations in the section, and only one station at which there was an assigned operator during other than the regular eight-hour shift. Therefore, no change could have been made in station forces if CTC were installed. Furthermore, because of the very few meets or passes, the installation of CTC controlled power switches might not save much train time. The conclusion was that the signal department should prepare estimates and plans for simple automatic block signaling that would provide complete protection for train movements.

No pole line was available on which to install line wires for signal controls or for power distribution for signals. Roughly, the approximated estimate for a pole line was about $2,000 per mile, totaling $240,000 for the 120 miles. This was one of the factors that led to the decision to utilize the Trakode system, in which all signal controls are handled on the rails, without the use of line wires. Fortunately, commercial power at 120-volts a.c. was available at practically all the locations where needed in the signal system. Thus, no signal power distribution line circuit was required.

Before starting the signal project,

several sidings, not now needed, were retired. At Gayles, and at Boyce, one switch and a portion of old siding were retained as house tracks. Five other sidings were removed.

The relays on this project are the quick-detachable, plug-in type, mounted on racks in sheet metal cases. Rear doors give access to the wiring at the rear of the racks. These cases are set on foundations made of angle-iron framework.

Each wire from the rail terminates in the case on a Raco Clearview type lightning arrester. Union USG arresters are connected across the track circuit at both the feed and relay ends. The USG arresters are also used to shunt around the insulated joints at repeating cut sections.

The storage batteries are the Edison nickel-iron type, eight cells of 160-a.h. being used at each signal. Two cells of 80-a.h. are used for track circuits at intermediate locations and one cell at all other locations. These batteries are on floating charge from rectifiers.

Single-conductor, seven-strand, No. 6 or No. 9 (depending on length) copper cable is used from relay cases to bootleg outlets for track connections. In each bootleg box the No. 9 stranded is clamped with Ohio Brass Company Spearhead track connectors of hard-drawn bronze cable, rope lay—7 by 19 pre-formed construction, which extends in insulated bushings through the side of the box and plugs in ⅜-in. holes in the rail. This construction—Spearhead track connector—is used from terminals in switch circuit controllers to rails, the cables being run in straps, nailed to the sides of ties. The switch circuit controllers are the GRS Model 8. The operating rods and switch foot are the self adjusting type made by Railroad Accessories Corporation.

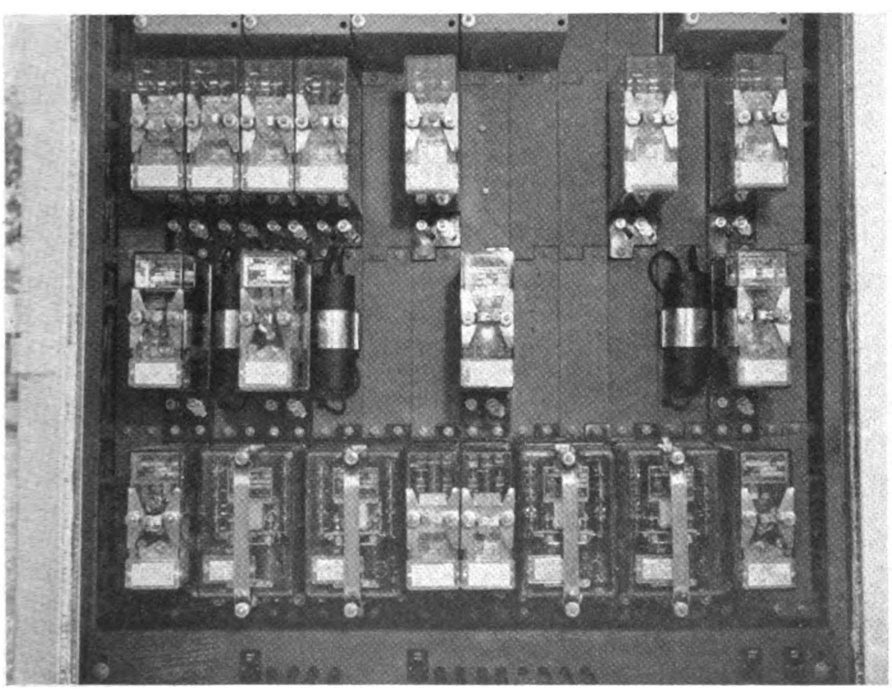
This signaling was planned and installed by signal forces of the Texas & Pacific, under the direction of J. L. Weatherby, signal engineer, the major items of signal equipment being furnished by the General Railway Signal Company.

How Track Circuits Operate

Trakode, a system developed by the General Railway Signal Company, utilizes track circuits with polarized energy, pulsating at a relatively slow rate. These track circuits provide a means of controlling wayside signals in both directions without the use of line wires. Hence the system may be applied to control absolute permissive block signaling or the automatic signals in centralized traffic control territory. Due to the pulsating nature of the track energy, the track circuits can usually be considerably longer than conventional direct current track circuits. The slow rate of pulsation lengthens the service life of the code responsive relays.

To help understand the basic principles of Trakode, consider a polar track circuit having a polar-biased track relay. This relay is equipped with two armatures, one responding to each polarity of current. By pole changing the current at the transmitting end of the track circuit, two pieces of information can be sent to the relay end. This could be used to control an H or a D relay for controlling a signal. By slowly pulsating this current so that the track circuit is alternately energized for a fraction of a second and then deenergized for about two seconds, more can be accomplished as follows:

1. Track circuits can be made longer.
2. By changing polarity, positive and negative code characters are available, but by pulsating the energy, two more characters may be transmitted. This is done by pole changing the current in the middle of an energized period so that one rail is first negative and then positive in respect to the other. The order may be reversed so that positive is first. Hence these code characters are negative-positive and positive-negative respectively. At the receiving end of the track circuit, decoding units detect which of the four characters is received.
3. In the long deenergized period, the same information may be transmitted back from the relay end of the track circuit. Therefore, any one of the four characters may be used to control an opposing signal.



The relays are the plug-in type, in sheet-metal cases

What Is Dependent Coding

A pulse transmitted from a head block (end of siding) is received at the first intermediate signal, or repeating cut location, and is repeated to the next track circuit as soon as it is received. The pulse is thus repeated through a succession of track circuits until it reaches the next head block.

However, at the intermediate signals, the character of the pulse about to be repeated may be changed from that being received, to indicate the position of the intermediate signal. When this changed pulse is received at the next head block, it conditions the circuits so that a similar pulse is transmitted and repeated back to the first head block, during the deenergized period between pulses.

It must be remembered that for normal Trakode operation, only one pulse is being transmitted through a block at a time. A pulse is sent in one direction, and after it has been received at the other end, another pulse is sent back. This is termed "dependent" coding, since the transmission circuits at the end of the block are conditioned by the pulse being received so that they will transmit a pulse back as soon as reception is ended.

When a train enters a block, it prevents the transmission of pulses to the opposite end and so ends the dependent coding. It also puts all opposing signals in the block to stop. The apparatus at the opposite end of the block then transmits pulses at a fixed rate and with polarity characteristics to give the proper signal indications to the train. Such transmission is termed "independent" coding.

In Trakode used in APB signaling, the tumbledown time of the opposing signals is not dependent upon the cascaded times of the signal mechanisms or their slow repeaters. Since the entrance of a train will release all opposing track relays almost simultaneously, the opposing signals will go to stop at the same time, regardless of the number of intermediate signals in the block. Also, failure of any intermediate signal to clear will not affect clearing of other intermediate signals between the failed intermediate and the leaving signal.

APB Signal Control

Fig. 1 shows a typical APB signaling layout with control limits for opposing and following moves. This particular arrangement of controls is shown here only for the purpose of demonstrating Trakode and may be simpler or more complex than shown. The opposing stop control of entering signal 21, for example, does not have to reach all the way to the opposing leaving end, as shown.

Fig. 2 shows a typical track diagram, with the signaling arranged for APB operation. The signal aspects are controlled by the presence or absence of coded energy in the track circuits and by the polarities of the codes as follows:

Aspects	*Code*
green	+
yellow	–
red	0

Diagram A shows the normal condition with no train present. All the signals are normally clear for both directions of traffic. All of the pulses for controlling the signals to green are shown as positive and are transmitted, in the direction of the arrows, alternately from station B to station C, and from C to B. The dependent coding with the repeating action from track circuit to track circuit is normally present in each section, except the detector track circuit at each siding end.

When B transmits a particular pulse to C and it is received, C in turn sends a pulse back to B with the same repeat operation. The polarity of the pulses need not be the same.

In Diagram B, a train at station B has moved onto the detector track circuit. The overlap has been arranged so that this removes all eastbound transmission right up to station C, and causes a tumbledown of westbound signals 13, 15, 17, 19, and 21 to red.

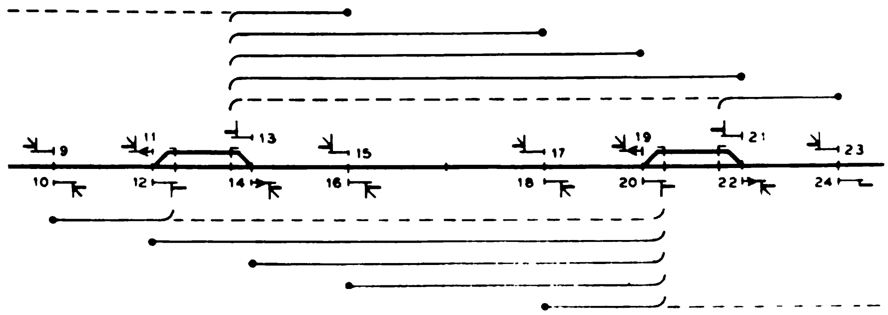


Fig. 1—Chart A—Control for opposing train movements, the solid lines indicate limits for Stop controls, dotted lines indicate limits of Approach controls

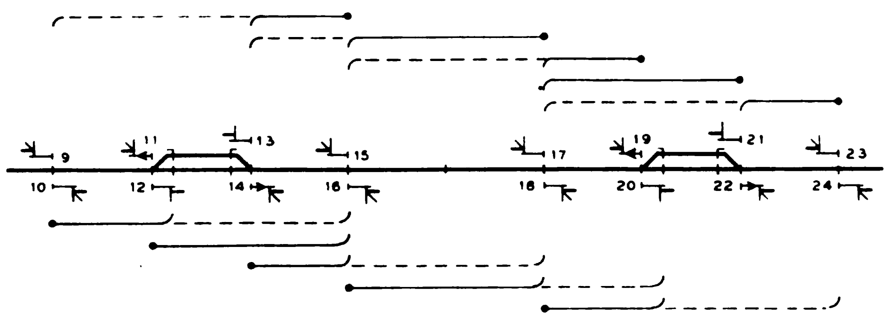


Fig. 1—Chart B—Control limits for following trains, the solid lines indicate limits for Stop controls, dotted lines indicate limits for Approach controls

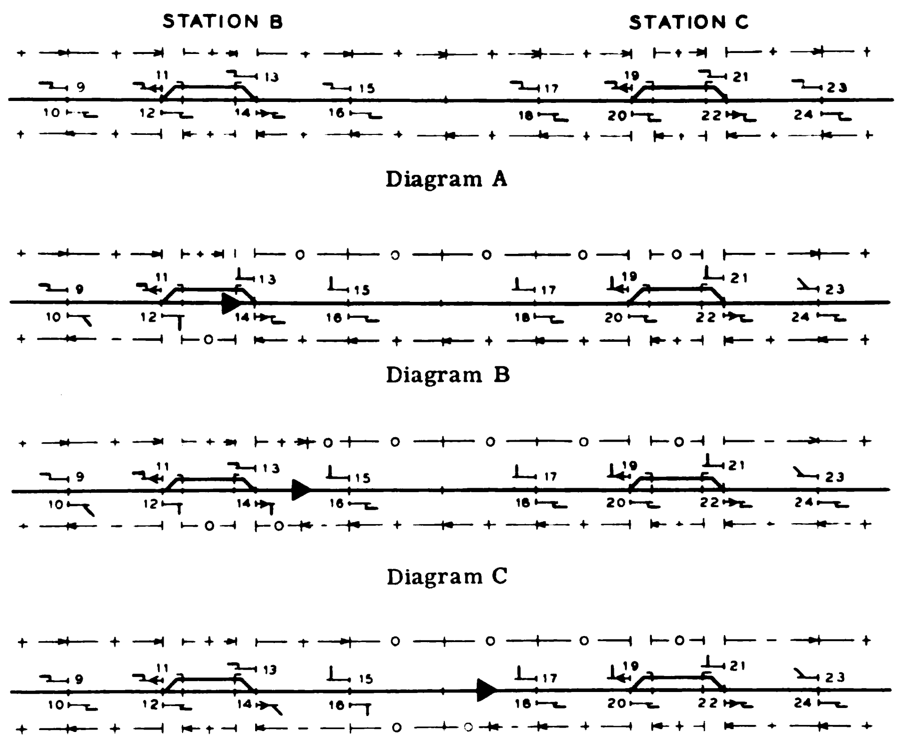


Fig. 2—Typical track diagram, with signaling arranged for Absolute Permissive Block operation, showing an eastbound train movement from one siding to next

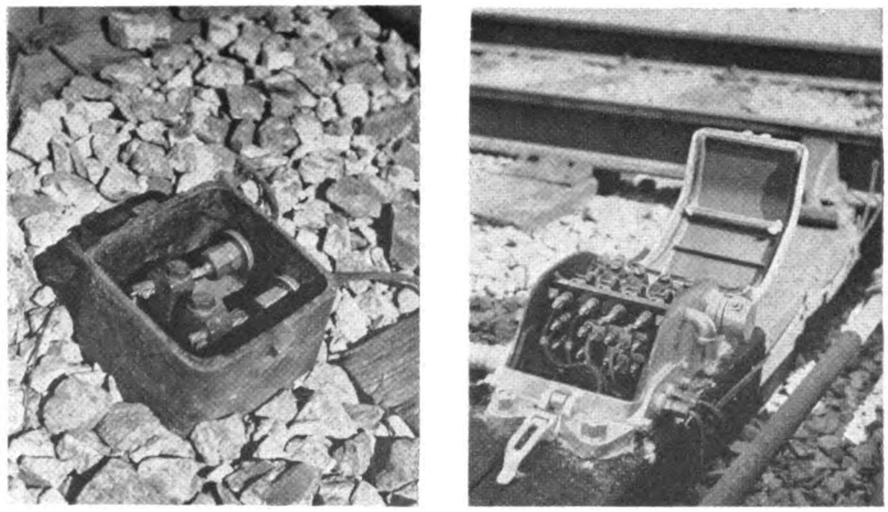
Signal 21 at red causes negative pulses to be transmitted to signal 23, controlling it to yellow. Station C, after waiting the normal time for pulses to arrive from B, changes to independent coding and continues to send positive pulses toward B, keeping the eastbound signals cleared for the train to proceed toward C.

In Diagram C, the train has accepted signal 14, cutting off westbound positive pulses and placing 14 at red. Signal 12 remains at red rather than changing to a yellow aspect because the train is still in the overlap limits of signal 12. Note that independent positive pulses are transmitted toward the rear of the train from signal 13. The train nearing signal 16 has actuated the approach circuit which changes to negative the pulses feeding from signal 16 to the train.

In Diagram D, the train has passed signal 16, leaving it at red. Signal 16 transmits negative pulses to control signal 14 to yellow for a following move, and 14 transmits positive pulses to control signal 12 to green. Note that although positive pulses are being transmitted from signal 13 to signal 15, signal 15 does not clear because of the directional stick circuit, which also prevents transmission toward signal 17. The approach-actuated stick circuit at signal 18 changes the positive pulses feeding from signal 18 toward the train to negative pulses.

Typical Siding

The block diagram in Fig. 3 shows the function organization of Trakode when applied at a typical siding. Each siding end has a detector track circuit which serves a two-fold purpose. It provides additional overlap against simultaneous entry, and also isolates the two Trakode circuits, thereby protecting against the breakdown of insulated joints. The signaling is arranged for APB operation in both directions. Signals are three-position except sig. 13 and sig. 12. These are two-position in this instance for reasons of simplicity, although Trakode is capable of controlling a third aspect as will be explained later. For the same reasons, only two code characters, positive and negative, will be used in the circuit descriptions to follow, although four characters are available.



Track connections are harddrawn bronze rope-lay, through insulated bushings

Briefly, the transmission procedure involves the following steps:

1. The polarity of the pulses to be transmitted is determined by the position of a particular signal.
2. The length of each pulse, and therefore the rate of transmission, is predetermined.
3. The pulse, positive or negative, is generated and applied to the rails from the battery.
4. A time delay is provided between transmission and reception of successive pulses. This is to prevent a possible induced voltage from the rails (rail kick) from operating the track relay inadvertently.

At the opposite end of the track circuit, reception of the pulses takes place thus:

1. The track relay responds to the polarity of each pulse by operating one of its two armatures as indicated by POS. and NEG.
2. The pulse activates a code detecting unit which operates one of the control relays.
3. Either the H or D signal control relay picks up, according to the pulse polarity, and remains up as long as pulses of the same polarity are received.
4. The H relay responds to negative pulses and controls the signal to the yellow aspect, and the D responds to positive pulses for a green aspect.

Circuit explanations of this new system will be in next month's issue

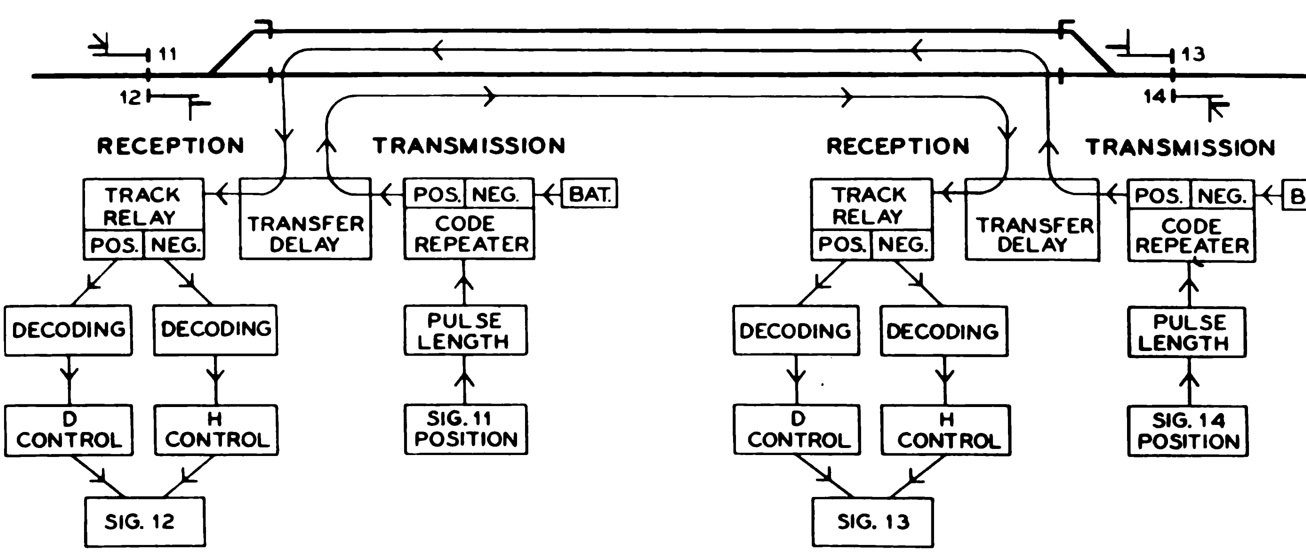


Fig. 3—Block diagram showing function organization of Trakode when applied to a typical layout