Santa Fe CTC's Double Track Line

Increased track capacity and improved operations result from traffic control system installed on 98 miles in Kansas. Both tracks have signaling for either direction running that saves one to two hours for important freight trains. Features include new No. 24 high-speed crossovers, special "helper" signals and quick release of electric locks.

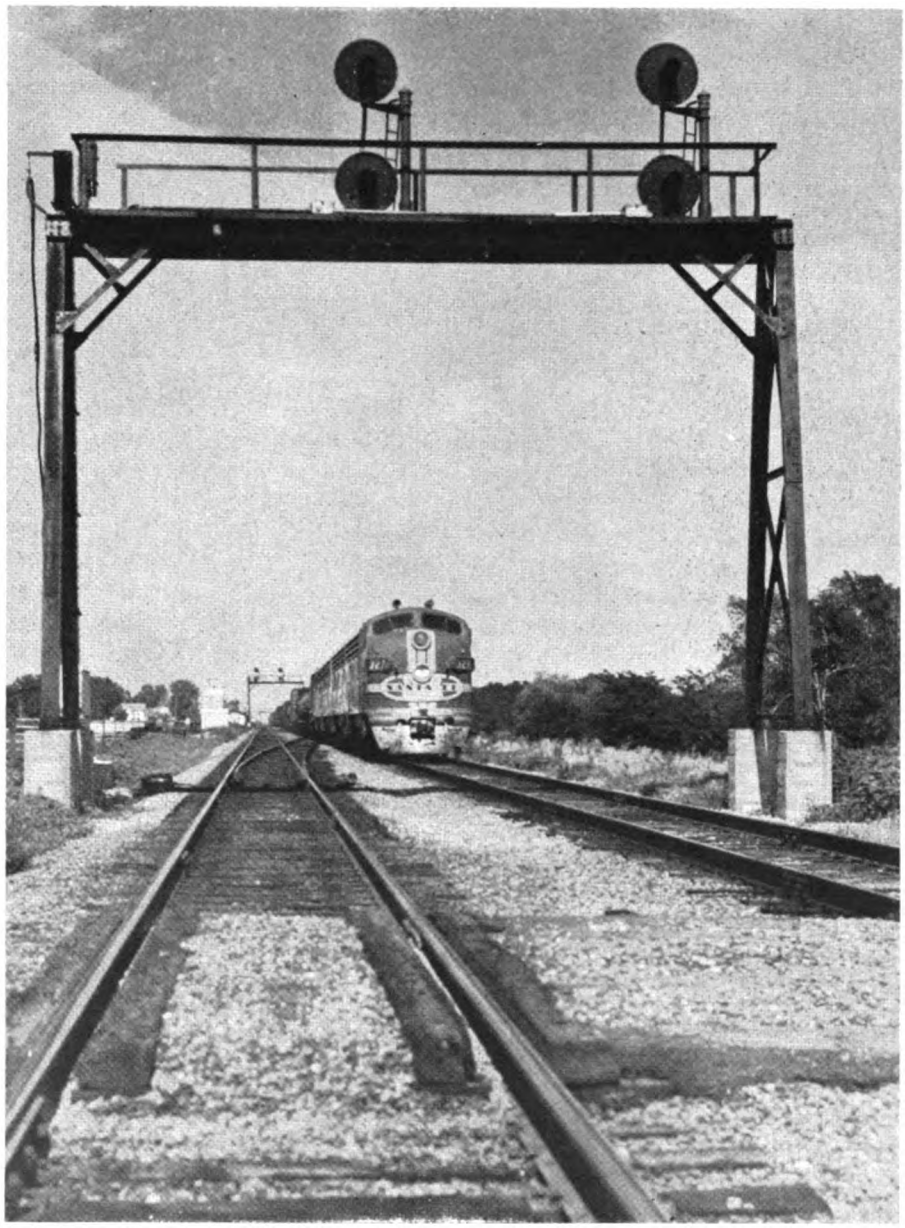
ON 98 MILES between Holliday, Kan., and Emporia, Kan., via Ottawa Junction, the Sante Fe has installed centralized traffic control for train operation by signal indication in either direction, on each of both main tracks. This project includes power switches and signals to replace several previous locally controlled interlockings and remote control layouts, and also power switches and signals at several new crossover layouts.

This is a busy section of railroad. The daily traffic includes about 27 passenger trains, 27 through freights and several locals. Extra freights are operated in peak seasons of fruit and grain.

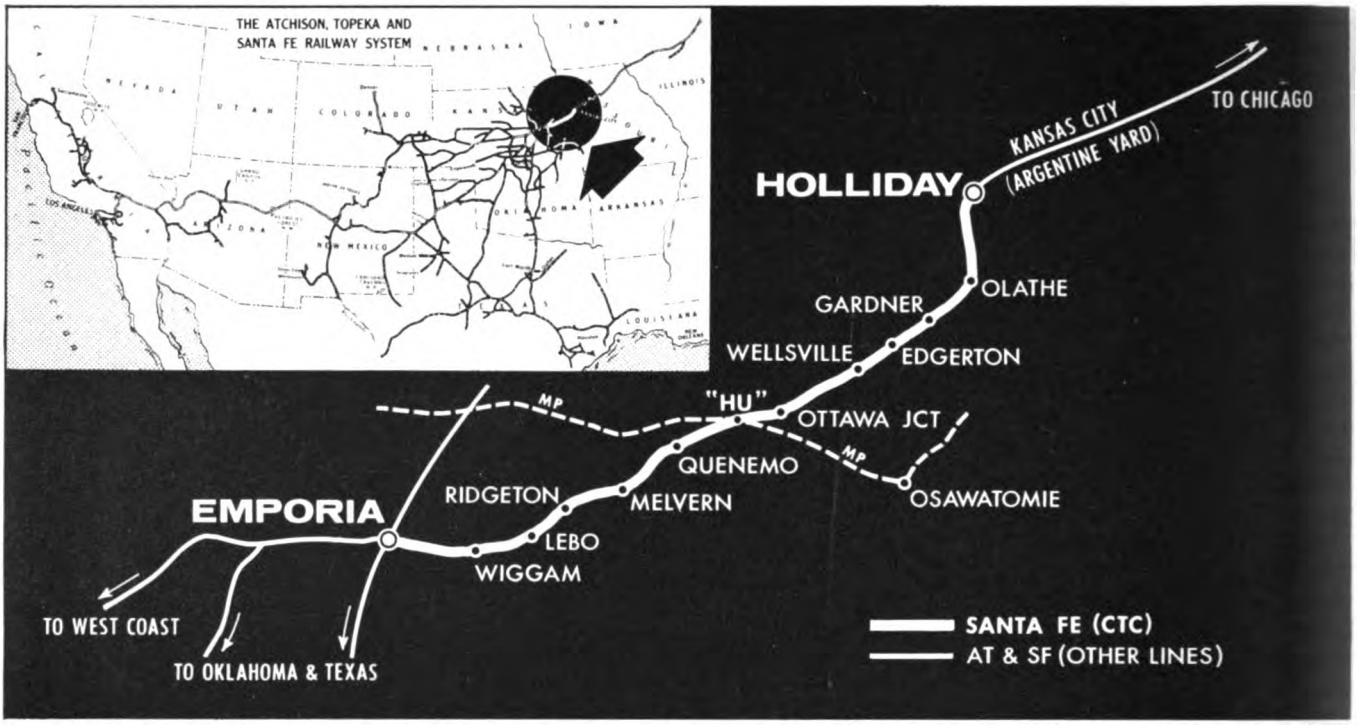
Previous Signaling and Interlocking

Automatic block signaling was previously in service, one track was signaled eastward and the other westward. Locally controlled interlockings, either mechanical or electrical, were previously in service at Olathe, Ottawa Junction, Tower HU, Melvern, Lebo and Wiggam, which is in the east section of Emporia. Power switches and signals at ends of sidings at Edgerton, Quenemo and Ridgeton were each remotely controlled from the nearest interlocking. Both ends of a siding at Ridgeton and another at Quenemo were controlled from Melvern. Four crossovers and junctions of the Howard branch and the Topeka line at Emporia were controlled from the Emporia dispatcher's office. In these interlockings and remote control layouts, spring switches, rather than power switches, were used at six switches at the leaving ends of sidings.

Even with all this signaling and interlockings, trains lost too much time. In part, this was the result of using timetables and train orders to



Reverse signaling on both tracks. Signal bridges rebuilt with high precast concrete piers.



This CTC project is on the Santa Fe mainline that handles trains running between Chicago and the West Coast and Texas.

authorize train movements. Most of the sidings were of insufficient length to handle trains now being run. Another handicap was that each main track was signaled only one way, so that the idle track could not be used for trains of the opposite direction without recourse to such expedients as manual blocking. Thus the objectives of the new CTC were to: (1) authorize train movements by signal indication both ways on each of the two main tracks; and (2) provide crossovers between main tracks (where not already in service) so that trains could be diverted from one track to the other to make run-around moves. Thus idle main track is used to keep all trains moving, rather than allowing some of them to waste time on sidings. Another objective is to require fewer sidings, and to avoid necessity for expensive extensions to the existing sidings.

The new CTC includes new power switch machines and signals to replace the previous locally controlled interlockings and the remote control layouts, as well as additional new crossover layouts at Gardner, East Gardner, Wellsville, Ottawa, Quenemo, MP 75 and Ridgeton. This new system includes 6 single switches, 24 crossovers, 78 home signals and electric locks on 52 hand-throw main track switches on spurs, emergency crossovers or house tracks. All these switches and signals are controlled by one machine in the office in Emporia. The machine is made up of three coding sections of the US&S type L, form 506A. Two sections are on d.c. code lines and the other uses carrier, Emporia to Ottawa, for the east segment.

What the CTC Does To Save Train Time

Now, movements are authorized by aspects displayed by signals at the control locations where trains are directed to: (1) keep moving; (2) diverge via a crossover; (3) take siding; or (4) stop. This new system is saving train time, as explained by J. H. Blake, division superintendent. For example, an important westbound freight, No. 91, is due to leave Argentine Yard near Kansas City at 11 p.m. In most instances, with the previous automatic signaling and interlockings, this train took siding at Holliday, or other places, for westbound passenger trains, such as No. 15, No. 17 or No. 47, as well as second No. 17. A result was that freight train No. 91 lost time standing in sidings. Train orders could not be transmitted and delivered in time for No. 91 to be advanced between other westbound trains, and there was no readily available means for running the westbound freight on the eastward track, if sections of that track were idle. As a result, the freight train No. 91 lost 1 hour to 2 hours or more while getting out of the way of passenger trains of the same direction.

Now, with the new CTC system, using signals to authorize train movements, and either-direction operation on both tracks, freight train No. 91 most always keeps going all the way to Emporia ahead of passenger trains No. 17, No. 15 and second No. 17. Thus, day after day, No. 91 runs on time. Similarly, other freight trains are being handled with improved on-time performance.

Previously, when any train was delayed, following trains were likewise delayed because there was no practical means readily available for using the other main track to run trains around the standing train. Now, if a train is delayed, other trains of the same direction can be run around on the other main track by the CTC system. This has been done to advantage in many instances.

In some sections the two tracks are separated as much as a half-mile to get better grades. On six miles between Gardner and Edgerton the two tracks are on different alignment, ranging up to a quarter-mile apart. In this section the south track includes six curves ranging from 2-deg. to 3-deg., 33-min., whereas the "north" track includes only two curves, 59-min. and 2-deg., 7-min. To

avoid the speed restrictions on the "south" track, trains of both directions are routed on the "north" track in this section. To aid in this an extra crossover was installed at Gardner.

Large warehouses and storage yards for the Navy and the Naval aviation training station are located north of the tracks between Olathe and Gardner East. Spur tracks lead from the "north" main track to these warehouses. Previously the switching crews which served these warehouses lost a lot of time when clearing the main track for trains. Therefore, as part of the CTC, a power crossover was installed at Gardner East, and dispatcher-controlled "holding" signals were installed at MP 28, three miles east of Gardner East. Now the dispatcher can set the signals for the switching crew to have exclusive use of the "north" main in this section, thereby completing their work in less time. Meanwhile, all other trains can be routed over the "south" track.

Special Signals Help Trains in Curve Territory

The two Gardner power crossovers were spaced approximately two and one-half miles apart to allow traffic to be diverted around the north track while switching operations are taking place at the US Naval Base connection. This distance is sufficient to hold the longest train that might be used in this territory, and the crossovers are located to facilitate these run-around movements.

To gain the necessary separation, required the placing of the east crossover very close to the 2-deg. 30-min curve. It was readily seen that the westward home signals could not be observed around this curve and for this reason two extra signals, Nos. 311 and 313, were placed at the east end of this curve to give the engineman of westward trains a last-minute appraisal of the condition of the home signals. These signals are referred to as "helper" signals in that the block is not broken at this point, and braking distances are not affected. A westward train might pass the normal approach signal location at signal 291 and observe a yellow aspect, on account of the interlocking being in use for a conflicting train. Preparation would be made for a stop, but while traversing the distance to the helper signal, it will be recognized that the crossover might be restored to normal and the route cleared up for the westward train after 291 is passed. In this event helper signal 311 will change to the clear aspect and there will be no question of stopping at the interlocking with short view of the home signal.

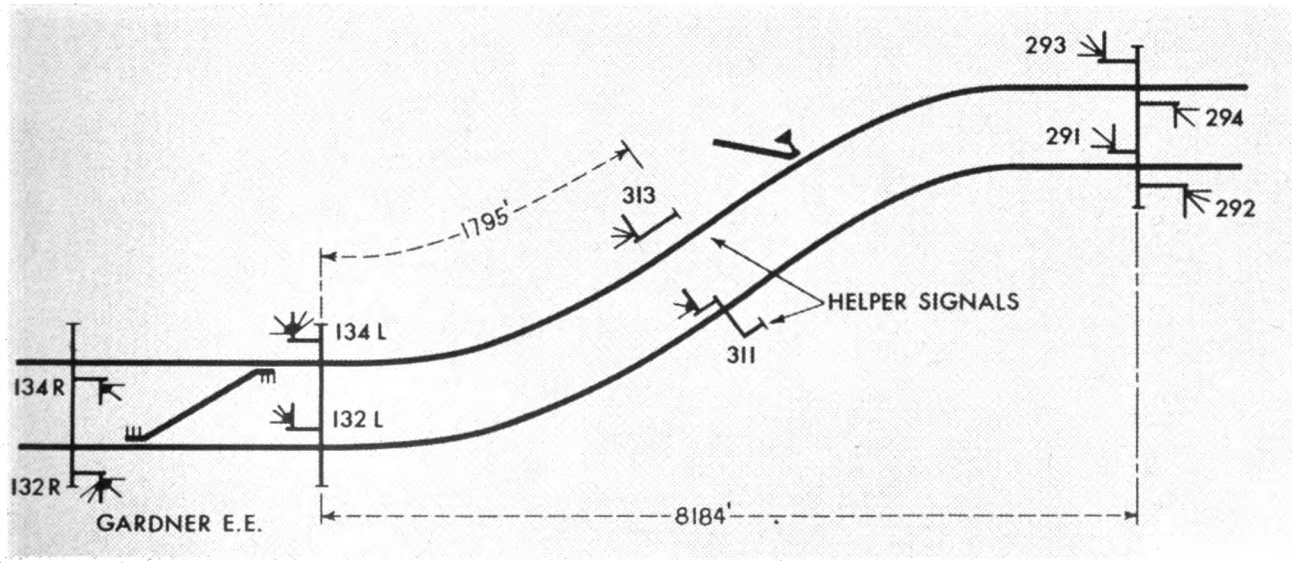
Considering the activity of train movements between the two Gardner crossovers, the railroad people considered the helper signals as an essential addition to avoid difficulty of train operations on account of the impaired view of the westward home signals. Experience has proved that the functioning of these special helper signals avoids serious complaints from enginemen in handling trains.

"HU" Now Semi-Automatic

West of Ottawa the HU Interlocking Tower originally controlled a siding switch, one main line crossover, and the crossing of Missouri Pacific line extending from Osawatomie westward toward Colorado. This interlocking was electromechanical with pipe-connected switches and electric signals controlled by attachment levers above the Saxby and Farmer machine. As there was no further use for this tower with the CTC, the entire interlocking was converted to electric type and control taken to Emporia. As far as the Missouri Pacific is concerned, however, the signaling is on an automatic basis. Manual control is superimposed on Santa Fe home signals, but this is contingent on occupancy of the controlling approaches by Santa Fe trains. If a Missouri Pacific train occupies the approach control section ahead of a Santa Fe train, the MP signal takes precedence and clears automatically. Arrangements are made for alternate movements over the crossing as between MP and Santa Fe, to prevent either road fleeting trains ahead of the opposing road.

Since this is essentially an automatic crossing, a 20-pen time recorder was provided for analysis of train movements at any time. The Santa Fe dispatcher is given full in-

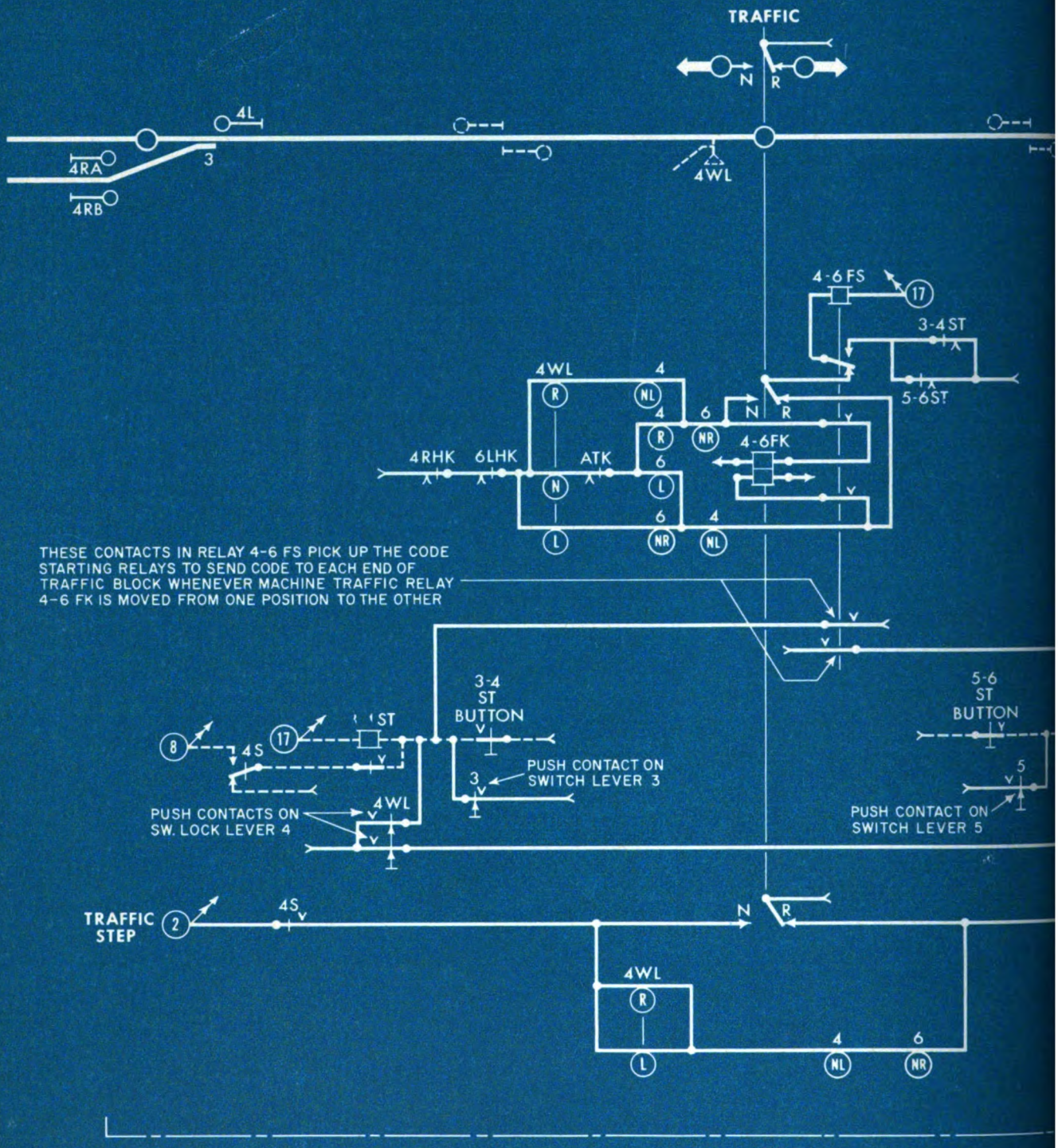
(Continued on page 18)



Helper signals 311 and 313 responds to clearing of home signals 132L and 134L respectively. Signal 313 can display yellow-over-yellow in addition to red, yellow or green. Signal 134L can display red-over-flashing yellow or red-over-green; also red, yellow or green.

Machine Circuits Next Page ▶

Typical Simplified CTC Machine



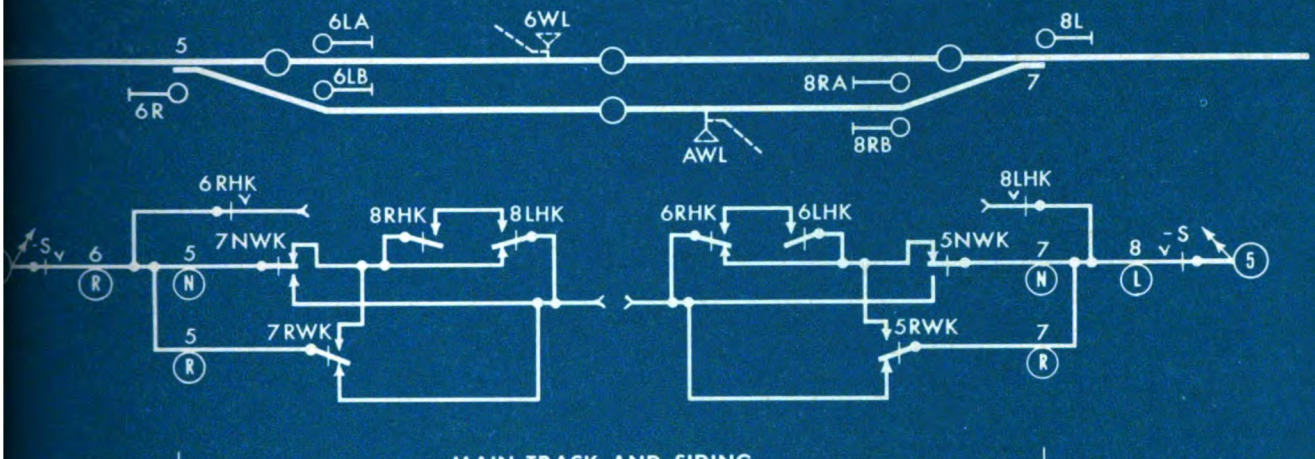
(FIG. 1) **GROUP A**

A feature of this Group A circuit in Fig. 1 is that when the traffic relay in the machine is reversed, a code is automatically sent to both ends of the traffic block to position the traffic relays in the field to agree with the traffic relay in the machine. This office traffic relay is positioned by the signal lever at the entering end of the block. No traffic levers are used on the machine. The field traffic relays operate the reversible two-wire block circuit.

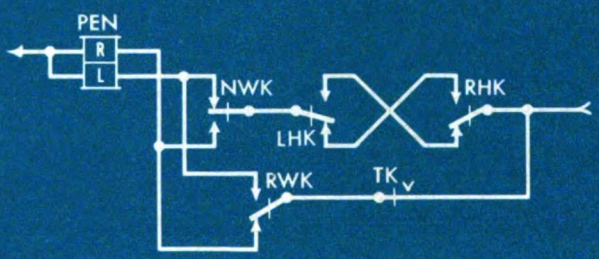
When setting up control for an electric lock on a hand-throw switch, the machine traffic relay for that block may be positioned as required by operation of the corresponding switch lock lever. These are three-position levers of the push-turn type. Such a lever is normally on center, being turned to the right or left as a means for clearing the intermediate signals for the direction in which the train on the spur is to go. When the switch lock lever is operated, a code is sent to each end of the traffic block, whether or not the machine traffic relay is moved.

In Fig. 1, electric switch lock 4WL is in a territory which has group A machine circuits. To get a quick release to come out of this spur, the dispatcher turns lock lever 4, and a code will go out to each end of the traffic block, thus putting battery on each end of the two-wire reversible signal circuit. When the man on the ground pulls the padlock, he will get a quick release, provided the track is unoccupied and entering signals are at Stop, and lock relays are up.

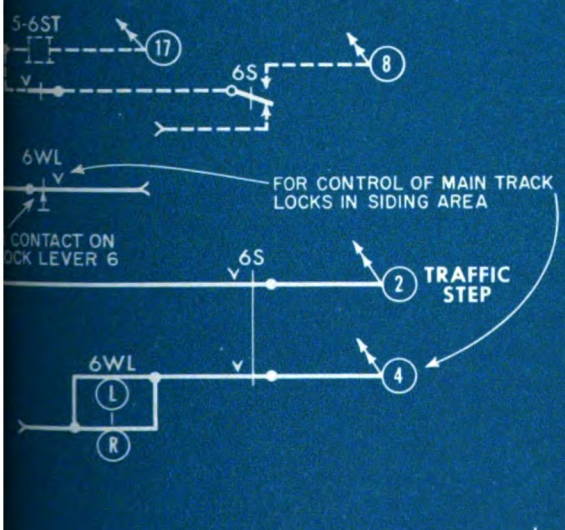
ircuits – Traffic Reversal System



(FIG. 1) **GROUP B**



3-POSITION "OS" PEN CONTROL



LEGEND

GROUP A { TRAFFIC REVERSAL SYSTEM USING REVERSIBLE SIGNAL CONTROL CIRCUITS AND CODE CONTROLLED TRAFFIC CONTROL RELAYS

GROUP B { TRAFFIC REVERSAL SYSTEM USING TWO WIRE REVERSIBLE SIGNAL CONTROL CIRCUIT AND LOCALLY CONTROLLED TRAFFIC CONTROL RELAYS

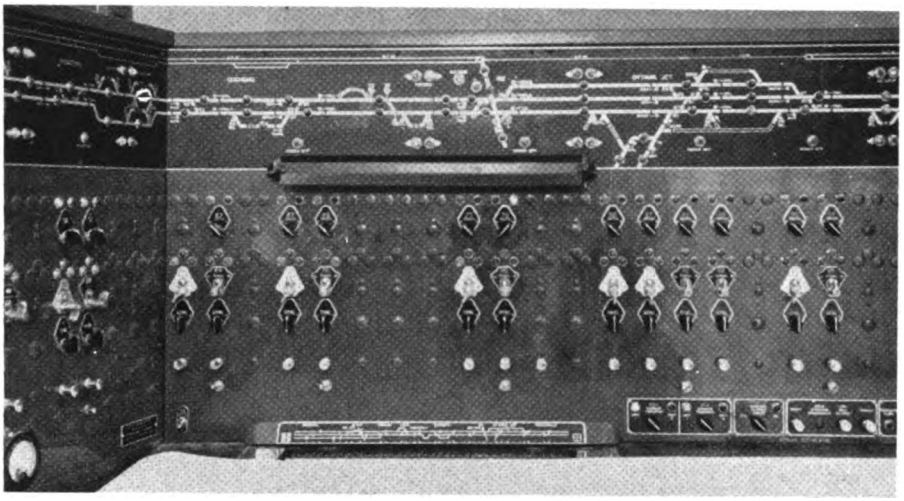
The machine circuit shown in Group B in Fig. 1 applies for control of a switch lock on main track within the limits of the length of a siding such as lock 6WL. In this location battery is normally on each end of the two-wire reversible signal circuit, when no controlled signal is clear to enter that section. Therefore, an extra circuit is used to give dispatcher permission for a quick release of the switch lock.

In locations where several switches are in a group and considerable switching is done, the controls are arranged so that the release controlled by the dispatcher will hold the group of switches unlocked, if they have once been unlocked, as long as the dispatcher leaves his lever in the unlocking position, even though the switches in the field may be returned to normal and padlocked.

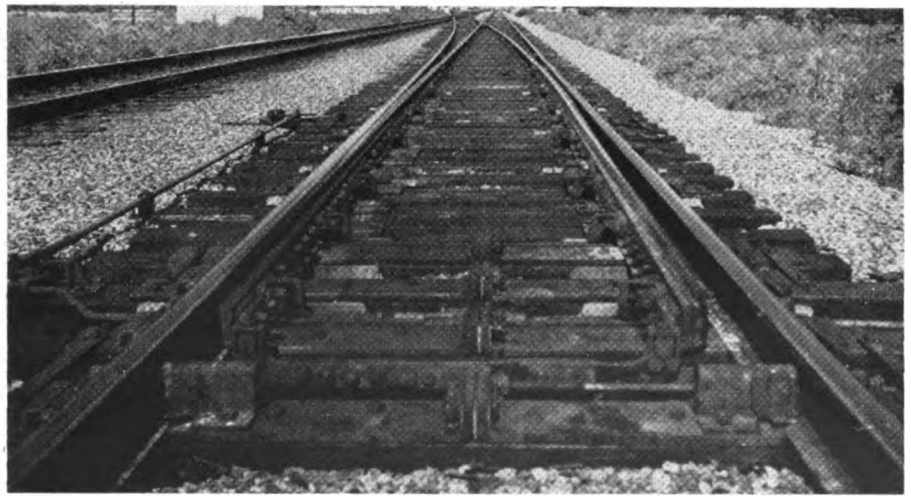
Electric switch lock AWL in Fig. 1 is on the siding, and Santa Fe practice requires only phone permission from the dispatcher to use the lock. The AWL will unlock immediately when the padlock is removed, provided the track between entering signals is unoccupied and the entering signals are at Stop, with lock relays picked up or the power switches set for diverting route.

A feature included in both the A and B group of machine circuits is that the dispatcher is prevented from knocking down the entering signal at one end of the traffic block if he attempts to clear the signal at the other end.

Single-conductor Number 9 cables extend from the instrument house to each rail connection.



A special feature is the use of push-turn switch control levers on this CTC machine.



This No. 24 crossover is 469 ft long including 39-ft curved points. Note heavy construction.

SANTA FE CTC INSTALLATION

(*Continued from page 15*)

formation of track occupancy by MP trains, as well as the position of MP home signals. Operation of this crossing on this basis has been reasonably successful, even though the interlocking separates the equivalent of three high-speed main tracks with heavy traffic on both lines. Some delays are inevitable as schedules may coincide as between the two railroads. Full protection is provided and emergency manual releases can be used in the event the normal interlocking processes are disrupted from any cause.

The crossovers between main tracks previously in service in this territory were No. 14, and these were converted to No. 20 at their previous locations. However, three of the additional new crossovers, one at Gardner and two at Wellsville, are extra long with 39-ft curved switch points and No. 24 frogs, which is something new in track work on main lines. With main tracks at 14-ft centers, using No. 24 frogs, a No. 24 crossover is 469 ft long. The objective in using these new No. 24 long crossovers is to increase the speed at which trains can be routed from one track to the other and thus save time and fuel. On these long crossovers, diverging moves from one main track to the other can be made safely at speeds up to 50 mph for freight trains, and the same for passenger trains, with no discomfort to passengers or spilled coffee in the dining car.

The maximum speed for freights is 60 mph. A freight one mile long will pass over the No. 24 crossovers at 50 mph, rather than 40 mph as on the No. 20 crossovers. The saving for the entire period (1) decelerating, (2) running entire train through crossover, and (3) accelerating to 60 mph —would total several minutes, as well as saving considerable diesel fuel. The saving in time and fuel is much greater when such a crossover move is being made by a train on an ascending grade or when approaching such a grade.

These new No. 24 crossovers are well constructed. The 39-ft curved switch points are reinforced with steel bars applied with 1-in. bolts. At Wellsville crossovers, the six switch rods, as well as the head rod are the vertical-pin MJ type. Insulated gauge plates 1-in. by 8-in. are used on ties No. 0, 1, 2 and 3. At Gardner the No. 24 crossover is fitted with conventional transit clip rods. Adjustable rail braces are used on ten ties.

To be sure that the entire length of the points move over when the switch machine operates, a special pipe connection extends via cranks and rollers from the operating rod to an extra connection on the switch in the thirteenth tie space from the point of the switch. To ease the operation, three roller bearings are used under each switch point. A com-

pound of graphite is used on the switch slide plates. Each switch is operated by a dual-control M23A low-voltage switch machine.

The previous automatic block signaling, for one way only on each of the two main tracks, was completely revised and rebuilt to provide automatic signaling either way on each of both tracks, just like two single tracks side by side. Previously most of the automatic signals were style T-2 low voltage semaphores and were spaced for comparatively short blocks, ranging from 8,000 ft to 10,000 ft. The new automatic signals are the searchlight type and are spaced for blocks ranging up to 13,900 ft long. In the previous one-direction signaling there were 76 automatic block signals, compared with 94 such signals on the new system for either way, on each of both tracks.

The signals display conventional AAR Signal Section aspects. Most of the automatic block lengths provide ample braking space, but where a block is less than maximum train-stopping distance, the double yellow aspect is provided as an advance-approach on the second signal in approach to one displaying "red."

As this was intermittent inductive train stop territory, wayside inductor equipment and controls were installed for all the new signaling.

Searchlight Signals Are on Bridges

The signals on this project are all new, being the H5 and H2 searchlight type. Each signal is either on a mast at the right side of the track governed, or on a bridge over the right rail of the track governed. As both tracks are each signaled both directions, most of the signals are on bridges. At each intermediate location, on those sections where the two main tracks are at normal 14-ft centers, the four signals (two for each direction) are on one bridge. These bridges are fabricated steel structures, reused from the previous signaling, with a vertical clearance above rail of 25 ft, an increase compared with past practice, to be sure to clear especially high loads, such as those in the last war. To attain this higher clearance, for bridges of previous design, higher precast concrete foundations were built in the material yard at Emporia. This method was very successful in saving time and expense of field pouring of foundation piers.

Special Features of Control

The Santa Fe has developed special features not only for the levers in the CTC machine, but also for circuits in the machine and for transmission of controls to field locations. These features have advantages for simplicity and reliability.

A special Santa Fe feature is that the switch levers are the push-turn type. The "push" action serves the same purpose as a "code-starting" button. These levers are in the top row of the control panel. The signals are controlled by conventional miniature levers, which are in the second row. A special help to the dispatcher is that the levers for signals on the "north" track are pointed up, and the small escutcheon plate behind such a lever is black, but levers for signals on the "south" track are pointed down and escutcheon plates are white.

Electric locks on main track hand-throw switches are controlled by push-turn levers which are in a row below the signal levers. Code starting buttons are in a row below the lock levers.

The track diagram includes indication lamps to repeat track occupancy of all sections of main track and power-operated sidings. Also, lamps on the diagram show the established traffic direction set-up for each overall block between major layouts. As used on this Santa Fe project, the push-turn switch levers are an advantage in expediting line-ups, because a switch code control goes out as soon as a switch lever is operated. Also, by putting the switches on code station assignments which are superior to those code assignments having the signals, misrouting is avoided. The dispatcher always sets the switch levers and dispatches the code before setting the signal lever.

In some instances a switch and signal are on the same code station. In such instances, it would appear at first thought, that the use of push-turn switch levers would cause unnecessary coding, but the Santa Fe experience is that, normally, the switch and signal lever, and starting button below the signal lever, are all operated before the first half of the code has gone. Thus, normally no additional coding results from the use of the push-turn switch levers. If the dispatcher is delayed when positioning the signal lever and pushing the code start button, a second code will go out. However, this has not proved to be a problem.

This project includes a telephone circuit which is superimposed on the CTC code line. High-efficiency Monophones are located in the instrument houses or phone boxes at all the field locations. Trainmen, signal maintainers, inspectors and supervisors have access to these phones to call the dispatcher, or to answer a call from the dispatcher. When the dispatcher is to call a maintainer he sends out a CTC code that lights a lamp and sounds a horn at the location being called. If a trainman is to call the dispatcher he whistles into the transmitter, which picks up a voice frequency relay in the office, or he is heard over the loudspeaker regularly in use.

Pole Line Construction

The line wires for the new signal system are on a new 10-pin crossarm on the pole line used also for communication wires. This pole line is owned 100 per cent by the railroad.

The CTC code circuit is on a pair of No. 6 Copperweld wires. The 480-volt a.c. power is on a pair of No. 6 copper wires, and the two-wire reversible signal controls are on a pair of No. 10 Copperweld wires. All these wires have a weather-proof covering of polene plastic.

Buried cables are used at field locations. A 7-conductor No. 9 cable and a 12 or 19-conductor No. 14 cable are run from the instrument house to each power switch. A 7-conductor No. 9 and a 12-conductor No. 14 are run to each signal. Each electric lamp feed is on two conductors of the No. 9 cables, and likewise single-conductor No. 9 cables extend from the house to each rail connection. The wiring in the instrument houses and cases is single-conductor No. 14 stranded.

The CTC installation was planned and constructed by Santa Fe signal forces under the jurisdiction of J. A. Parkinson, General Superintendent of Communications and Signals, V. O. Smeltzer, Superintendent of Signals, System, and O. C. French, Signal Engineer, Eastern Lines.