TRAIN STOP INDUCTOR is about 80 ft in approach to each main-track signal

Santa Fe Installs CTC on Single Track

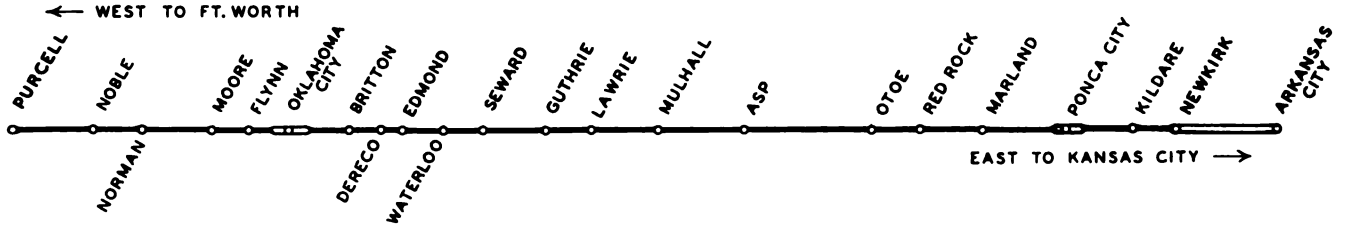
Project including automatic train-stop system saves train time and provides for higher average speeds on 142 miles

The advantages of centralized traffic control, to replace automatic block on single track, are being proved daily on a project recently completed by the Santa Fe on 136 miles between Newkirk, Okla., and Purcell, Okla. This is part of an important Santa Fe route between Chicago and points in Texas, via Kansas City, Mo., Arkansas City, Kan., Oklahoma City, Okla., Ft. Worth, Tex. and Dallas, Tex. On the Newkirk-Purcell section, the daily schedules include 6 passenger trains, 6 through freights and two local freights. Counting extras, a total of 16 to 20 trains are operated daily.

The new CTC is part of a program of improvements to provide for train operations at higher maximum speeds; 90 mph for passenger trains and 60 mph for freights; and to promote safety, as well as on-time performance which will mean reliable up-to-date railroad service to the public.

Lighter Grades and Curves

Except for short sections this subdivision traverses prairie, with rolling grades, ranging up to approximately 0.6 per cent. However at seven places the grade ranges up to 1.0 per cent. An early part of the improvement program was to improve the grades and curvature in the worst sections. This required considerable heavy construction. In the four-mile section through Waterloo, the ascending grade westward, formerly ranged up to one per cent, and included six curves, 4 deg to 5 deg 31 min, and two curves 6 deg. After the reconstruction, this four miles has a maximum grade of 0.7 per cent and maximum curvature of 1 deg. On the entire Newkirk-Purcell section the ruling grade eastward, now ranges up to 1 per cent for about 2.7 miles between Laurie and Mulhall. The ruling grade westward ranges up to 1 per cent for 2.2 miles just east of Otoe. Four other sections of 1 per cent are short. Speed restrictions on account of curves are 60 mph for passenger trains and 50 mph to 40



mph at four curves for freights; to 65 and 50 on one curve; to 75 and 50 at two places; to 80 and 50 at three curves; to 80 and 55 at one curve; and to 85 and 50 at four curves.

Thus, considered as a whole, this Newkirk-Purcell section has such few grades and heavy curves that passenger trains can be operated at high speed, 90 mph, for a large percentage of the distance, and, except on grades, the freight trains can be operated at or near 60 mph on a large part of the distance. Furthermore, the track is well constructed and maintained, using heavy rail, good ties and crushed rock and chat ballast.

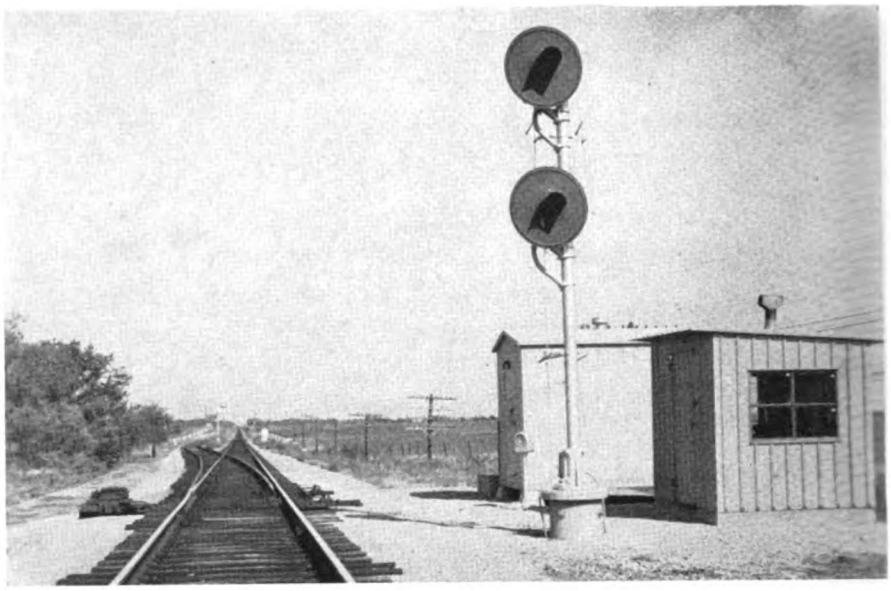
Fewer and Longer Sidings

As a part of the program, numerous changes were made in sidings. Sidings at Orlando and Waterloo were removed. Short sidings at Kildare, Flynn, Dereco and the short siding south of Norman, no longer to be used by through trains, were left in service as house tracks with electrically locked hand operated switches. Fourteen sidings were lengthened to capacities ranging from 125 to 276 cars. These sidings are at Newkirk, Marland, Red Rock, Otoe, Asp, Mulhall, Lawrie, Guthrie, Seward, Edmond, Britton, Moore, Nobel, and Purcell. New long sidings were built at Norman, Burnett and Perry. These 17 sidings are on single track.

New Operation at Ponca City

Previously, on 6.5 miles through Ponca City, the main line was double track, with automatic signals for right-hand running. Because of street crossings, train speeds are restricted to 30 mph. The passenger station is on the south side of the track. With this arrangement, there were numerous train delays. When a westward passenger train was making its station stop, no eastward freight train could run on the eastward track between the passenger train and the station. Also the passenger trains prevented freights from using the westward track.

The new project includes two double layouts of crossovers and one single crossover, all power operated, and located as shown on the plan, and the signaling is arranged for train movements in both directions on each of the two tracks. Now, each passenger train can be routed to make its station stop on the track adjacent to the station, so that the other track can, at the same time, be used by freight trains in either direction. Furthermore sections of either track (west of the station where no street crossings are involved), can be used by a freight train, as the equivalent of a siding, to run a passenger train around on the other track. Thus, the new arrangement prevents numerous delays compared with the previous operation. Another advantage is that, for some periods during the day, through freight trains of both directions can be routed on a given track, thus allowing exclusive use of the other track for switching moves, thereby directly expediting service to shippers.

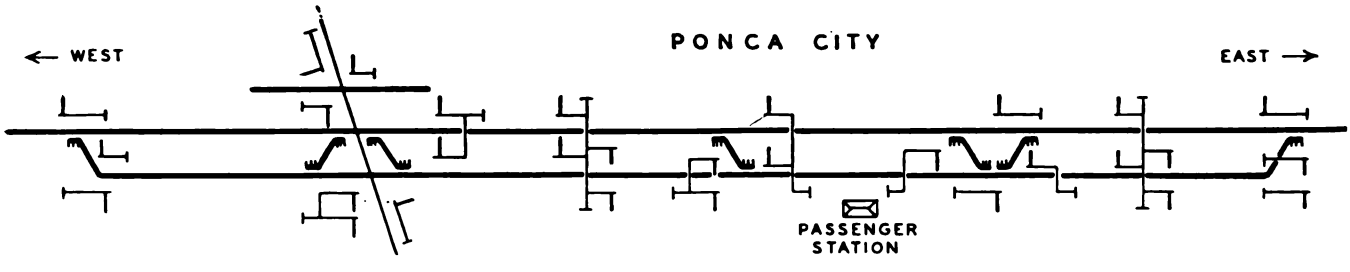


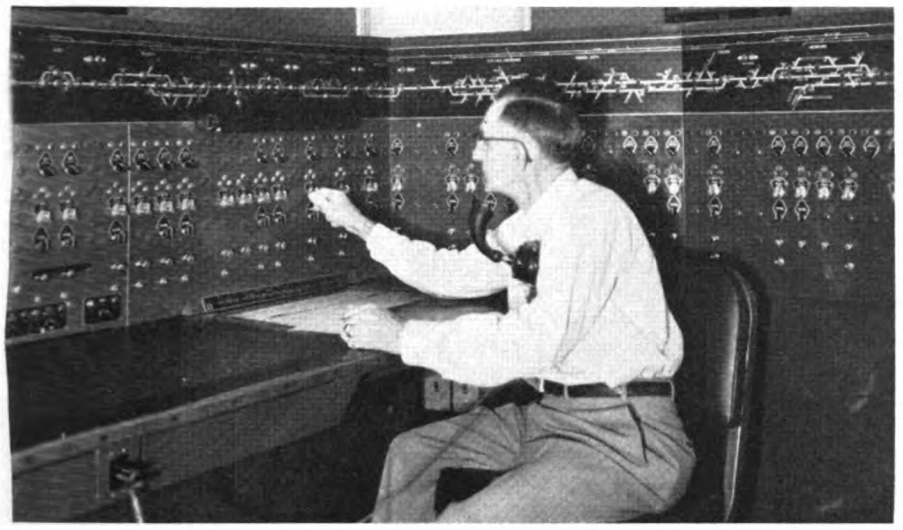
TRACK CIRCUITS ON SIDINGS enter into the control of signals

CTC Replaces Automatic Block

After completing all these track improvements, the next phase of the program was to replace the old semaphore automatic block signaling with a modern centralized traffic control system, by means of which trains utilize the new track facilities to the best advantage. With the power switches, trains enter and leave sidings without stopping. All train movements are authorized by signals, under the control of the dispatcher, thus eliminating numerous delays compared with the former practice of using time tables and train orders, with automatic signal protection.

Eastbound passenger train No. 12 now averages 57.8 mph between Oklahoma City and Newkirk, 108 miles, including six stops at intermediate points. Through freight train No. 39, is scheduled to make the run over the 153.3-mile sub-division, Arkansas City to Purcell, in 4 hours 30 minutes. The dispatcher states that, before the CTC was installed, he had difficulty in getting this train over the sub-division in its schedule time. Now he can do this easily, and can make up 20 to 30 minutes if necessary. Tonnage freights are now making the run in about one hour less than previously. Much of this time is saved by using the CTC to advance trains for close meets, in fact many meets are made without stopping either train; two such nonstop meets were made in the course of one hour recently, one of these meets being between two important freight trains, No. 37 and No. 38. Also the dispatcher says that passenger trains can do better than pre-





PUSH-TO-TURN switch lever sends out code when turned

vious and therefore can easily make up 15 to 20 minutes if they are received behind schedule.

Signal Aspects Save Time

New No. 20 turnouts with 30-ft. switch points were installed at the ends of the 17 sidings where power switch machines were to be placed. These turnouts are designed for trains to enter or leave the sidings at speeds up to 40 mph. This saves considerable time compared with 15 or 20 mph for shorter turnouts.

The sidings are equipped with track circuits to control signals and to control track-occupancy lamps on the control panel. When a switch is reversed for a train to enter an unoccupied siding, the entering signal displays the Red-over Flashing-Yellow aspect, and the signal in approach displays the Yellow-over Yellow aspect. Thus the engineman has advance information so that he can bring his train up to the turnout at the speed for which it was designed, 40 mph.

If the siding is occupied by a train of the same direction the entering signal can be controlled to display the Red-over-Yellow aspect, in which instance the signal in approach displays the single Yellow aspect.

Signals and Aspects

The signals on this CTC are the searchlight. The H-5 searchlight signals are used for all single-unit signals and as the top unit on all two-unit signals. On two-unit signals where the lower unit can display either of two colors (yellow or green), this unit is the H-2 searchlight type. This unit never shows red, and therefore a metal blind is used instead of a red roundel in the spectacle. This blind is black and shaped like a cone so that it cannot reflect light. On two-unit signals capable of displaying no color but yellow in the lower unit, this unit is an HC-33 lamp case with a yellow glass.

In the signals at the sidings, the lamps are the single-filament type, rated at 10 volts, 18 watts. In the intermediate signals the lamps are the double-filament type, rated at 8 volts, 13 + 3.5 watts. The lamps on all signals are normally lighted from a.c., being lighted automatically from storage batteries when trains approach, and the a.c. power has failed. The lamps are fed normally on a.c. from transformers, but if the a.c. fails, a relay transfers the lamp circuits to feed from batteries.

These signal aspects use only the three basic colors, red, yellow and green. Ordinarily, a signal displays only one light, such as green for Clear; yellow for Approach, or red for Stop. The second light appears only when needed to form a part of some aspect, other than the three named. In the yellow-over-yellow aspect, if one yellow lamp burns out, the remaining single yellow is more restrictive, and is thus on the safe side. In the red-over-flashing-yellow aspect, if the flasher fails to operate, the red-over-steady yellow is more restrictive. In the red-over-green, and red-over-yellow aspects, if the red lamp burns out, a relay operates to extinguish also the green or the yellow.

Automatic Train Stop, Too

An automatic train stop system of the intermittent inductive type forms a part of the signaling system on this territory. A wayside inductor is located on the ends of long ties at the right of the track about 80 ft. in approach to each main line signal. The 80 ft. distance is varied plus or minus if necessary to get the inductor at least 6 ft. from a rail joint, in order to minimize vibration damage to the inductor.

The coil in the wayside inductor is connected to contacts in a relay at the signal, so that the inductor coil is shunted when the signal is displaying the clear aspect. This circuit is on two separate single 19 strand No. 8 insulated cables which are buried 30 in. being spaced 12 in. apart.

The train-stop equipment on a diesel locomotive includes a receiver magnet mounted on the rear journal box on the front truck. The center line of the receiver is 25⅝ in. from the gage of rail, so that it rides directly over the center line of the wayside inductor, with a vertical clearance of at least 1 7/16 in.

When a signal is displaying the Clear aspect (high green), the corresponding wayside inductor is controlled so that it makes no change in the locomotive apparatus as the receiver on the locomotive passes over that inductor. However, if the signal is displaying any aspect other than Clear (high green), the train-stop equipment on the locomotive will function to apply the air brakes automatically, unless the engineman "acknowledges" by operating the acknowledging valve not to exceed 15 seconds before the receiver passes over the indicator.

To obtain a release after an automatic brake application has been installed, the engineman must first place the brake valve handle in "lap" position, and then wait the full minute required for the build-up of air pressure to restore the application valve to its release position. This waiting period is long enough to cause the train to be brought to a full stop. The engineman next operates the acknowledging valve to pick up the engine relay after which the acknowledging bell will sound. The brake valve handle may then be moved to release the brakes.

Coded Track Circuits

In this installation the signals in each siding-to-siding block are controlled by coded track circuits without the use of line wires for local signal controls except where highway crossing protection makes it necessary to use non-coded track circuits. When a signal is to be cleared for a westbound train (for example), a preliminary phase of the controls is to feed coded track circuit energy from the east to the west in the entire siding-to-siding block.

The 180-code controls a signal to display the green aspect; and the 75-code the yellow aspect. The 120-code causes a signal to display the yellow-over-yellow aspect. Any other code, absence of code; or steady energy, controls a signal to display the red aspect. If the lamp in a home signal burns out, any track code being sent to the signal in approach is changed to 75, so that the Approach aspect is displayed there.

When a train has departed from a siding-to-siding block, steady energy feeds through the track circuits in the direction of the last train movement, until the dispatcher sends out a control for the next train movement.

The OS switch detector track circuits use conventional 4-ohm d.c. relays, which are normaliy energized. In each OS detector track circuit the battery feeds at the entering signal, with one relay connected on the main track at the main track station-leaving signal, and a second relay on the siding, connected at the leave-siding dwarf signal. Both of these track relays must be up to clear a signal.

Switches Well Constructed

The switch machines are the type M-23A with dual control, and are operated by 20 volt d.c. motors. A pair of roller bearings is used on each switch. The points are 30 ft. long, and although they are reinforced they are flexible. An auxiliary pipe connection extends from the operating rod, via pipe and cranks, to connect to the No. 5 switch rod. This connection helps to move the switch points as a whole, and if the middle section of the points are obstructed, this special pipe connection prevent the switch machine from going over and locking up. In such an instance the overload relay would kick out.

Insulated gage plates ⅝ in. by 7½ in. are used on the ties No. 0, No. 1, No. 2 and No. 3. On two ties, these plates extend and are bolted to the machine to hold it in exactly correct position with reference to the rail. Adjustable rail braces are used on nine ties.

At main track switches connecting to house tracks and spurs, the old hand-throw switch stands were replaced with U.S.&S. T-21 hand-operated switch stands with Style SL21A electric locks.

Traffic Setup in CTC Machine

Special traffic circuits in the machine provide the office locking, and establish direction by code, initiated by an attempt to clear a leave-station signal. There are no traffic levers on the machine. Traffic lamps on the diagram show the direction in which traffic is established.

Turn and Push Levers

A feature of this control machine is that the switch levers are the turn-and-push type. When a switch is to be operated for a route, the dispatcher pushes and turns the lever to the desired position, this composite operation being the equivalent of positioning a lever and pushing a code-sending button, so that the control code for the switch goes out at once. Then the dispatcher positions the signal lever (to the left for southbound or to the right for northbound) and pushes a start button to cause the code to be sent.

Carrier for Code Line Circuit

The control machine is in the dispatcher's office at Arkansas City, Kan., which is 12.4 miles north of Newkirk, the north end of the 136.4 mile CTC territory to Purcell. The CTC line circuit is on two wires which are No. 6 Copperweld 40 per cent conductivity, with duraline weatherproof covering. Outgoing controls and incoming indications are handled by dc codes on the first 58 miles between the office and Perry. The line circuit in this section also handles two carriers between the office, Perry and Edmond, Okla., where carrier is converted to dc codes going on to field stations in the Perry to Edmond and Edmond to Purcell sections. Also dc indication codes from these sections go to Edmond and Perry where they are converted to carrier to go on back to the office. The carrier equipment is in duplicate at the office and at Perry and Edmond. If a set fails, the dispatcher can cut in the standby set.

Motor Car Indicators

As part of the new signaling, automatically controlled motor car indicators were installed to warn men on motor cars of the approach of trains. The indicators are located at the end of each siding and at each intermediate signal, and at other places, averaging about 4,000 ft. apart. Having seen an indicator indicating "clear", a man has time to proceed at normal motor car speed to the next indicator, and take his car off the track.

When indicating "clear" an indication shows three 1-in. black dots in a vertical row. When indicating

MOTOR-CAR INDICATOR shows clear

that a train is approaching, an indicator shows three 1 in. dots in a horizontal row. Each indicator is marked to show the extent of control each way, for example 1.7 miles south and 6.9 miles north.

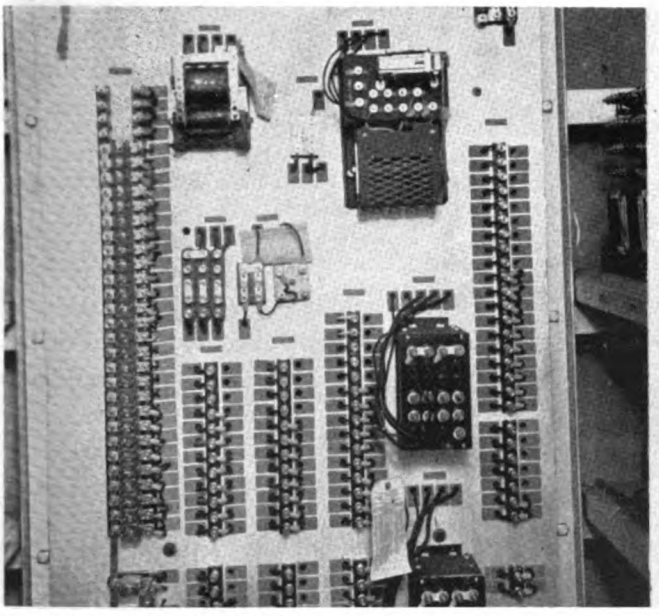
These indicators, which have 40-ohm coils, are normally energized by line circuits which break through front contacts of track relays or track repeaters.

The line control circuits for these indicators are on iron line wire which was used previously in the original semaphore automatic block signaling. Separate batteries are used to feed these indicator line circuits so that there is no connection with the signaling system.

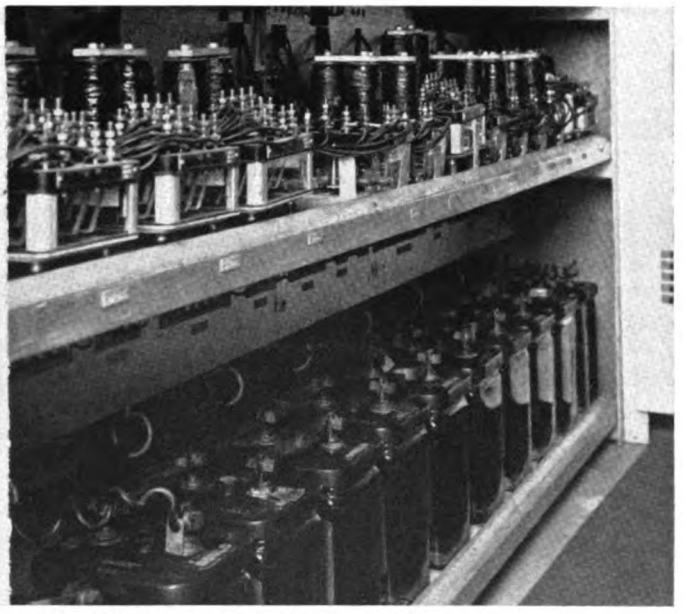
Power Supply

The 440-volt a.c. power distribution circuit extends both ways from feed locations about 15 miles apart. This circuit is on two No. 6 copper, weather-proof line wires. The 440/120 volt line transformers are rated at 100 watts at the cut sections; at 250 watts at intermediate signals and at ends of sidings including only one power switch. At locations including two or more power switches or other extra apparatus the transformers are rated at 500 watts. These transformers are the General Electric air-cooled type, mounted on cross-arms.

In the house at the end of each siding there is a set of 13 cells of 80-a.h. Gould lead storage battery which feeds the switch machine, and part of it serves also to feed the code



RECTIFIER AND TERMINALS on board



RELAYS AND BATTERIES in sheet-metal house

equipment. A set of 5 cells of 80-a.h. lead battery feeds the local relays and circuits and acts as standby for the signal lamps which are normally on a.c. A similar battery for the same purpose is used at each intermediate signal.

In most instances each of the coded track circuits is fed by two 80-a.h. lead storage cells in multiple. Because each coded track circuit must be fed either way, two such batteries are required for each track circuit, in the siding-to-siding sections. Each of the OS switch detector track circuits is fed by four 500-a.h. primary cells in series multiple. These are either Edison or National Carbon. A rectifier across these cells carry all but about 10-20 m.a. of the normal load. At the control station in Arkansas City, the code line is normally fed from a code line unit. If the a.c. supply fails, a tuned reed alternator is started to feed the line unit, and telephone and carrier equipment. This alternator which can put out 2 amp. at 120 volts is fed from a special battery consisting of 8 cells each of 160-a.h. lead storage battery connected in multiple to give 320 a.h.

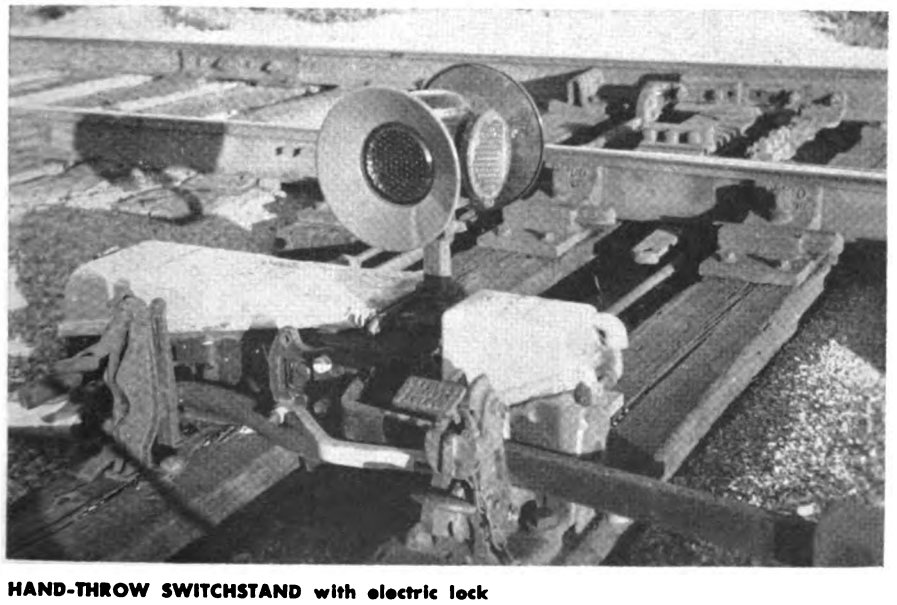
Housings

At the end of each siding having a power switch, the relays, coding equipment and batteries are in a concrete house 6 ft. by 10 ft. The shelves in these houses are wood plank, 2 in. thick.

On the wall in the end opposite the door there is a ⅝-in. plywood panel on which are mounted the arresters, terminals for incoming cable wires, and the low-voltage transformers and rectifiers. An outer door opens to the rear of this panel thus facilitating the work of bringing in and terminating the cables.

Also at each power switch at the end of a siding there is a galvanized iron sheet metal building 8 ft. by 6½ ft. that is used as a tool room and warming room by trackmen, especially during snow storms if necessary to assign a man to keep the snow cleaned from the switch.

In addition to conventional voltmeters and ammeters, the maintainer at Arkansas City headquarters is furnished with special instruments for testing electronic equipment in the carrier apparatus. These instruments include a Hickok Model 534B tube tester, a U.S.&S. carrier level meter, and a Hewlett Packard audio oscillator.



HAND-THROW SWITCHSTAND with electric lock

Interlocking Replaced

At Black Bear a single-track branch line of the Frisco crosses the Santa Fe. This crossing was previously protected by an automatic interlocking which was replaced by a semi-automatic plant as part of the CTC project. The Santa Fe home signals are controlled by the dispatcher. With no Santa Fe train on the approaches or home signal limits, the Frisco signal will clear when a Frisco train enters the approach. This holds the Santa Fe signals at Stop until the Frisco train clears the plant limits.

This centralized traffic control was planned and installed by railroad forces under the jurisdiction of G. K. Thomas, Signal Engineers, System, and D. W. Fuller, Signal Engineer Eastern Lines. The major items of equipment were furnished by the Union Switch & Signal Division of the Westinghouse Air Brake Co.