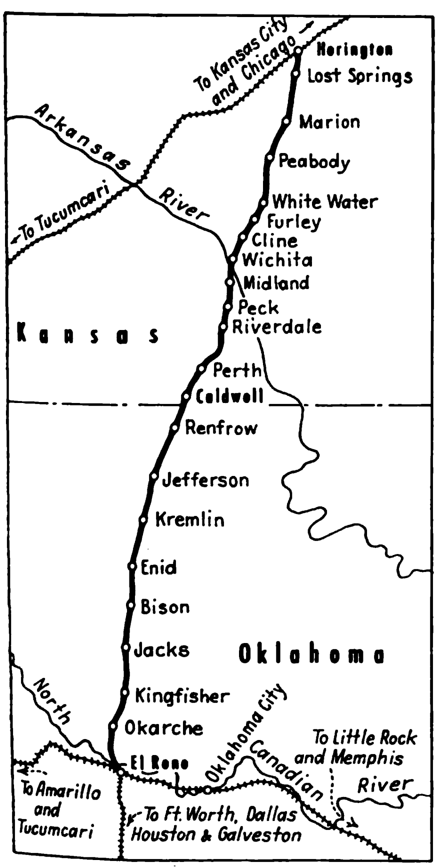
Rock Island Adapts C.T.C.

To Medium-Traffic, Single-Track Line

On a 231-mi. project the costs were reduced by equipping only 19 of 34 previous sidings and by utilizing modern normally-deenergized coded track circuits, thereby obviating line wires

EXCELLENT benefits in saving train time are being accomplished by the centralized traffic control recently completed by the Rock Island on 231 mi. of single track between Herington, Kan., and El Reno, Okla. Of interest also is the fact that the cost of the project was reduced by adapting the system for a medium volume of traffic. The project was planned for a traffic of about 12 to 15 trains, including 6 passenger trains and 6 to 9 freights. Actually the freight traffic has continued at a high level so that the number of trains daily now ranges from 18 to 22 or more. Nevertheless, the C.T.C. system is handling the trains satisfactorily and no further additions are contemplated at this time.

This territory is a portion of a through route between Chicago and points in Texas, via Rock Island, Kansas City, Topeka, Herington, El Reno, Ft. Worth, Dallas, Houston and Galveston. Automatic signaling or centralized traffic control was previously in service on the 661 mi. between Chicago and Herington, while the 1947-48 programs completed either one or the other of these forms of signaling on the 447 mi. from Herington through to Dallas.



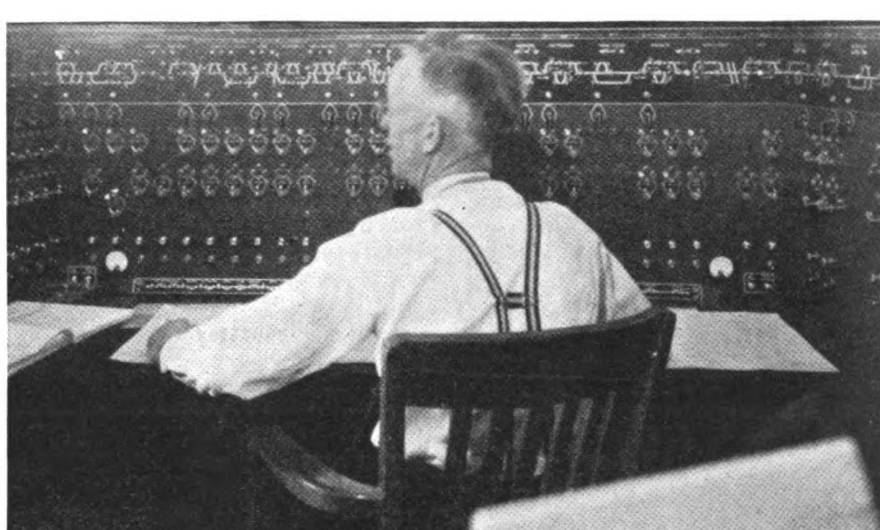
The 231 mi. of C.T.C. as shown in Fig. 1, map above, is controlled by the one machine operated by the dispatcher at Caldwell, Kan., at the center of the project

Crossing at El Reno

At El Reno this north-and-south line crosses the east-and-west line of the Rock Island which extends from Memphis westward through Little Rock, Oklahoma City, El Reno and Amarillo to Tucumcari, where it connects with the Rock Island-Southern Pacific Golden State Route, between Chicago and California. On account of the interchange at El Reno, the volume of freight traffic handled in both directions is heavier between Herington and El Reno than between there and Ft. Worth. Accordingly, centralized traffic control was installed on the El Reno-Herington section, while automatic block was installed on the El Reno-Ft. Worth territory.

Few Curves and Grades

Between Herington and El Reno the railroad traverses rolling prairie country. The curves are relatively few, and most of them are less than 1 deg., there being only one curve of 2 deg., and this is located at Corbin, Kan. Grades, for the most part, are rolling and not to exceed 0.7 per cent. The longest grade ranges from 0.65 to 0.7 per cent for about 4 mi., ascending southbound, just north of Concho, Okla. Thus train speeds are not restricted on account of curvature or to any great extent by grades. The track is in good condition with heavy rail, good ties and ballast. The maximum permissible train speeds are 50 m.p.h. for freight trains, 70 m.p.h. for passenger trains consisting of conventional equipment hauled by steam locomotives, and 79 m.p.h. for Rocket trains hauled by Diesel-elec-



Southbound fast freight at Corbin

tric locomotives. The faster passenger trains average about 61.8 m.p.h. over the division, and the through freights about 34.2 m.p.h.

Number of Sidings Reduced

Train movements were previously authorized by timetable and train orders, no automatic block signaling being in service, and the siding switches were all operated by hand-throw stands. The sidings previously used for meeting trains were about 4 mi. to 4.5 mi. apart. Experience, which the Rock Island has had on other divisions, proves that C.T.C. permits traffic to be handled satisfactorily with fewer sidings. Accordingly, on this new project, power switch machines and signals, controlled by the dispatcher, were installed at only 19 of the 34 sidings. The power sidings are spaced about 9 to 12 mi. Some of the intervening sidings were removed and the remainder are being left in place until experience, through a few seasons of peak traffic, determines whether some should be equipped for C.T.C. Up to now, the train operation has been satisfactory with as many as 25 trains daily. Therefore, quite likely these remaining intervening sidings can be removed, except where needed for connections to house tracks or industry spurs.

When planning the signaling arrangements, no signals were located at the switches of the hand-throw intermediate sidings. For example, as shown in Fig. 2, there are no signals at Hennessey. The first automatic block west of Bison is 8,200 ft., and the first one east of Jacks is

Table of Car Capacities of the C.T.C. Power-Equipped Sidings

Siding	Number of Cars
Lost Springs	124
Marion	92
Peabody	124
White Water	124
Furley	92
Cline	E 106 W 118
Wichita	Yards
Midland	146
Peck	93
Riverdale	118
Perth	93
Caldwell	Yards
Renfrow	92
Jefferson	96
Kremlin	92
Enid	191
Bison	92
Jacks	92
Kingfisher	134
Okarche	92
El Reno	Yard

7,700 ft., these distances being train-stopping distance plus a safe margin. A shorter block such as this, in approach to a station-entering signal, permits maximum time, when a train is approaching, for the switch to be lined and the signal cleared. An advantage of this relatively short block, such as 8,2000 feet from the west end of Bison to the first intermediate, 3575, is that if a westbound freight is on the siding for a westbound passenger train, the freight can depart sooner because the passenger traverses the short block in less time.

Three remaining automatic signal blocks between Bison and Jacks range from 11,600 ft. to 13,900 ft., i.e., from 2.2 mi. to 2.4 mi. This arrangement is adequate. The use of these three longer blocks, as compared with four about 9,370 ft. long, saves one double set of intermediate signals, and as compared with five blocks about 7,500 ft. long, saves two double sets of intermediate signals.

The signals are the searchlight type, and, except as discussed below, each unit is capable of displaying the three standard colors, red, yellow and green. On a station-entering signal at a power switch, the mast is high enough that the upper unit is 20 ft. above the level of the rail. The lower unit, which can display only red or yellow, is 10 ft. below the upper one. Thus the bottom unit is in the location of a third "arm", rather than that of a second one. The aspect of red in the top "arm", over yellow in the third "arm" is the Rock Island standard for Restricting, Rule 290, for a signal governing into a siding. The sidings are equipped with track circuits for track-occupancy indications on the control machine but the signals are not controlled through these track circuits.

For Short Blocks

In some instances the block between the signals at the two ends of a siding is less than train-stopping distance for all trains, as for example the distance at Jacks is 4,900 ft., as shown in Fig. 3. Accordingly, an extra lower unit was installed on approach signal 3645. With the westward station-leaving signal R106 at Stop and station-entering signal R104 at Approach, then signal 3645 is controlled to display the Ap-

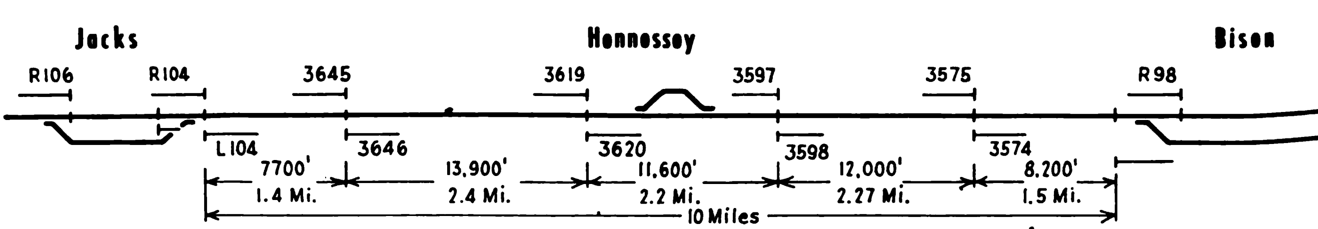


Fig. 2—Blocks near Jacks and Bison are shorter than others in overall block between equipped sidings at Jacks and Bison

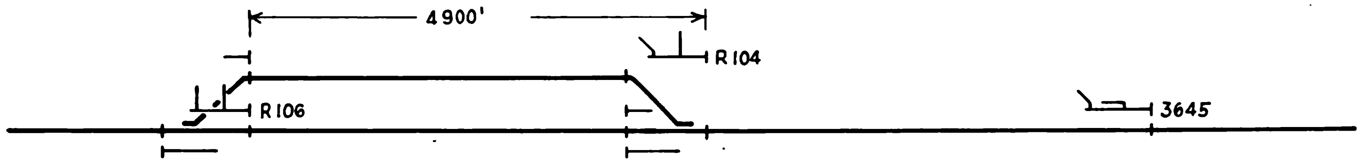
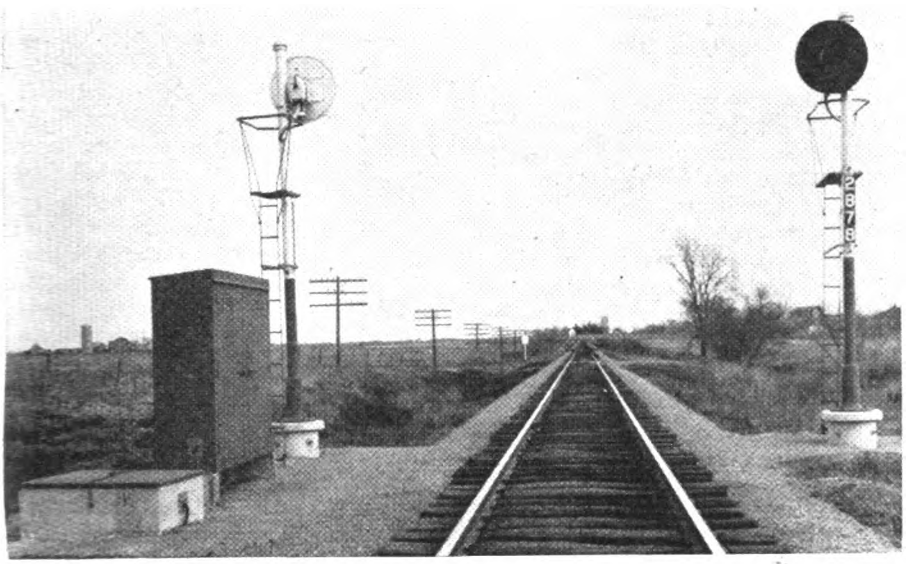


Fig. 3—Use of the Approach-Medium signal aspect

proach-Medium aspect, yellow-over-green. The lower "arm" on signal 3645 is a non-operative ordinary lamp unit with a green lens. The lamp in this unit is lighted only when the Approach-Medium aspect is to be displayed. On the entire project with 19 power-equipped sidings, a total of 37 signals are thus equipped to display the Approach-Medium aspect.



Typical intermediate signal location with no line connections

Either Direction, Normally-Deenergized Coded Track Circuits With No Line Wires

The track circuits between sidings are the coded type, with primary battery, arranged to feed in either one direction or the other, and are normally deenergized. The advantages of coded track circuits are that: (1) They can be longer than conventional circuits, thus eliminating or reducing the number of cut sections; (2) they can be used to control signals to three or more aspects without the use of line circuits; (3) they can be used to control electric locks on hand-throw switches without requiring line wires; (4) they can be used to check the track occupancy of a siding-to-siding block without requiring line wires; and (5) they are more economically maintained. The advantage of the normally-deenergized feature, as applied by the Rock Island on a territory with a medium number of trains, is that it is practicable to operate the intermediate signals and track circuits between sidings from primary batteries, thereby avoiding the expense for two line wires for an a.c. power distribution circuit between sidings.

The track circuits and signals in a station-to-station block are "turned on" to feed through from siding to siding, when the dispatcher is lining up to clear a station-leaving signal. The track circuit feed is in the direction opposite to the train movement.

The ballast is clean and free from the rail, and the normal ballast resistance is not less than 4 ohms per 1,000 ft., so that the coded track circuits can be 9,000 ft. or more in length, as compared with a maximum of approximately 3,500 ft. for conventional d.c. track circuits, according to experience on the Rock Island. Thus the coded track circuits permitted the use of only one such circuit in blocks up to 9,000 ft. in length, thereby obviating two-cut section locations.

On the 74 mi. between Medford and Wichita the rail joints are bonded with Cadweld rail-head bonds, and on the remainder of the project pin-type mechanically-applied rail-head bonds of several manufacturers were used, including the Ohio Brass, the American Steel & Wire Co., and the Hanlon & Wilson.

How a Track Circuit Feeds Either Direction

In order that a track circuit may be used to feed in either direction, there is both a relay and a battery at each end of every such track circuit. The basic principles are shown in Fig. 4, the circuits being arranged so that normally, when deenergized, the relay at each end is connected to the rails, and the batteries are on open circuit. When a line-up is to be established for a westbound train, for example, controls, which are initiated by the dispatcher through the C.T.C. line code, eventually cause the right code transmitter repeater relay, RCTPR, to be operated back and forth 75 times each minute. Each time the "left" contact closes, an impulse of energy from the positive side of the battery feeds through the coil of relay RTR to the "top" rail. This relay, however, is not operated by this energy because it is polar-biased, and, therefore, will operate only when the energy is positive to the "left-hand" terminal, as drawn.

The feed in the track circuit is to the right, and, at the right end, these impulses energize and release the track relay LTR 75 times each minute. Contacts in relay LTR con-

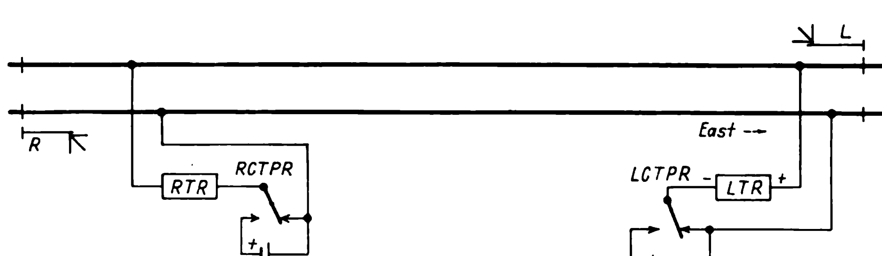


Fig. 4—Basic principles of either-direction coded track circuits

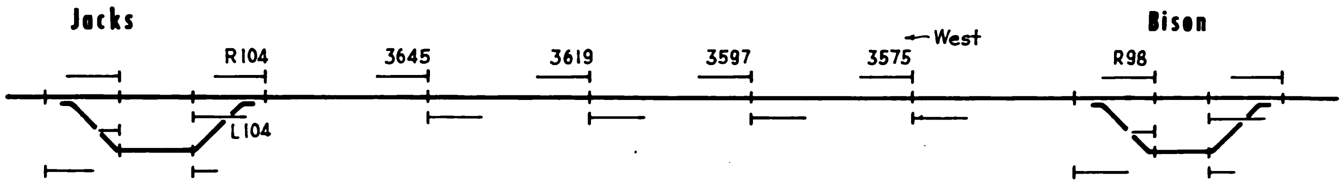


Fig. 5—Application of coded track to a station-to-station block

trol circuits through repeating relays and decoding equipment to energize relays to control the aspects of signal L. Code at 75 times per minute controls the signal to the Approach position. Code at 120 or 180 control a signal to the Clear position.

As Applied to a Station-to-Station Block

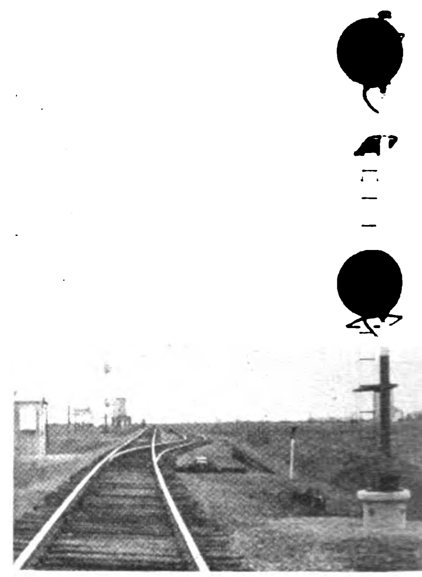
As shown in Fig. 5, when westward station-leaving signal R98 at Bison is to be cleared, the dispatcher sets his levers and pushes the code-starting button which sends code control to the field stations which causes 75 code on the track circuit to be fed eastward from the east end of Jacks to signal 3645. This causes this signal to be controlled to the yellow position. Then, 180 track code is fed eastward and is repeated through the track circuits to control signals 3619, 3597, 3575 and R98 to the green position. Also receipt of the 180 track code at the field station at the west end of Bison causes a C.T.C. indication code to be sent to the office to light the lamp in the track diagram to indicate that the Bison-Jacks station-to-station block is unoccupied and that traffic is lined up westward between these stations. This incoming indication also establishes circuit locking in the machine, as will be discussed later.

When the locomotive of the westbound train passes each of the intermediate signals, a corresponding directional stick relay at each signal is picked up. When the rear of the train passes the first intermediate signal, 3575, a control through the stick relay causes 75 track code to feed eastward to control signal R98 to the Approach aspect if the dispatcher has again sent out control to clear this signal for a following train.

When the rear of the westbound train passes the second intermediate signal, 3597, the control through the stick relay sends 75 track code eastward to signal 3575 to control it to the Approach position, and then 120 track code is fed eastward to signal R98 to control it to the Clear position, if the dispatcher has sent out control to clear this signal for a following train. Thus, either 180 or 120 track code is effective in controlling signals to the Clear position, but only 180 track code, fed as explained later, and received at the end of the station-to-station block, is effective in causing a C.T.C. line code to go to the office to indicate that the station-to-station block is unoccupied.

Checking Out the Block

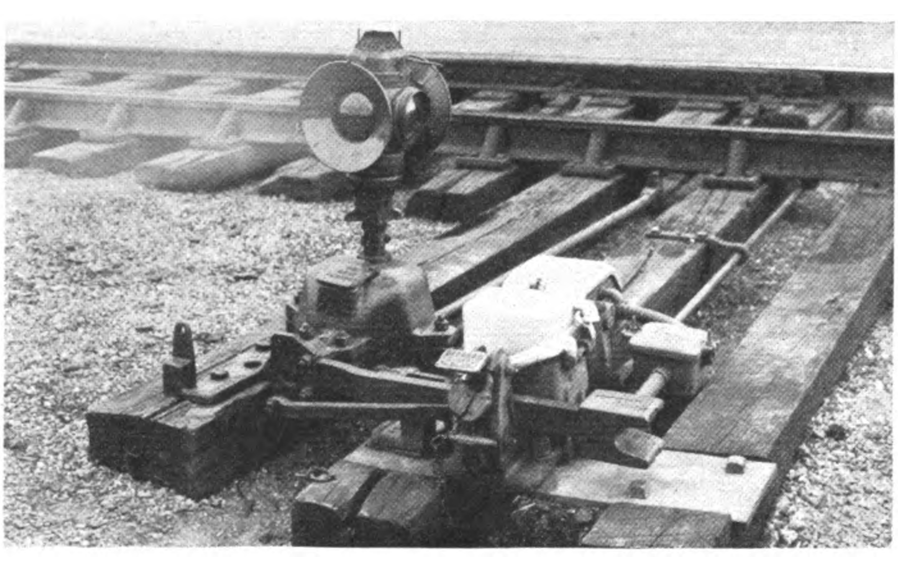
When the rear of the westbound train passes signal R104 at Jacks, and is thus out of the station-to-station block, 75 track code continues to be fed eastward to intermediate signal 3645, where the stick is released and the signal is operated to the yellow position. Then, because the directional stick relay at signal 3645 is released, 180 rather than 120 track code feeds east to signal 3619,



Station-entering signal at Corbin

which operates it to the Clear position, and in a corresponding manner the other two intermediate signals, 3597 and 3575, are operated to the Clear position, and 180 track code is being fed through the track circuits to be received at signal R98. On account of the fact that this is 180 rather than 120 track code, a C.T.C. line code is sent to the dispatcher's office to indicate that the station-to-station block is unoccupied, and then, if no control code has been sent out to clear the signals for another train, a code goes out automatically to the field station at the east end of Jacks to cut off the track code which had been feeding eastward through the station-to-station block. Thus, the track circuits and intermediate signals return to the dormant, i.e., normally-deenergized condition.

An important fact is that the selection of 120 or 180 code depends on the position of the directional stick relay at signal 3645. With the westbound train between signal 3645 and R104, the stick at 3645 is up



Electric lock applied to lever of hand-throw stand

and 120 code goes east. On the other hand, after the train has gone, the stick at 3645 is released and the incoming 75 code is effective in causing 180 code to be fed on eastward through the remaining intermediate automatic block to the west end of Bison.

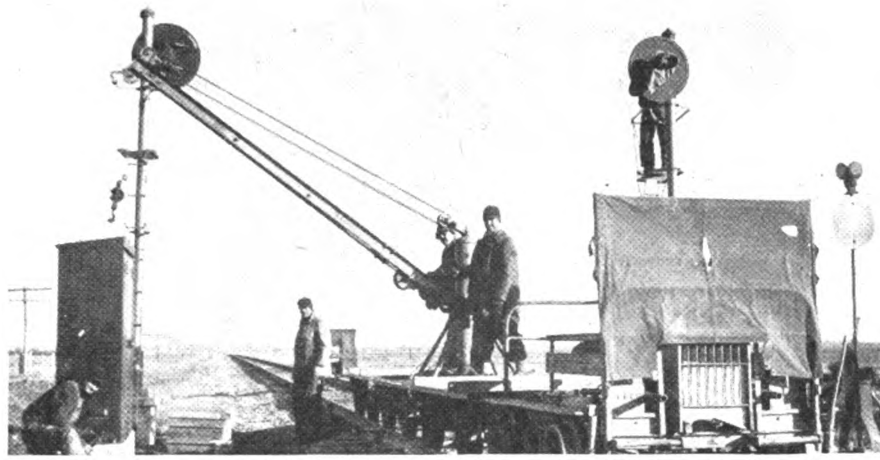
The directional stick relays at the intermediate signals can be picked up only by a train which approaches and passes the signal for the given direction. The pick-up circuit is through contacts of the approach lighting relay and repeaters of front and back points of the code-following track relay. The timing of the operation of these relays is such that the directional stick relays at the intermediates cannot be picked up when the track circuits are deenergized under lever control, nor can the sticks be picked up by an opposing train overrunning an opposing station-leaving signal at Stop.

Circuit Locking in the Control Machine

Circuits in the C.T.C. control machine are arranged so that after a signal control code has been sent out, no opposing control code can be sent that would knock down the signal cleared by the existing line-up, or disturb the established direction of traffic. For example, if a C.T.C. control code had been sent out to establish traffic direction westward and to clear signal R98, as previously explained and as shown in Fig. 2, the dispatcher might inadvertently position the lever for the opposing signal L104 at Jacks and push the code-starting button, but nevertheless the circuits in the machine would prevent the code from going out on the line. This form of circuit locking is in effect until the westbound train, as well as any following trains which enter the station-to-station block before the one ahead has cleared it, have all departed beyond the limits of the station-to-station block. Of course, if, after establishing traffic direction and clearing westward signal R98 at Bison, the dispatcher takes this signal away by lever control before it is accepted by a train, the track circuits revert to the normally-deenergized condition in the same manner as previously explained, and after an automatic time release has operated, controls can be sent out to establish traffic in the opposite direction.

Within Station Limits

Normally-energized conventional d.c. track circuits are used on the OS switch detector sections and on the section of main track opposite each siding. The local automatic controls of signals within these station limits are accomplished by conventional polarized line wire circuits, using three line wires, one for each direction, in combination with a common wire.



A crane on a motor car was used to erect the signals

Power Supply

A commercial supply of alternating current at 110 volts was available at all of the sidings at which power switches and C.T.C. field-station equipment was to be located. Therefore, at these locations, the a.c. energy is fed through transformers and rectifiers to charge storage batteries. At each field station there is a set of 13 cells of 160-a.h. lead storage batteries which feeds the 20-volt switch machine, and 8 of these cells feed the line coding equipment. The signal lamps at these switch locations are normally lighted from a.c., but if the a.c. power fails, these lamps are cut over to feed from the remaining 5 cells of the storage battery which is used also to feed local line circuits and various local relays. These storage batteries at about half the locations were made by Exide, and at the remaining locations by Gould.

No a.c. power distribution circuit was installed through the station-to-station blocks. At each intermediate signal location there is a set of 16 cells of 1,000-a.h. primary battery which is normally on open circuit. When a line-up is established, this battery operates the code transmitter relays and the coils in the searchlight signal mechanisms, and the signal lamp when a train enters the approach lighting limits. This battery also feeds the directional stick relay and the signal repeater relays as well as code-following repeaters and decoding equipment. These sets of primary battery on most of the territory are the copper-oxide type, but at some locations the air-depolarized carbon type primary batteries are used, these being either the Edison carbon type or the National Carbon Company's Eveready air cell type.

Each coded track circuit is fed by two cells of 1,000-a.h. Edison primary cells in multiple. The OS track circuits which are the normally-energized conventional type, are fed by three 500-ah. cells of primary battery.

Signal Lighting

The lamp in the searchlight signals are rated at 5 + 3.5 watts, 10 volts. At power switch locations where commercial a.c. power is available, the signal lamps are lighted continuously when on a.c. power. The intermediate signals are approach lighted under control of 0.3-ohm relays which are in parallel with the track circuit feed.

At each power switch field station, the batteries, relays and coding equipment are located in a 6-ft. by 7-ft. concrete house, made by Massey Concrete Products Corporation. At intermediate signals, the relays are in sheet-metal cases, one of which is shown in an accompanying illustration. At these intermediate signals, the primary battery is in concrete boxes.

The control machine and office equipment at Caldwell are housed in a new 20-ft. by 22-ft. one-story, fireproof, concrete block building, which is located west of the main track and north of the station.

The two line wires which were installed throughout the territory for the C.T.C. code line are No. 9, hard-drawn copper with weatherproof

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voice recording in his earphones. As applying to a train being made up for departure, he arranges the waybills and cards used in the teletype system for transmitting the outbound consist in train-check order in accordance with the recording. The transcriber has a foot-pedal control which permits the clerk to stop the "play back" or to reset the transcriber to repeat, either a portion or all of, the disk.

Numerous Advantages

One of the principal advantages of the new voice-recording system is that the yard clerk's check is thus available at terminal headquarters as soon as the last car of the drag has passed the grabber. This eliminates the time formerly required to send the check by tube or messenger to terminal headquarters. According to the New Haven, this minimizes one of the sources of delay to outbound trains.

Another advantage of the new practice is the increased accuracy. With the previous handwritten method, time was available to write down only the car number, not the initial, and legibility of the writing, particularly during rainy or cold weather, was impaired. With the voice-recording system, time is available to give the initial as well as the number, and, furthermore, it is now practicable to thus make a record of main-line trains moving at yard speed via the loop track directly to the departure yard. These checks are thus available in the office before the train arrives in the departure yard.

In order to allow the clerk an opportunity to remove disks from the Soundscriber and install new ones, the "number grabber" signals the office when the last car of a train or drag has passed. This signaling is accomplished by the "number grabber" turning a crank on a 20-cycle ringer, the output of which is connected to the line circuit. At the office, this energizes a relay which causes a buzzer to sound continuously to attract the attention of the clerks in the office. Then new disks are placed on the Soundscriber recorder for succeeding recordings. After the recording on one side of a disk has been played back to serve the immediate purpose, that same disk is returned to the Soundscriber to use the other side, and when both sides are "filled", the disk is retained as a permanent record.

For this new voice-recording service, a pair of wires is used between the grabber's location and the yard office. Coils were installed at each end to set up a simplex circuit which is used for starting and stopping the Soundscriber, by control of the push-to-talk button on the grabber's handset. The Soundscriber machine is electrically operated from the 110-volt a.c. commercial supply in the office. The only other power supply required is a set of three dry cells talking battery for the operation of the grabber's telephone transmitter.

The operation of this voice-recorder number-grabbing system was planned by J. L. Barngrove, Jr., assistant to general manager, and W. A. Moore, general superintendent of electric transmission and communication, the voice-recording and playback machines being furnished by the Soundscriber Corporation, New Haven, Conn., and installed by New Haven forces under the direction of G. N. Loomis, communication engineer.

Special Gate Circuits

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apply to control point "N", three of which are connected in multiple, for Harvard street and "M" for Heights boulevard.

For operating the gates in case of failure of the automatic controls, a special circuit was installed at each crossing which by-passes the automatic controls to permit manual operation until automatic control can be reestablished. In this circuit is a double-pole, double-throw switch normally disconnected from the automatic controls, when reversed controls the gates manually. At Heights boulevard, the instrument house door must be open to operate a door-operated switch to feed battery for the manual control. A red light is also lighted as a further reminder that the gates are not on automatic control.

In rare instances an engine or cars stop just short of a crossing, and the gates have raised due to operation of a timing relay. To protect a crossing for a continuation of such a movement, key-control stations are provided. These house a normally-closed controller which, when opened by a turn of switch key, drops a relay to lower the gates. The gates are held down when such movements occupy the crossing track circuit. There are five such control stations, two at Harvard street and three at Heights boulevard.

This project was planned and installed by the signal department forces of the railroad.

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covering. These wires are on the 1st and 2nd pins on the lower arm of the previously existing communications pole line. In siding limits, the 110-volt, a.c. power is extended from the passenger station to the instrument houses at both switches on a line circuit consisting of two No. 6 hard-drawn weatherproof copper wires. The three line wires for local line controls in siding limits are No. 10 hard-drawn bare 40 per cent Copperweld.

Between each instrument house and the switch machine, there are two buried cables, one of which is a six-conductor No. 14 and the other a six-conductor No. 9. To each high signal there are an eight-conductor No. 14 for controls and indication circuits and a two-conductor No. 9 for the lamp circuit. A six-conductor No. 14 cable runs to each dwarf signal. These buried cables terminate on terminals in a box at the base of the mast and from there single conductors extend up inside the mast and out through a flexible metal conduit to the signal. The track leads are No. 9 single-conductor buried cable. All cables connecting to the pole line are underground.

This centralized traffic control was planned and installed by signal department forces of the Rock Island, the principal items of signal equipment being furnished by the Union Switch & Signal Company. The instrument houses and all cases were wired in a shop in Chicago, and were shipped in car loads to construction headquarters. By means of a power derrick the concrete houses were set in place at their final locations. A Fairmont hand derrick on a motor-car trailer, pulled by a gang-type motor car, was used in the remainder of the field work to: (1) Set the pre-cast sectional concrete foundations for signals and instrument cases; and (2) erect the signal masts with ladders attached, and to set the sheet-metal instrument cases. Construction work was started at Caldwell, the center of the project, by two crews consisting of an average of 16 men per crew, one working north and one south. Each crew handled all classes of work except the wiring of cases and houses which was done at a central point. As the sections between controlled sidings were completed they were progressively placed in service.