CTC and Cab Signaling on Union Pacific

Single-track and double-track with all tracks signaled for train movements both ways on 177 track miles between Cheyenne and Laramie

CENTRALIZED TRAFFIC CONTROL and cab signaling have been installed by the Union Pacific between Cheyenne, Wyo., and Laramie, Wyo. Between these two points the double track was 56.5 miles. When the railroad was built through this section in 1868, the builders chose the easiest route over the Sherman hill which now reaches a maximum elevation of 8,014 ft., and includes long sections of grade at 1.55 per cent ascending westbound. In order to save train time and utilize locomotives more effectively on long runs, as well as eliminate helper service, a decision was made to build a new single-track line around the south side of Sherman hill, on a maximum ascending grade of 0.82 per cent.

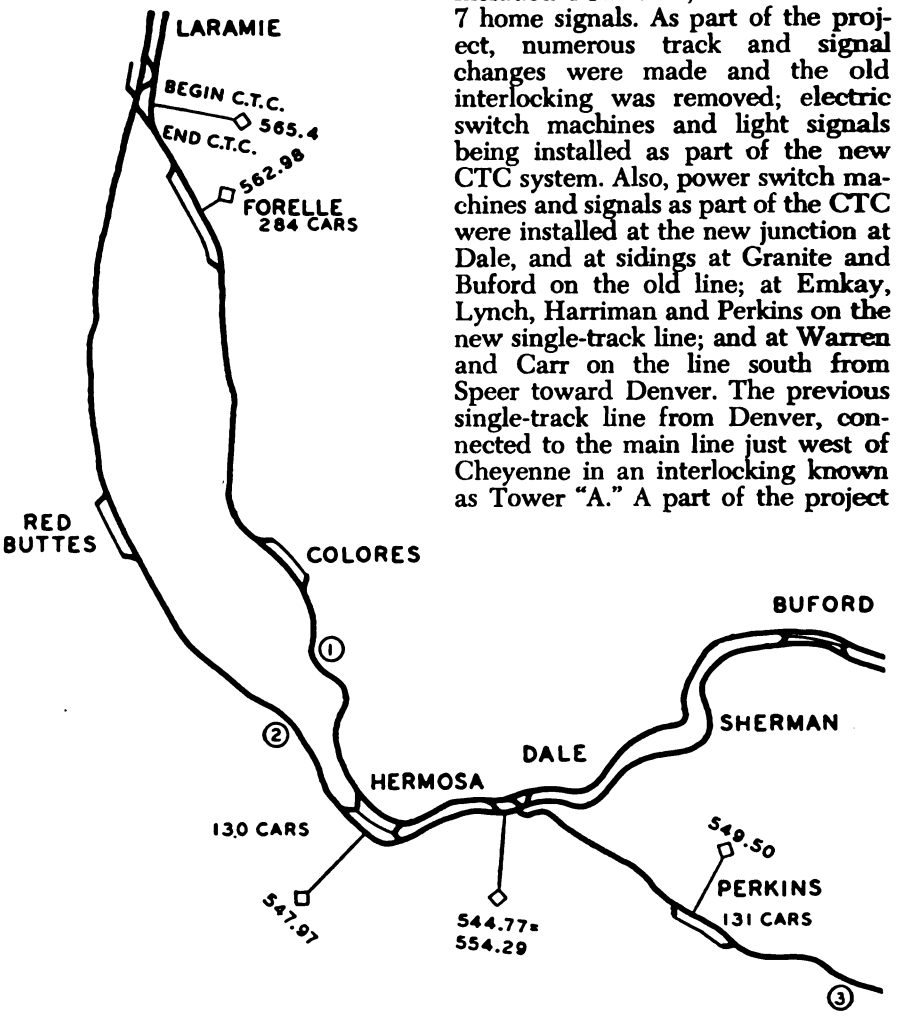
Prior to the construction of the new line, the daily traffic over the double-track, heavy-grade line included about 24 passenger trains, 52 freight trains and 20 helper engine movements. This double track was equipped with automatic block signals for single-direction running. Therefore, freight trains had to clear the main track for passenger trains, and as a result the freight trains, especially the westbound ones, lost too much time on sidings.

The new line branches off at Tower "A," 1.3 miles west of Cheyenne and goes south as two main tracks for 8.2 miles to Speer, from which point a UP line extends south to Denver, and from Speer the new line goes west via a devious route to connect with the old line again at Dale. Between common points, the new line is 43.5 miles long which is 9.5 miles longer than the double-track line via Sherman. Because of the lower grade, a diesel locomotive that could handle 2,400 tons westbound on the old line can now handle 5800 tons westward on the new line. Helper locomotives were required on most westbound freight trains, over the old line, but locomotives rated at 3,250 tons draw-bar pull can take 6,000 tons westbound on the new line. A diesel passenger locomotive used in through service can haul a westbound train of 12 cars up the grade on the old line from Cheyenne to Dale in about 45 min.

The primary purpose for the new single-track line is for westbound freight trains. Therefore, this leaves the double-track line to be used more effectively for passenger trains both ways, and for freight trains eastbound.

The old line via Sherman has been double-track for many years, with automatic block for right-hand running. Center sidings were located at Sherman and Hermosa; westward sidings at Corlette, Borie, Granite, Buford and Red Buttes; and eastward sidings at Forelle, Colores, Heard, Dale, Buford, Granite, Otto and Borie. Because of the numerous passenger trains, the freight trains lost too much time on sidings, these delays being in addition to time lost by westbound trains because of the heavy grade.

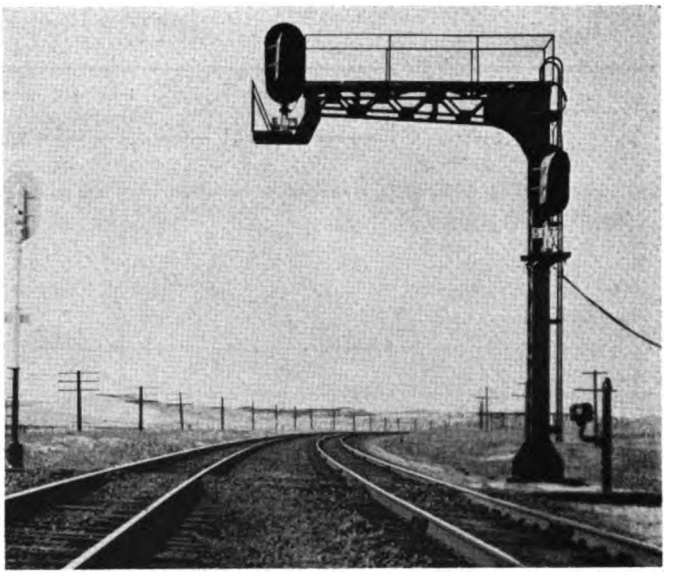
The new system includes centralized traffic control for train movements by signal indication both ways on both main tracks on the old line 54.4 road miles between Cheyenne and Laramie; both ways on both tracks on 8.8 road miles between Cheyenne and the west end of Speer; both ways on 34.5 miles of single track on the new line between the west end of Speer and Dale; on 12.7 miles of single track from Speer south toward Denver as far as the south end of Carr; and 3 miles between the west end of Speer to Borie. Thus the CTC includes 177 track miles of main track.



Interlockings Replaced

A mechanical interlocking at Borie included 4 switches, 1 crossover and 7 home signals. As part of the project, numerous track and signal changes were made and the old interlocking was removed; electric switch machines and light signals being installed as part of the new CTC system. Also, power switch machines and signals as part of the CTC were installed at the new junction at Dale, and at sidings at Granite and Buford on the old line; at Emkay, Lynch, Harriman and Perkins on the new single-track line; and at Warren and Carr on the line south from Speer toward Denver. The previous single-track line from Denver, connected to the main line just west of Cheyenne in an interlocking known as Tower "A." A part of the project

LEAVE SIDING DWARF is above snow



BOTH MAIN TRACKS are signaled both ways

was to add second track on this line between Cheyenne and Speer, and to make corresponding changes in the tracks and interlocking at Tower "A." Thus, the entire CTC includes 73 power switch machines, 25 electric locks on hand-throw switches and 92 lever-controlled signals.

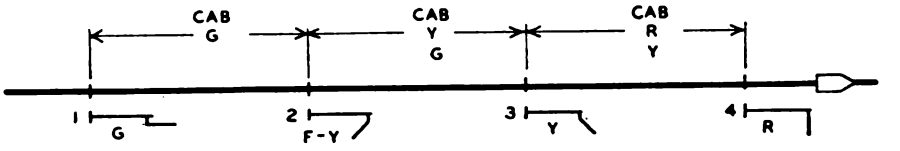
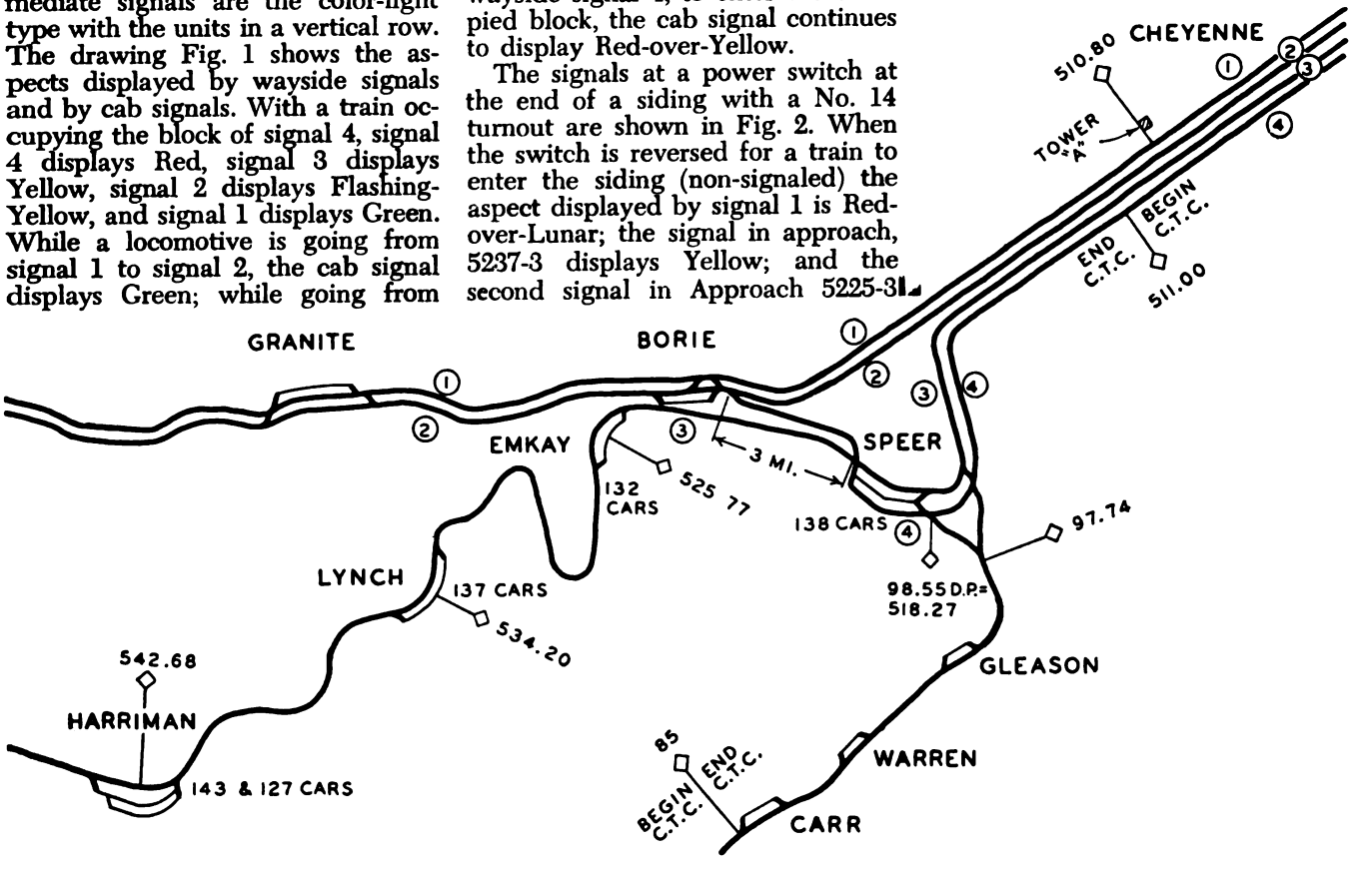


FIG. 1—ASPECTS of wayside signals and cab signals

New Signals and Aspects

On the entire project the lever-controlled absolute Stop signals are the searchlight type, and the intermediate signals are the color-light type with the units in a vertical row. The drawing Fig. 1 shows the aspects displayed by wayside signals and by cab signals. With a train occupying the block of signal 4, signal 4 displays Red, signal 3 displays Yellow, signal 2 displays Flashing-Yellow, and signal 1 displays Green. While a locomotive is going from signal 1 to signal 2, the cab signal displays Green; while going from signal 2 to signal 3 the cab signal displays Yellow-over-Green; while going from signal 3 to signal 4 the cab signal displays Red-over-Yellow; and if the locomotive passes the Red wayside signal 4, to enter the occupied block, the cab signal continues to display Red-over-Yellow.

The signals at a power switch at the end of a siding with a No. 14 turnout are shown in Fig. 2. When the switch is reversed for a train to enter the siding (non-signaled) the aspect displayed by signal 1 is Red-over-Lunar; the signal in approach, 5237-3 displays Yellow; and the second signal in Approach 5225-3 displays the Flashing-Yellow. The layout at Dale Junction where the new single-track main line from Speer connects with the double track including a No. 20 turnout and cross-



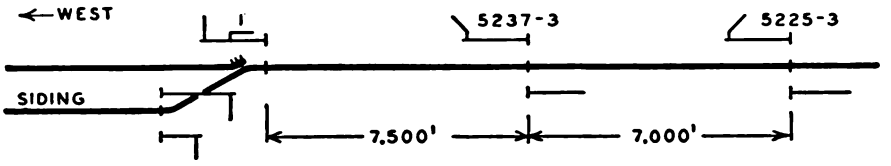


FIG. 2—ASPECTS with switch reversed for diverging move to siding

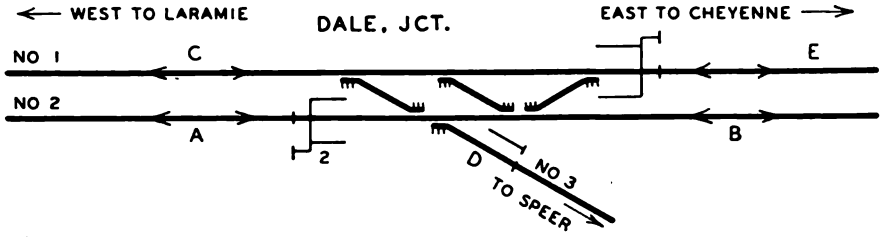


FIG. 3—ASPECTS for crossover and junction line-up

overs, is shown in Fig. 3. When lined up for a "straight" route on track 2 from A to B, the aspect displayed on Signal 2 is Green-Red-Red. For A to D, the aspect is Red-Green-Red. For A to E, the aspect is Red-Red-Green.

Coded Track Circuits

On switch detector OS sections, on sidings, as well as on main track sections for control of highway crossing signals, the track circuits are the conventional d.c. type, using 1 ohm relays for "OS" sections and 4 ohm relays on sidings. All other track circuits are the reversible coded type. When not in use these track circuits are normally energized with steady energy. All tracks are signaled for train movements in either direction. When lining up for an eastbound train, for example, between two controlled layouts, a preliminary part of the controls causes coded track circuit energy to feed cascade westward through the entire station-to-station block. This is coded a.c. and d.c. energy. To control the Green aspect on a signal, the code is 180; to control the Flashing-Yellow the code is 120; to control the Yellow the code is 75; any other code, steady energy, or absence of energy controls the Red aspect. The a.c. cab signal control code is superimposed on the d.c. track circuit energy. This is done by connecting the secondary side of the W-5 transformer in circuit from the positive side of the track battery, so that the code detector repeater relay codes the a.c. cab signal energy as well as the d.c. which controls the wayside signals. Thus the wayside signals and the cab signals are controlled by coded energy in the rails, no line wire circuits being required for these controls.

The lamps in the signals are normally dark, being lighted on approach control. This requires a two-wire line circuit which is, indirectly, used also to control block-occupancy lamps on the dispatcher's control panel.

At each intermediate signal there is a special switch by means of which the trainmaster can set the signal to display the dark aspect when checking signal observance by engineers.

Each of the intermediate color-light type signals is equipped with a special sheet metal hood that, in most instances, keeps the snow from accumulating on the lenses.

Double-Tier Control Machine

The CTC control machine is of special design, the control panel being 69¾ in. high. The diagram across the top shows not only the double track between Cheyenne and Laramie, but also the new single track so that this diagram is 12¼ in. high. Instead of one row of switch ad signal levers with starter buttons, this machine has two rows; the top row for the double track line, and the bottom row for the new single track line, this being roughly in accordance with the relative locations of the two lines. This aids the dispatcher in identifying the group of levers quickly. To facilitate identification, a name plate giving the name of the field station is located below each set of switch and signal levers. Each set of switch and signal levers are numbered consecutively, starting with 1. This aids in identification and provides simplicity in the number of circuits, especially if changes are made later. The track-occupancy indication lamps in the track diagram are Red for "OS" sections, Amber for block territory between control points, and White with a letter "S" for sidings.

For sending a control code to change a switch or signal, the corresponding lever is pushed and turned with one motion. The code start action is obtained by pushing the lever—there are no separate start buttons. Code start action for controlling functions operated by push buttons or toggle switches, such as maintainers' call lamps, is obtained by pushing but not turning a switch or signal lever in the same panel after positioning the button or toggle switch involved. At the top of the panel there is a row of push-turn buttons for the control of electric

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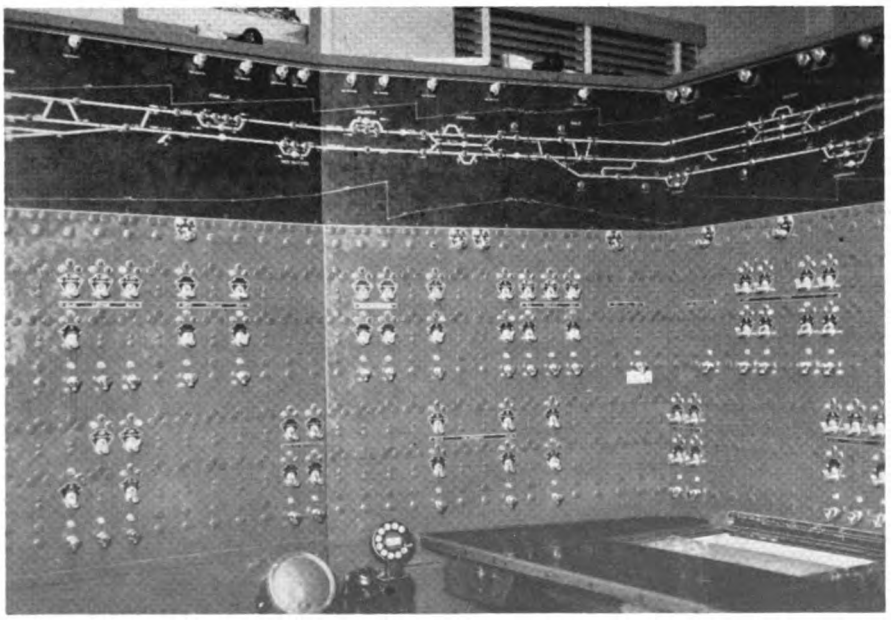

DOUBLE-TIER arrangement of control panel is special

U. P. CTC

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snow melter switch heaters on the power switch layouts. When a switch heater is "on," a special blue indication lamp is lighted above the center of the corresponding switch lever. The center panel is 5 ft. long with a wing section 5 ft. long at each end, thus totaling 15 ft.

The control system used is the U.S.&S. Type L-Form 506C for 35 Station basis. This system is identical to the 506A system in general coding and stepping action. It differs from the more familiar 506A in the manner in which controls and indications, in excess of seven at a location, are obtained. In the 506C System, any number of controls and/or indication functions can be operated on one station call code. The control indication codes can be terminated independently on the 10th code step or any even numbered step thereafter. This is accomplished by the use of extension units at the field location and additional chain and storage relays at the office.

The field extension units for the 506C system are different in makeup from the field storage units for the 506A system. These extension units do not require a separate station call code. They merely produce additional chain repeat actions. Each extension unit contains 3 relays. Each unit added to an LCS unit produces an additional chain repeat action and provides for 7 additional controls and 7 additional indications. All extension units are identical and any number may be added to an LCS unit to accommodate all of the control and indication functions at a location. Total function steps possible for a 506A system are 7x35. In the 506C system, there can be any number of steps at each location.

MOTOR-CAR INDICATORS also installed

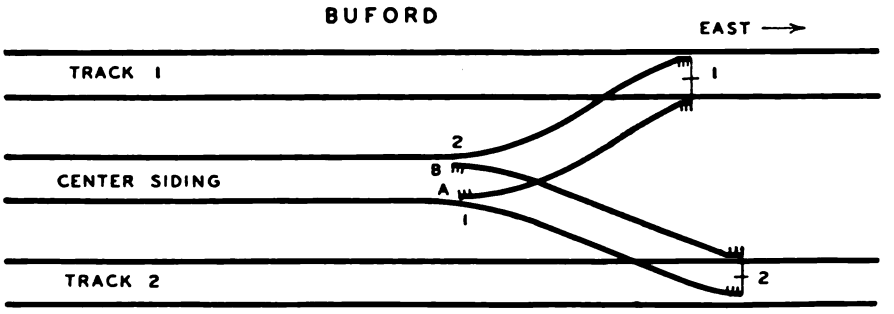

FIG. 4.—FOUR switch machines at end of center siding

Two Code Line Circuits

The code line circuit is on two No. 6 Copperweld, 40 per cent conductivity, weatherproof line wire. One such circuit, "A," extends from the office at Cheyenne via the old double track, applying on tracks 1 and 2 to Dale Junction, and on track 1 to Laramie. The second code line circuit, "B," extends from the office at Cheyenne applying on tracks 3 and 4 to Speer, with a loop on south to Carr, then on track 3 from Speer to Dale Junction, then on track 2 to Laramie.

Four Switch Machines at End of Center Siding

At Buford, on the double-track main line, the siding is located between the two main tracks, and is connected at each end to both main tracks so that a train approaching on either track can enter the siding, and can depart on either main track, as shown in Fig. 4. To prevent cars or trains on the siding from drifting out to foul the main line, the crotch switch is used as a derail, both points normally being open. To secure this result, each point of this crotch switch is operated by a separate switch machine.

The switch machine that operates crotch switch point "A" is paired in the same controls with main track switch 1, and switch machine that operates crotch switch "B" is paired with the switch machine that operates main track switch 2.

Track Occupancy Indicators for Motor Cars

As a part of the new CTC project, position-type, track-occupancy indicators were installed at various locations to warn employees of approaching trains. They are usually mounted in pairs, one for each direction, and are more numerous on curves where sight distances are relatively short. The numbers on each indicator indicate the mile post to which it controls. If a man passed an indicator showing "Clear," he has time to reach the next indicator before a train arrives. The indicators are spaced on time-distance factors, considering the motor car as 10 m.p.h. and the maximum speed allowable for trains in the territory over which the indicator will govern. The indicators are the MC-1 type, 40 ohms, connected in series, and their territories governed overlap. Between Tower "A" Cheyenne and Dale Junction via the original line, indicators are provided only for track No. 1. Between Tower "A" Cheyenne and Speer, indicators are provided only for track No. 4. The line circuits are on No. 9 bare iron wire. These motor car indicator circuits are controlled by track-repeater relays and are independent of signal control circuits.

Motor car operation is by permission of the dispatcher. When a track car operator wants to use the track, he calls the dispatcher. If there are no trains in the vicinity the dispatcher will issue to the track car operator a permit to use a certain portion of the line for a particular time. The dispatcher will take two blocks, mark the time which the motor car is to be off the track, and place these blocks over the signal levers which control the signals governing into the territory used by the track car operator. These blocks prevent the dispatcher from moving the lever. Thus the track car operator knows that the dispatcher cannot clear a signal allowing a train into the section of track he is on. When the motor car operator reaches his destination, he notifies the dispatcher, who then removes the blocks, permitting operation of the signal levers. Motor car setoffs are located at every indicator, every signal location and every battery cut location. Telphones for calling the

ELECTRIC SWITCH HEATERS are the so-called "rod" type

dispatcher are located in booths at the ends of sidings, on or near electric locks, in all stations and maintainers' houses.

Rock Slide Detectors

At several places the new single-track line extends through deep cuts with steep rock walls. Rock slide detectors were installed in these cuts. Woven wire fencing is supported from ⅜-in. galvanized iron stranded messenger attached to wood posts. At the center of each fence the fencing is attached to a "floating" section of 3 in. by 3 in. wood attached to the ends of the woven wire fencing and under tension of coiled springs to hold the fencing taut. A circuit controller is connected to the 3 by 3 piece of wood. If a falling rock strikes the fencing, the 3 by 3 piece of wood is moved, and the circuit controller is operated to cause the signals in approach from both directions, to display the red aspect, until the controller is manually reset. When one of these detectors is operated, a corresponding indication lamp is lighted on the dispatcher's control panel.

Telephones, Too

The telephone train dispatcher's circuit is superimposed on the CTC code line and is connected to telephones in booths at all power switch location home signals and at electric locks on hand-throw main track switches in homes of track foremen, signal maintainers and operators' offices. These phones are for use by trainmen and track car operators.

A total of about 75 such phones are connected to this line. In the office, a loudspeaker amplifier is normally connected to the line so that the dispatcher hears anyone wishing to contact him when they speak into the phone. If the dispatcher wants to call the home of a track forman for example, he pushes

FENCE DETECTS falling rocks

a call button on a telephone selector box located on the control panel to his left (shown in picture of CTC machine) which sends a code to the proper station controlling a bell in the house of the foreman. The foreman then answers the phone. The dispatcher may send a code to shut the bell off. The foreman also can shut the bell off by pushing a button which picks up a stick relay. This relay drops when the dispatcher sends a code to cancel the call.

New Pole Line

As part of the project, a new pole line was built including grade A creosoted pine poles 25 ft. to 50 ft. long with 5 in. to 7 in. tops, spaced 40 to the mile. The top arm, which is 4 ft. long, carries two No. 6 bare Copperweld wires for each line for the 2,300-volt, 60-cycle a.c. power distribution circuit. This circuit is fed west from Cheyenne to Granite and to Harriman. A second feed from Laramie goes east to Granite and to Harriman.

At each feed location General Electric automatic substations are provided with automatic switching devices, that are connected so that if power from one source fails, power from a second source is cut in automatically, within a period of 5 seconds.

At field locations, such as at Speer, Dale Junction, or the end of a power siding, the 2,300/120-volt line transformer is rated at 1 kva, and the output can be adjusted in the range from 110 to 121 to 134 volts. At such a location the lightning arresters and ground connections are one pole each way from the transformer. This is done for safety, to eliminate the possibility of a man touching a ground wire when working on the transformer or its connections. As an aid in lightning protection, an overhead static wire, connected to ground at each end, is run on insulators on a special vertical angle iron on one pole each direction from the transformer. The transformers were furnished by General Electric. Capacitors are used, about 15 miles apart, to improve voltage.

Electric Switch Heaters

The electric switch heaters are the so-called "rod" type attached to the inside of the web of the stock rails. These heaters were made by General Electric and are rated at 500 watts to the foot for the first 8 ft. starting at the switch point, and the rating tapers to 250 watts per foot at the far end, the total rating being 16 kva for the heaters on both rails at a switch. These heaters are fed at 440 volts, and special line transformers rated at 50 kva are provided at such locations.

With the exception of the a.c. to feed the cab signal code on the rails, all the circuits in this project are fed from storage batteries which are the Edison nickel-alkaline type. At the end of a siding a set of 20 cells of A4H feed the switch machine motor. Two cells of the same type in series feed each track circuit. Eight cells of B4H feed the lamps and local circuits at each signal, and approach controls, and the same battery operates code transmitters for track codings. Storage batteries are charged by rectifiers with a two-rate charge control relay.

At the Cheyenne office the "A" code line is fed by 80 cells of 20-a.h. each (Edison storage battery) and the "B" line is fed by 92 cells of the same type.

This CTC project was planned and installed by Union Pacific signal forces. The major items of signalling equipment were furnished by the Union Switch & Signal Division of the Westinghouse Air Brake Co.