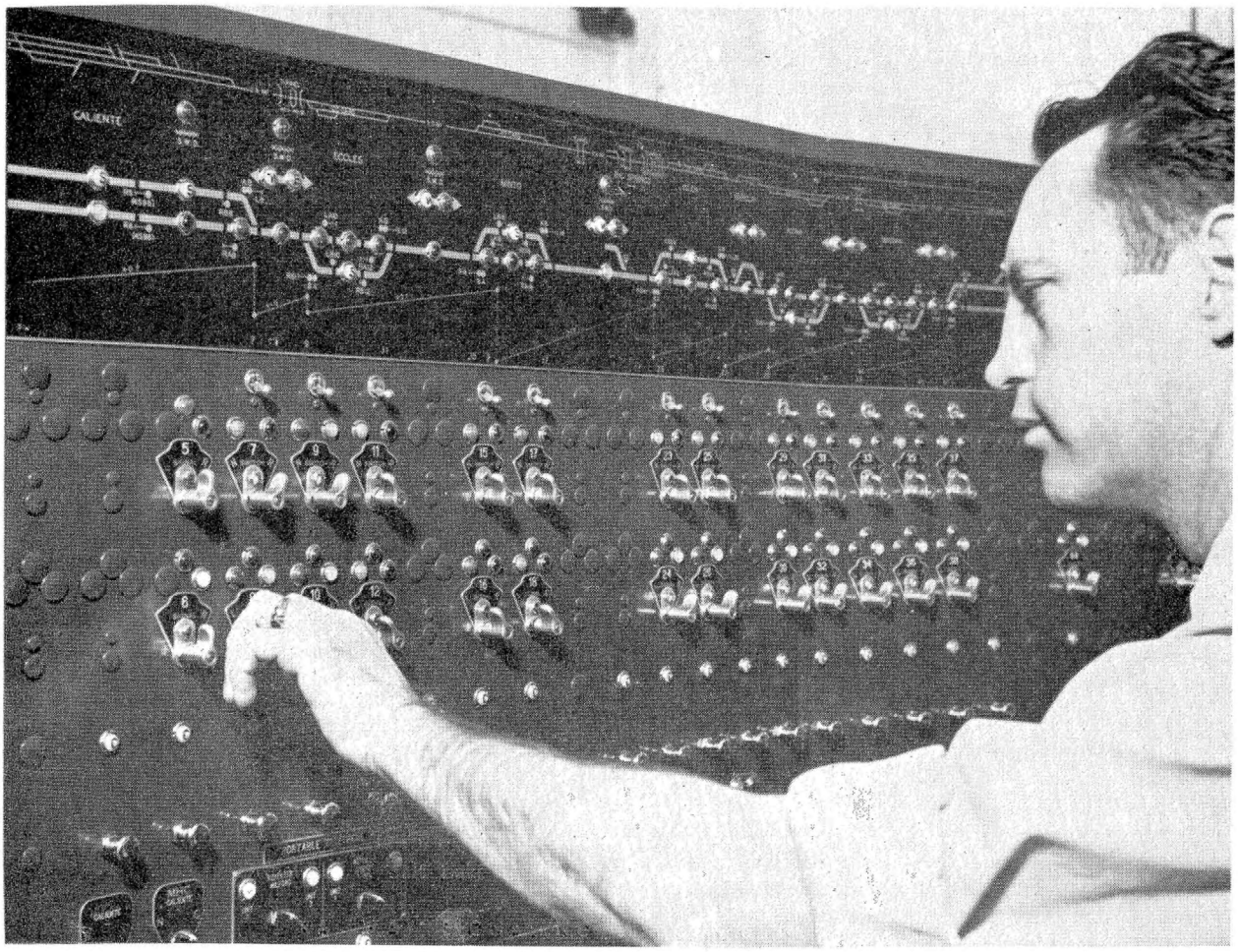
625 Miles of C.T.C. in one Stretch

Train operation by signal indication is now an important help in saving train time, as for example stock trains average 39.4 m.p.h. and a passenger train 66 m.p.h. over a sub-division with long 0.8 per cent grades

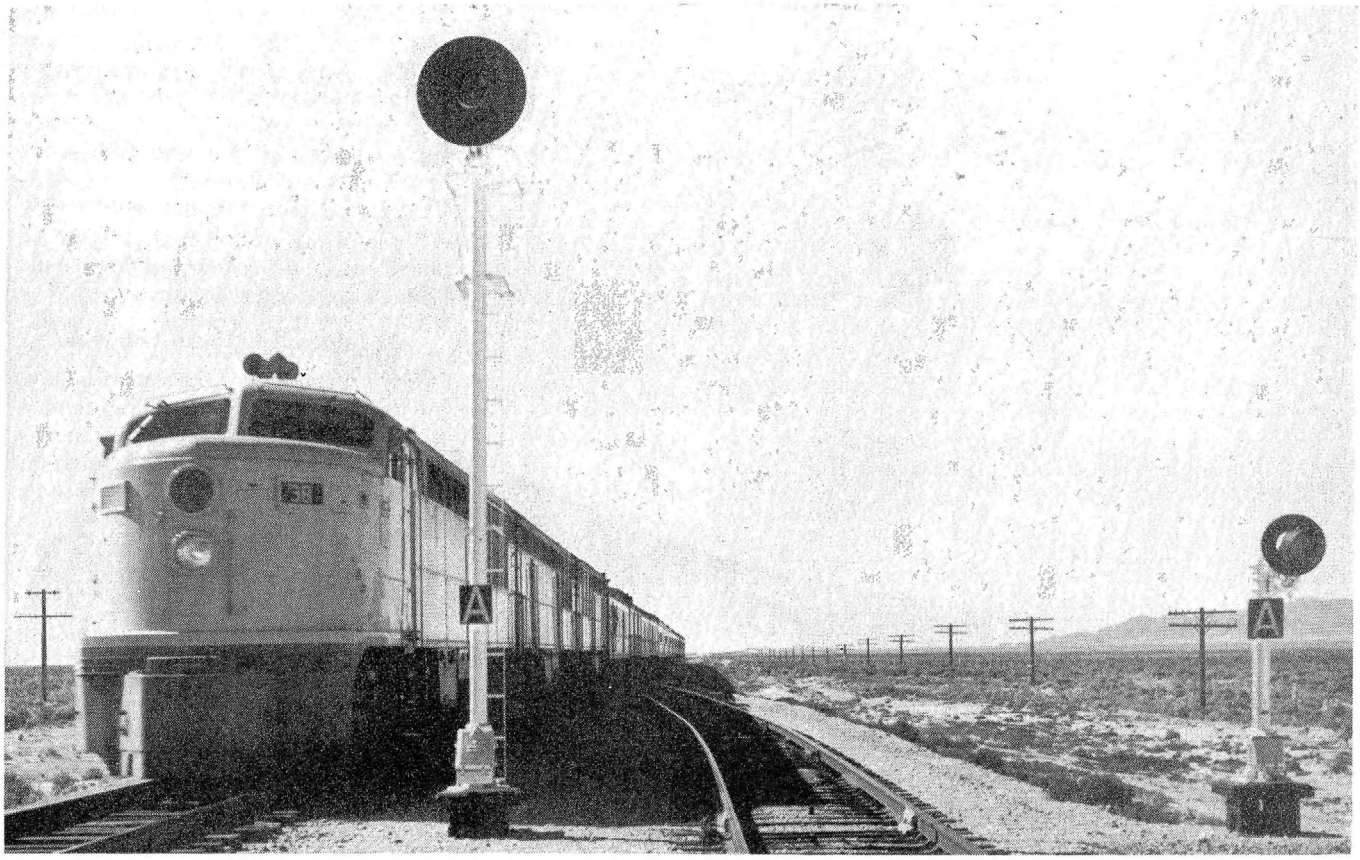
ON the route to Los Angeles, Cal., the Union Pacific has completed an installation of centralized traffic control on 324.5 mi. of single track between Salt Lake City, Utah and Caliente, Nev., which is connected at Caliente with the previous installation extending from Caliente to Daggett, Cal., 300.9 mi., completed in 1943, so that now the entire 625.4 mi. is operated by signal indication under C.T.C. control. Between Daggett and Riverside, Cal., 100 mi., the Union Pacific operates over a double-track section of the Santa Fe, and on the Union Pacific between Riverside and Los Angeles, centralized traffic control is now being installed on 50 mi. of single track and 8.8 mi. of double track. This will completely equip all the Union Pacific trackage with C.T.C. between Los Angeles and Salt Lake City. The main route of the Union Pacific eastward from Salt Lake City to Omaha is all double track.

Grades and Curves

From Salt Lake City, the railroad extends westward on the flats about 18 mi. to Lake Point. Except for some rolling grades for 14 mi., between Stockton and Ajax, the line ascends westward at an average 0.8 per cent for 60 mi. between Lake Point and Boulter. Then the line descends at an average 0.8 per cent westward for 25 mi. between Boulter and Champlain, with rolling grades for 10 mi. between Champlain and Lynndyl, which was a sub-division point. Between Lynndyl and Milford, the railroad traverses a high plateau with short rolling grades and with relatively few curves. Also, from Milford



Dispatcher at Salt Lake City controls signal at Caliente, 324 mi. away



Above—View at a typical siding, including a power switch machine and C.T.C. controlled searchlight signals—of special interest is the "high" mast for the leave-siding dwarf signal

Below—Map of the 805-mi. route Salt Lake City to Los Angeles

west to Tomas, 70 mi., the railroad continues across this plateau with light rolling grades. From Tomas to Crestline, 12 mi., the line ascends westward at grades ranging up to 1 per cent. Between Crestline and Caliente, 34 mi., the line follows down a canyon route, with grades descending westward ranging up to 2 per cent, and numerous curves ranging up to 10 deg. Therefore, on account of grades and curves, the train speeds are limited. However, faster speeds are practicable on the more open plateau between Lynndyl and Tomas.

Twenty to Thirty Trains Daily

On the territory between Salt Lake City and Caliente, four through passenger trains are operated in each direction daily. These include the streamliner City of Los Angeles which operates at an average of 66.5 m.p.h. westbound and 69.0 m.p.h. eastbound on the 207 mi. between Salt Lake City and Milford. This territory includes the long 0.8 per cent grades as explained above.

As a result of the rapid increase in population in Southern California, the preponderance of freight traffic between Salt Lake City and Caliente is westbound, and consists

of live stock, dressed meats and manufactured products. Westbound live-stock train No. 229 is scheduled to leave Salt Lake City at 12.:30 p.m. daily and make the run of 821 mi. to Los Angeles in 27 hr. This train is made up exclusively of stock cars, most all of which are special Union Pacific cars with roller bearings. The first section of this train handles up to 75 cars and, on numerous days, a second section of this train is operated. On the 207 mi. between Salt Lake City and Milford, this stock train makes an average of 39.4 m.p.h. Two westbound time freights, scheduled daily, handle merchandise and other fast freight. The eastbound traffic consists of fruits, vegetables and other agricultural products, as well as some manufactured products.

In addition to the through trains, three ore trains are operated each direction daily between Lund and Lynndyl, 124.5 mi. Each of these trains consists of about 75 loaded cars eastbound, and the same number of empty cars westbound. The maximum speed of these trains is 30 m.p.h., which increases the track occupancy accordingly.

Twenty-One Sidings Eliminated

Previously the sidings were spaced 4.5 mi. to 5.5 mi. apart. Experience on other sections of single track, handling 20 to 25 trains daily where the Union Pacific has installed C.T.C., has proved that train movements have been expedited so that numerous sidings could be eliminated. Accordingly, when planning the installation of C.T.C. between Salt Lake City and Caliente, 21 sidings were eliminated, as such. At 16 of these locations single sidings were removed and at one location where there were two sidings, one was removed. Also at five towns, the previous single sidings were shortened or converted to spurs with one switch only, and are to be used only as industry tracks. Between Warner and Stockton, 3 mi. of second track was removed except for a short siding at a mid-point, Bauer.

At the remaining locations where power switches and signals were installed in the C.T.C. system, the sidings were lengthened to hold at least 122 cars, and some will hold as many as 137 and 143 cars. Where practicable to do so, an objective in making these changes was to avoid adverse grades for trains when pulling out of sidings. At Bloom, the siding was moved 3 mi. west to get it off of a 0.6 per cent grade and onto practically level territory. At Strong, the siding was moved 3 mi. to get it off of a grade.

As a part of the track improvements, new No. 14 turnouts with 24-ft. switch points were installed at the ends of the power sidings.

In Salt Lake City, the line westward from the passenger station makes a junction at Buena Vista with the freight line from North Yard. This junction is 4.4 mi. from the yard and includes power switches at two crossovers and the west end of the siding. Counting this siding at Buena Vista, there are 26 C.T.C. power-operated sidings between Salt Lake City and Milford. Also at Lynndyl, which formerly an intermediate terminal, there is a yard which in effect includes three power-operated sidings. At Milford, the yard entrance switches at both ends are power operated and included in the C.T.C. Between Milford and Caliente, 117 mi., there are 14 single sidings, in addition to double sidings at two locations, Lund and Modena, all of which are power operated in the C.T.C. system.

Also as part of the C.T.C. project, at main track switches for spurs and house tracks, some hand-throw switch stands were replaced with hand-throw switch-and-lock machines which include lock-rod protection, the same as at power-operated switches. These machines are each equipped with electric locks which lock the operating lever in the normal position. These switch-and-lock machines, with electric locks, were installed on 11 main track switches between Salt Lake City and Caliente.

All Controlled From One End

Of importance is the fact that the power switches and signals at sidings for authorizing train movements on the entire 324 mi. between Salt Lake City and Caliente are all controlled from an office at division headquarters at Salt Lake City. Due to the length of the territory and the number of controlled points involved, it was necessary to divide it into six sections. This was accomplished by the use of coded carrier equipment so the entire territory could be controlled on two code line wires. Details of this carrier equipment will be discussed later.

Previously when train movements were authorized by timetable and train order with automatic block, there were three dispatching districts; Salt Lake City-Lynndyl, 120 mi., dispatched from Salt Lake City; Lynndyl-Milford, 89 mi., dispatched east from Milford; and Milford-Caliente, 118 mi., dispatched west from Milford. In the new system, there are two C.T.C. control machines in a new fire-proof building at Salt Lake City. One 15-ft. machine controls the 120 mi. between Salt Lake City and Lynndyl, and a 17.5-ft. machine controls the 205 mi. between Lynndyl and Caliente.

Benefits of the C.T.C.

The new C.T.C. system, including power siding switches and signals to authorize train movements under the direct control of the dispatchers, is now an important aid

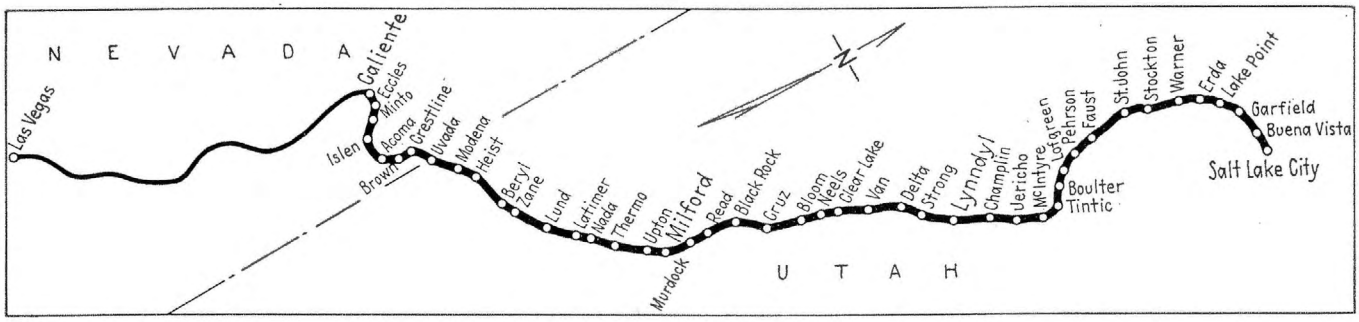
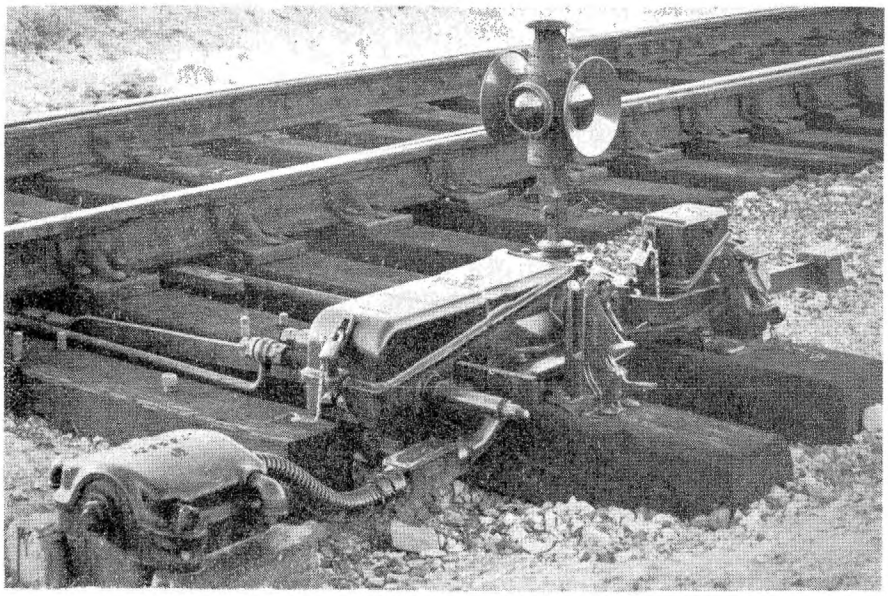


Fig. 1—Map of 324 mi. between Salt Lake City and Caliente showing the locations of sidings

in expediting train movements. The power switches eliminate train stops formerly required to permit trainmen to operate hand-throw switches. This time saving makes it possible for a train of about 80 to 100 cars to depart from one siding, run to some other siding and enter in a period which is 12 to 15 min. shorter than when the hand-throw switches were in service. This time saving is adequate in many instances to permit a train to be advanced one or more sidings when otherwise it would have been delayed. Previously, the dispatcher had no close check on the exact location of trains and, furthermore, he could not anticipate progress of trains nor could he quickly change orders to take advantage of changing conditions. As a consequence, trains lost time waiting on sidings when vacant track and time were available to advance these trains, simply because of no adequate means of directing them to do so. Now the dispatcher is informed of the location and progress of each train by means of the lamps on his C.T.C. control panel. Therefore, he can control the signals to direct trains to advance and thus make close meets. A further important advantage with C.T.C. is that trains can be directed to depart from terminals when they are ready to go. Previously when operating by train orders, if a train was not ready to go when expected, further delay was required to prepare and issue new orders.

As explained by the division superintendent, G. A. Cunningham, in practice the C.T.C. signaling is as simple as the stop-and-go traffic signals on city streets. The trains just keep going, or they take siding or leave siding according to the signal indications. In numerous instances, trains make meets without either train being required to stop. Thus, the C.T.C. system is the coordinating element that makes it possible to use the motive power effectively, i.e., keep the trains in motion at the maximum permissible speeds throughout a very high percentage of the time they are on the road. One result is that the freight trains get over the division in several hours less than previously. For this reason, it was practicable to extend runs and thus eliminate two intermediate terminals for engine crews and freight train crews.

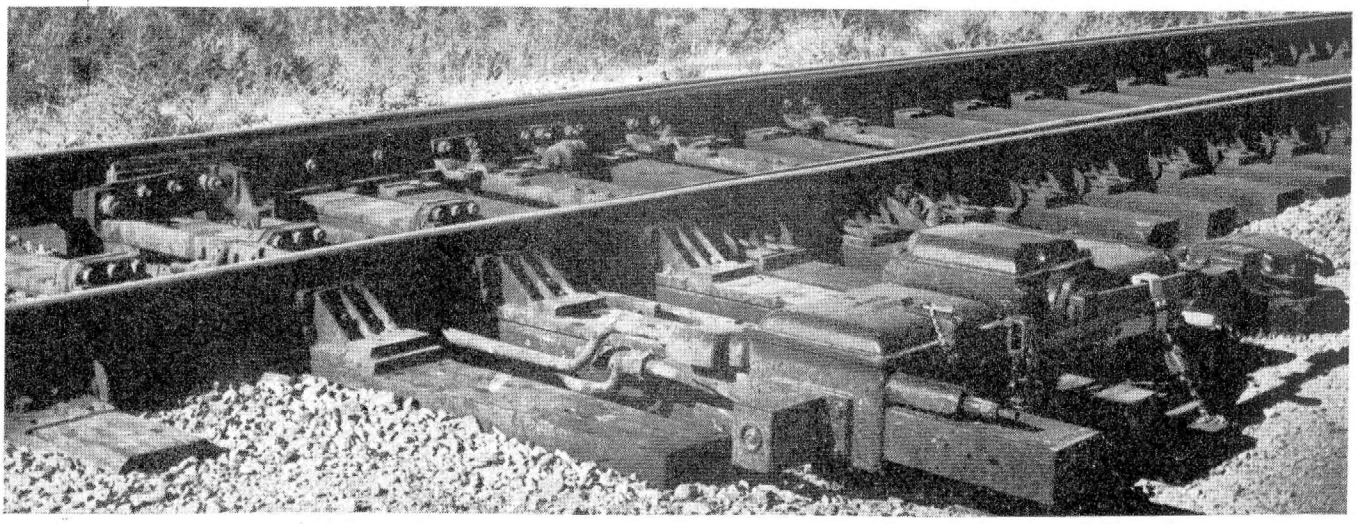


Hand-throw switch-and-lock machine with electric lock on the lever

Two Intermediate Terminals Eliminated

Formerly one run was between Salt Lake City and Lynndyl, 117 mi., and the next run was between Lynndyl and Milford, 89 mi. Now these are combined to make one run of 207 mi. between Salt Lake City and Milford. Previously, there was one run between Milford and Caliente, 117 mi., and a second run, 125 mi. between Caliente and Las Vegas. Now the run is between Milford and Las Vegas, 243 mi. By thus eliminating Lynndyl and Caliente as intermediate terminals, the time formerly lost in train stops, changing crews, etc. is being saved. The use of Diesel-electric locomotives, better track and the C.T.C. have all contributed to save enough time overall to extend these runs.

Furthermore, as explained by the division superintendent, the operation under C.T.C. is much safer than perviously by timetable and train order with automatic block. The C.T.C. concentrates the engineman's attention on the signals, rather



Siding switches are operated by dual-control electric switch machines

than reading orders and checking his timetable and watch. Also, the C.T.C. eliminates accidents that might be the result of errors in issuing, transmitting, reading and obeying written orders; in reading timetables and in checking watches.

An important factor contributing to safety is that the signals controlled by the dispatcher normally display the Stop aspect, and the circuits are interconnected in the field so that only one of two opposing signals can be cleared. Therefore, in C.T.C., if a signal displays a proceed aspect when it was not supposed to, no opposing or conflicting signal can be cleared.

Flashing Yellow Aspect

The C.T.C. dispatcher-controlled signals at the ends of sidings are the searchlight type, which display red, yellow or green. The intermediate signals are the color-light type with three separate lens units; red, yellow and green in a vertical row. Where blocks are less than train stopping distance in length, arrangements were made at the second signal in approach to display flashing-yellow as a fourth aspect, "Advance-Approach." This special aspect is used at 12 signals on the Salt Lake City-Caliente territory.

At the "two-arm" searchlight entering signal at each switch, a filament check circuit is used. If the light in the top "arm" is burned out, the lower "arm" is automatically prevented from displaying a "Proceed" indication, and the approach signal is controlled to display the "Approach" aspect. The objective is to give enginemen advance warning so they can stop short of the signal where a light is burned out, and to avoid any misunderstanding of the indication displayed on a "Two-Arm" signal.

This C.T.C. installation includes time locking at controlled points which goes into effect automatically, if a signal, which had been cleared, is controlled to the "Stop" aspect, and no change in the established route can be made until the expiration of the time interval.

On the Control Machine

The control machines in the office at Salt Lake City have some special features of interest. On the track diagram in each line representing a power siding, there is a lamp which is lighted when the siding is occupied. These siding indication lamps are white with the letter "S" outlined, whereas the track occupancy lamps on the main track portions of the diagram are red for "OS" sections and amber for sections of main track between sidings or in station limits.

Above each section of the diagram representing single track between sidings, there is a traffic-direction symbol with an arrow pointed in each direction and with two lamps; a white lamp to indicate that traffic is set up westward, or a green for eastward. Normally the traffic controls remain in the direction last used.

On the panel above the illuminated track diagram, there is a track plan which shows mileages and the car capacity of sidings, and below the diagram there is a condensed profile showing the average grades. Small toggle switches located above the switch levers control call lamps on the instrument houses at power switches. The switch indicator lamps are green for normal, and amber for reverse. A red indication light above each signal lever is lighted when the signals controlled by that lever are at Stop, a green light indicates a clear westward signal, and a yellow indicates a clear eastward signal.

Carrier for C.T.C. Controls

As mentioned previously, the C.T.C. on the entire 324 mi. between Salt Lake City and Caliente is controlled from two C.T.C. machines in the dispatchers' office at Salt Lake City. One machine controls the 120 mi. between Salt Lake City and Lynndyl, and a second machine controls the 205 mi. between Lynndyl and Caliente. All

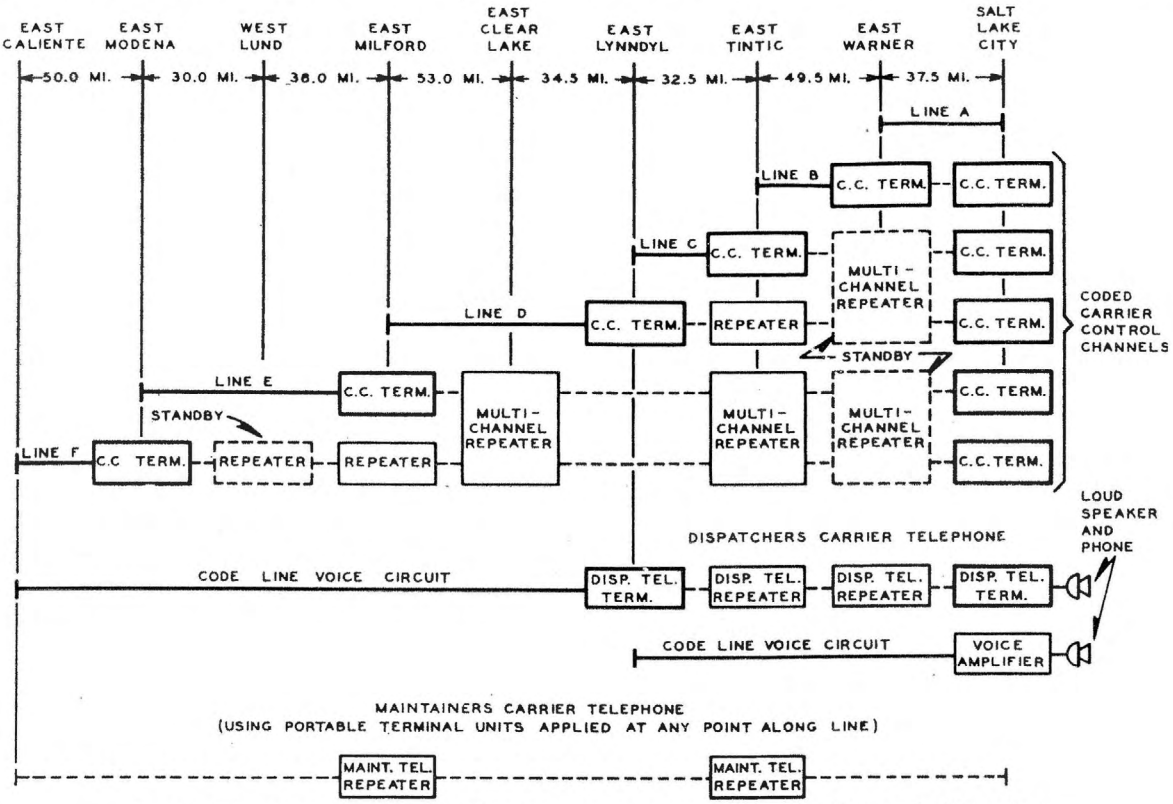


Fig. 2—Schematic arrangement of carrier equipment on the two C.T.C. code line wires

of the outgoing control codes, as well as the returning indication codes are handled over the two C.T.C. code line wires from Salt Lake City to Caliente. Figure 2 shows schematically the arrangement of carrier equipment at Salt Lake City and at the various field locations between there and Caliente. All items of carrier equipment shown in Fig. 2 are provided with duplicate sets, with controls provided so that the dispatcher can select either set in event some portion of any item of carrier equipment fails. Figure 3 indicates the carrier frequencies used.

In addition to the local d.c. codes and the C.T.C. coded carrier, the two C.T.C. code line wires handle both physical and carrier telephones. Conventional telephone train dispatching equipment was in service previously with a dispatcher at Salt Lake City working west to Lynndyl, and two dispatchers at Milford, one working east to Lynndyl and the other west to Caliente. This telephone circuit remains in service for other than train dispatching, numerous phones with selector calling being added in the homes of track foreman and signal maintainers as additional phone facilities.

The C.T.C. telephones in the offices of operators at way stations, and the telephones at C.T.C. field locations, as well as at electric locks at hand-throw switches, are on the C.T.C. code line. The dispatchers are all in Salt Lake City now. The dispatcher for the Salt Lake City-Lynndyl section has a direct voice circuit on the code line for communications in that territory. The dispatcher for the Lynndyl-Caliente section is connected to his voice circuit on the code line between Lynndyl and Caliente by means of duplex carrier on the C.T.C. wires.

The same two C.T.C. code line wires also handle 35 kc. carrier for simplex telephone service. This is used by the maintainers who are furnished with portable 35 kc. phone sets which they can connect to the code line in instrument houses or other locations so that they can talk with no disturbance to the dispatcher.

If a maintainer in the field is wanted, the dispatcher uses the toggle switch on his machine to send out a code to light the call lamp on the track side of the instrument house or houses in the territory where the maintainer is working. When such a lamp is controlled, a buzzer is sounded inside the house. The lamp stays lighted and the buzzer continues to operate until the dispatcher sends out a code to cut them off.

Coded Track Circuits

Conventional d.c. neutral track circuits, with 4 ohm DN-12 relays, are used on the OS sections, and on the crossing signal approach sections, but otherwise the track circuits on this entire project are the coded type. In this territory, the railroad traverses considerable arid country with few highways so that it was seldom necessary to cut the coded track circuits for control of crossing protection. The coded track circuits are used effectively ranging up to 11,000 ft. in length, thus eliminating cut sections in blocks, up to two miles long.

Normal Steady Energy

The track circuit codes are established under the C.T.C. control to feed between two sidings in the direction opposite to a proposed train movement. This lineup of traffic direction remains after the train has gone but the coded track circuit energy is replaced with steady (non-coded) energy, until the dispatcher sends out a control to clear a signal. No traffic levers, as such, are used. Traffic direction is established automatically when a C.T.C. control code is initiated to clear a "station-leaving" signal.

Motor Car Indicators

Neutral reverse coded track circuits are used on passing tracks and polar reverse coded track circuits are used on the main tracks through stations.

As a part of the new C.T.C. proj-

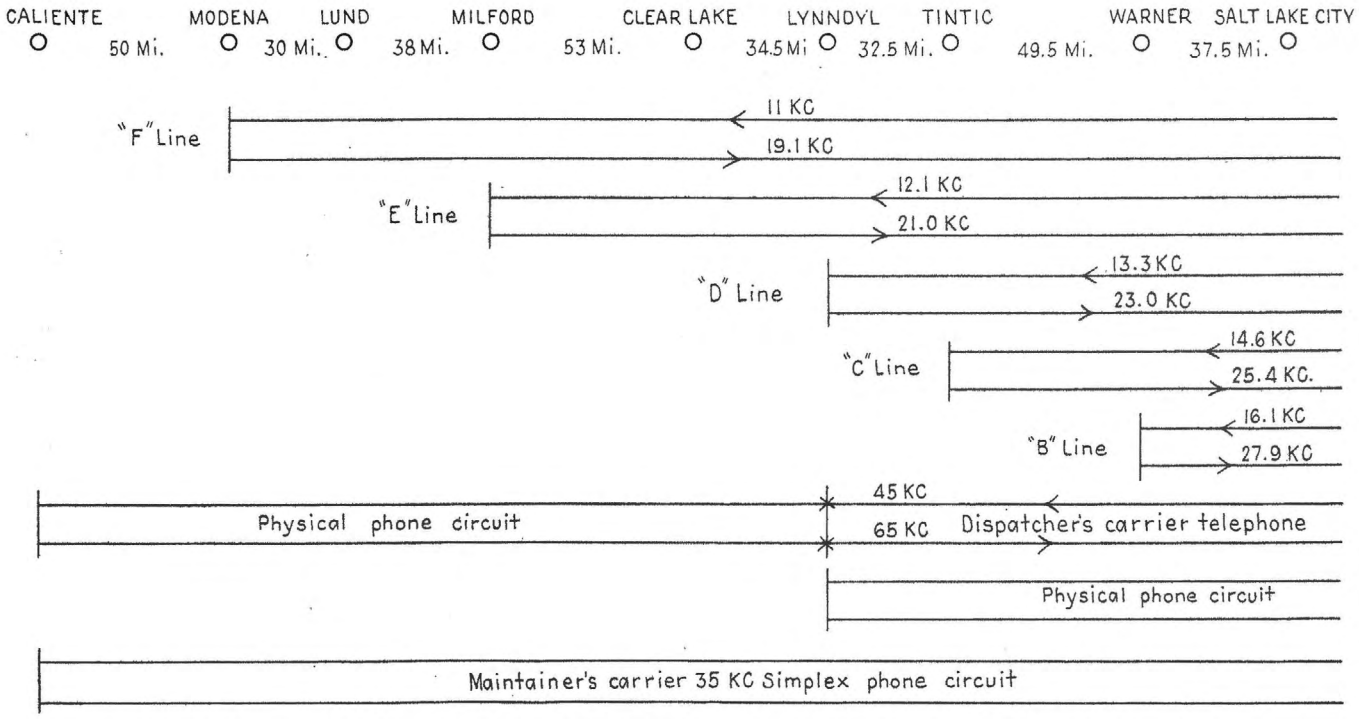
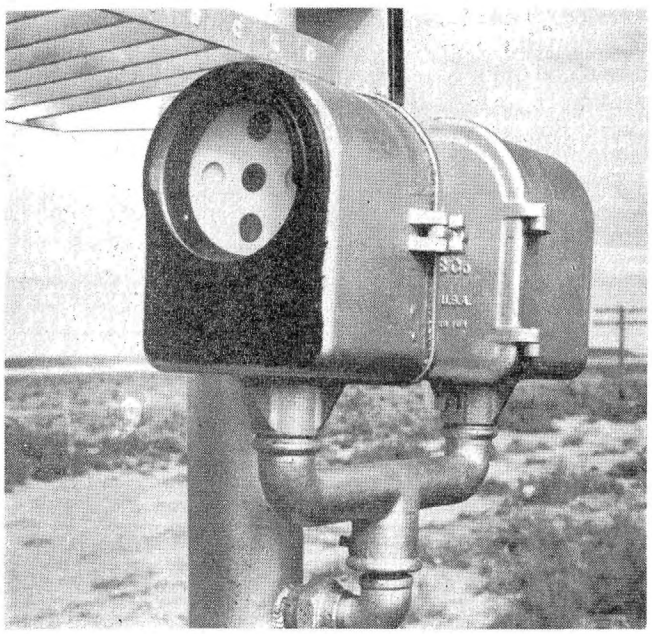
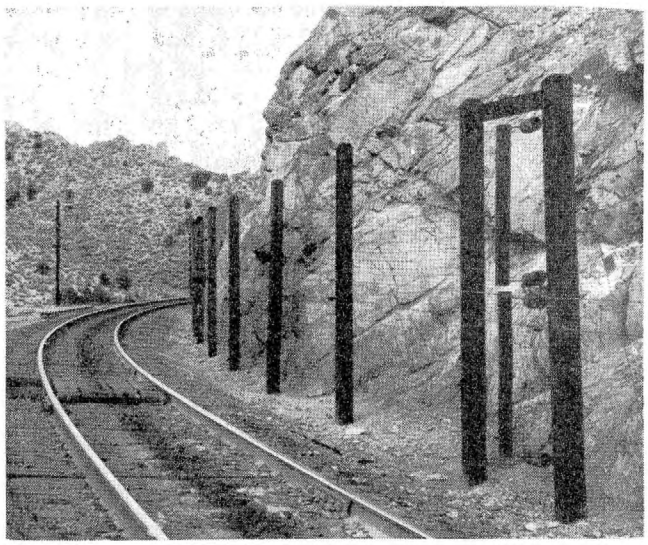


Fig. 3—Diagram showing frequencies used by carrier equipment on the two C.T.C. code line wires

ect, position-type motor car indicators were installed at various locations to warn men on motor cars of the approach of trains. In general, the indicators are used more extensively on curves or other places where the view is obscured. On the average, there are four indicators to the mile of road. Each indicator is marked to show the limits to which it is controlled. If a man passes an indicator showing "Clear," he has time to proceed out on straight track where he can get a good view, or to proceed to the next indicator and set his car off. This is based on an average motor car speed of 10 m.p.h. and the speed of the fastest train operated through the territory protected by each indicator.



Motor-car indicator displaying "Clear"



Rock-slide detector fence

These indicators are the MC-1 type, 40 ohms, and are connected in series. The line circuits are on No. 9 bare iron line wire that was used previously for the control of the automatic block signaling. These motor car indicator circuits are controlled by contacts of track relays or repeaters, but are independent of signal control circuits.

Power Supply

On a large portion of this C.T.C. installation, it was necessary to install a 2,300-volt single-phase a.c. power distribution line circuit. The territory between Salt Lake City and Caliente is fed at several locations, including Salt Lake City, Warner, Lynndyl, Milford and Modena. The 2,300/110-volt line transformers are the General Electric Hypersil type. These transformers are rated at 750 watts at power switch layouts, and at 500 watts at intermediate signal locations. Enclosed type, fused cut-out plugs are located on the same crossarm with the line transformers. The G.E. pellet type arresters on the 2,300-volt line are on the crossarm on the next pole in both directions, this being done to improve safety for men working on the poles.

If the a.c. power is out of service for any extended period of time, the line can be sectionalized and fed as required by emergency gasoline engine driven alternators rated at 220-volt, 10 Kw. These emergency sets were made by Onan & Sons, Minneapolis and were furnished through Fairbanks, Morse & Co.

Lamps on A.C.

The signal lamps at power-operated switch locations are fed from low-voltage transformers normally, but if the a.c. fails, the lamps are fed from battery. The signal lamps at intermediate signal locations are fed from batteries which have automatic two-rate charging equipment. This equipment operates to reduce the battery charging rate after the battery voltage has reached a predetermined level. Except for the lamps, the signaling system normally operates on d.c., supplied from Edison storage battery, which are charged through copper-oxide rectifiers.

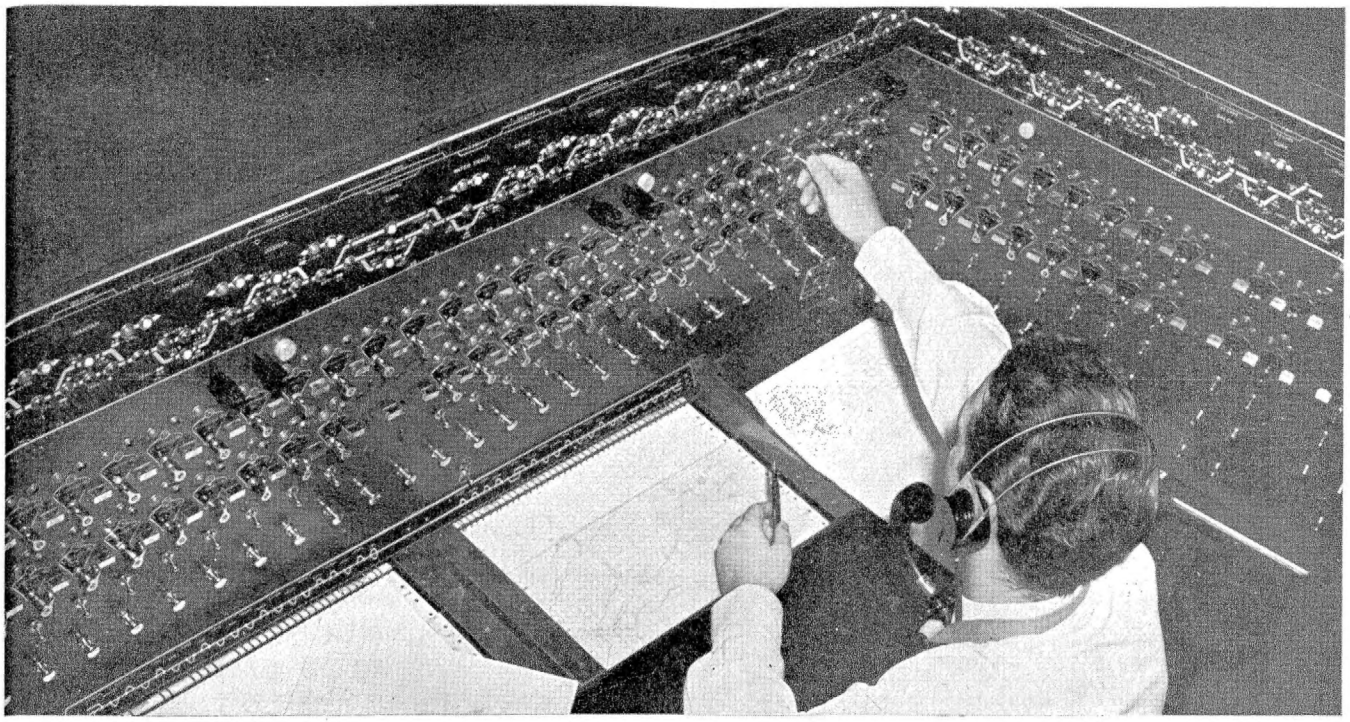
Each coded track circuit is fed by two 150-a.h. Edison storage cells. These batteries are on two-rate charge with the high rate in effect whenever the cell is feeding the track circuit. At each intermediate signal there is a set of 8 cells of B4H Edison storage battery to feed local circuits and the signal lamps. At each power switch there are three sets of Edison storage battery. One set of 12 cells of A4H battery to feed the C.T.C. coding equipment and one set of 8 cells of A4H battery to feed the signal circuits. These two batteries, in series, are used to feed the switch machine motor. Another set of 8 cells of B4H battery is used to feed the motor car indicator circuits and as standby for the lamps.

The carrier equipment, which normally operates from a.c., has been arranged to operate from tuned alternators fed by batteries, if the a.c. power fails. When there is an outage of a.c. power at any of the major feed locations, a corresponding indication lamp is lighted on the C.T.C. control machine.

Rock Slide Fences

At numerous locations through the canyon east of Caliente, there are rock-slide detector fences to detect slides and falling rocks that may obstruct the track. When a rock or slide strikes one of these fences, signals in each direction are set at the most restrictive aspects, and an indication is sent in to light a corresponding lamp on the dispatcher's C.T.C. control machine.

When a train is stopped at a signal affected by slide fence operation, the train crew inspects the damage and clears the track, if practicable. If no damage has occurred, a trainman resets the slide



This C.T.C. machine in the office at Las Vegas, Nev., controls the territory between Caliente and Las Vegas

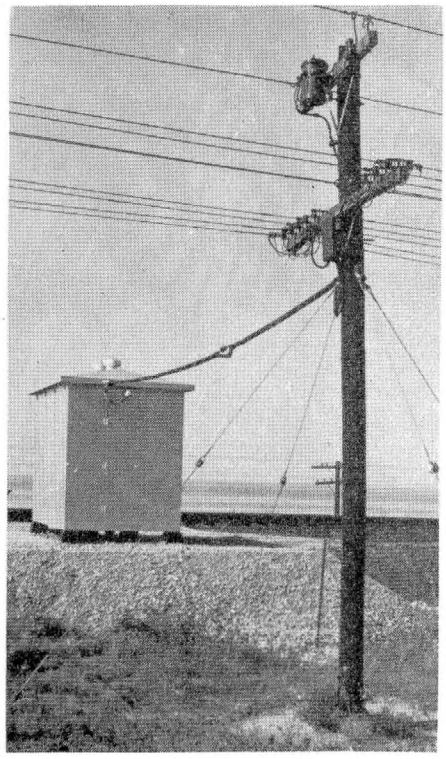
fence tripping device and the passage of the train by track-circuits operation, which restores the fence and signal controls to normal. If the damage is more serious, the track crew, signal men and other forces are called as required. After all repairs have been made and the slide fence tripping devices have been reset, the fence and signal controls can be restored to normal by operating push buttons located at the signals affected.

Pole Line Construction

Previously there was a signal pole line throughout this territory, but as a part of the C.T.C. project, it was necessary to reconstruct the pole in certain sections and to build an entirely new pole line on 118 mi. between Salt Lake City and Lynndyl and on 42 mi. between Uvada and Caliente. The poles are Southern pine treated full length and are set 40 to the mile. Except where high poles are required at crossings, the poles are 25-ft. The a.c. power wires are on a 4-ft. arm near the top of the pole, and the signal and C.T.C. wires are on a 10-pin arm 4 ft. lower.

The 2,300-volt single-phase a.c. power distribution circuit is on No. 6 bare copper wires. The two new line wires for the C.T.C. code are No. 6 medium hard-drawn copper with weatherproof covering. Other line control circuits are No. 10 Copperweld with weatherproof covering and No. 9 EBB iron.

The circuits to rails are in single-conductor No. 9 direct-burial cable. A five-conductor No. 6 and a seven-conductor No. 14 buried cable extends to each switch machine, and a five-or seven-conductor cable to each signal. These cables are of Kerite manufacture with no metal in the covering of the track cables, but with bronze tape in the other cables.



Line transformer on crossarm

This installation of C.T.C. was planned and installed by Union Pacific forces under the direction of T. W. Hays, general signal engineer. The major items of signaling equipment were furnished by the Union Switch & Signal Company.

Request Your Index Now

Continuing previous practice, a copy of the printed index to Railway Signaling and Communications for the year 1949 will be mailed to any reader who wants it to bind in with the 12 monthly issues for the year. Please send your request to H. E. McCandless, Circulation Manager, Railway Signaling and Communications, 30 Church Street, New York 7. If you sent such a request for either a 1944, 1945, 1946, 1947 or 1948 index, that request will automatically apply for the 1949 index, so that you need not send a new request now, unless your address has been changed.

Stimsonite All-Plastic Reflectors on Railroads—This is the title of an eight-page bulletin issued by the American Gas Accumulator Company, Elizabeth, N. J., presenting the advantages of using reflector materials in place of switch lamps on switch stands. It also discusses the use of reflector materials on railroad signs of various types, crossing gates and some signals.