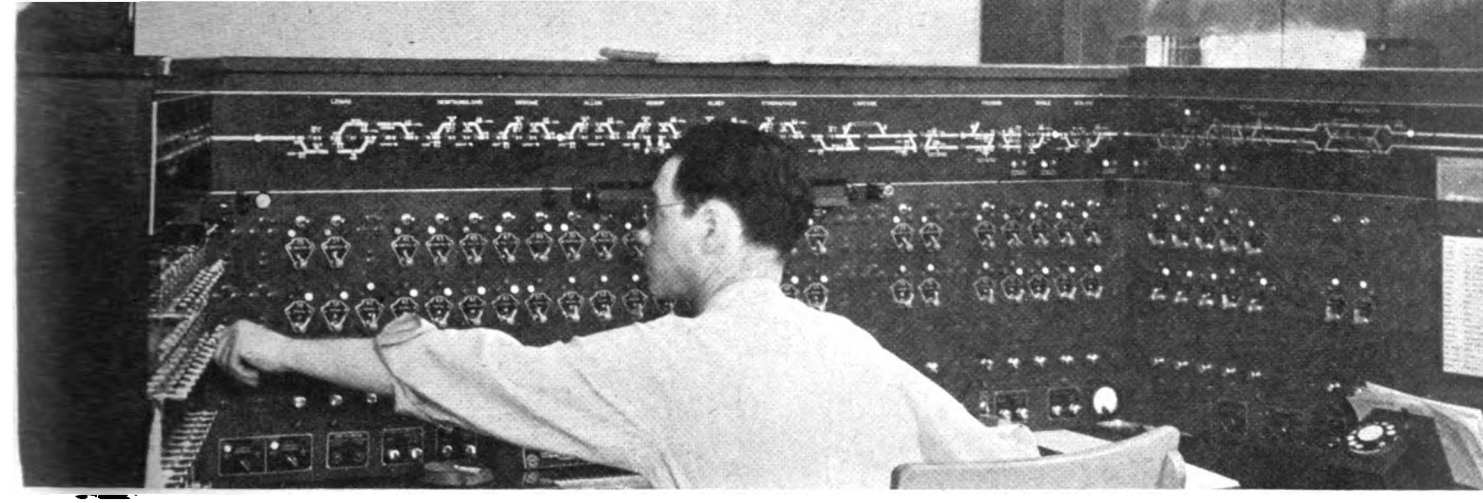


The C.T.C. machine in the office at Ogden, Utah

Southern Pacific Installs C.T.C.

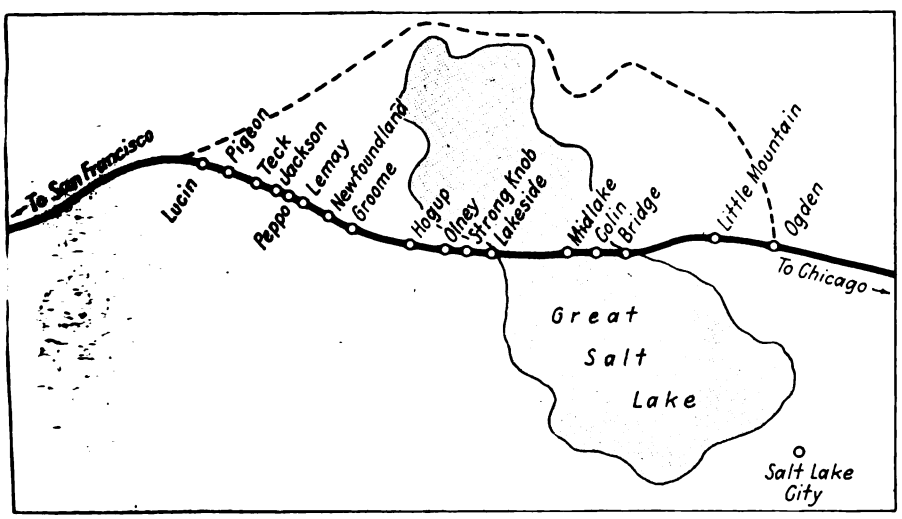
Project on 74.3 miles of road, including 11.9 miles on a trestle across Great Salt Lake, involves unusual construction practices and saves considerable train time

THE Southern Pacific has installed centralized traffic control on 68 miles of single track and 5 miles of double track between Lucin, Utah, and Bridge, which is 29.4 miles west of Ogden. This territory is on the Southern Pacific's 782-mile line between San Francisco, Cal., and Ogden, Utah, which, in connection with the Union Pacific and the Chicago & North Western, forms the 2,264-mile Overland Route between San Francisco and Chicago. Of the 782 miles on the Southern Pacific between San Francisco and Ogden, 398.5 miles is double track. In co-operation with the Western Pacific, paired tracks are used to the equivalent of double track on 177.6 miles. About 43.5 miles of single track between Vista and Massie, Nev., was equipped with C.T.C. in 1944, which, when added to the 74.3 miles equipped in 1946, makes a total of 117.8 miles of track, so that there is only 198.9 miles of single track remaining on the San Francisco-Ogden line that is not equipped with C.T.C.

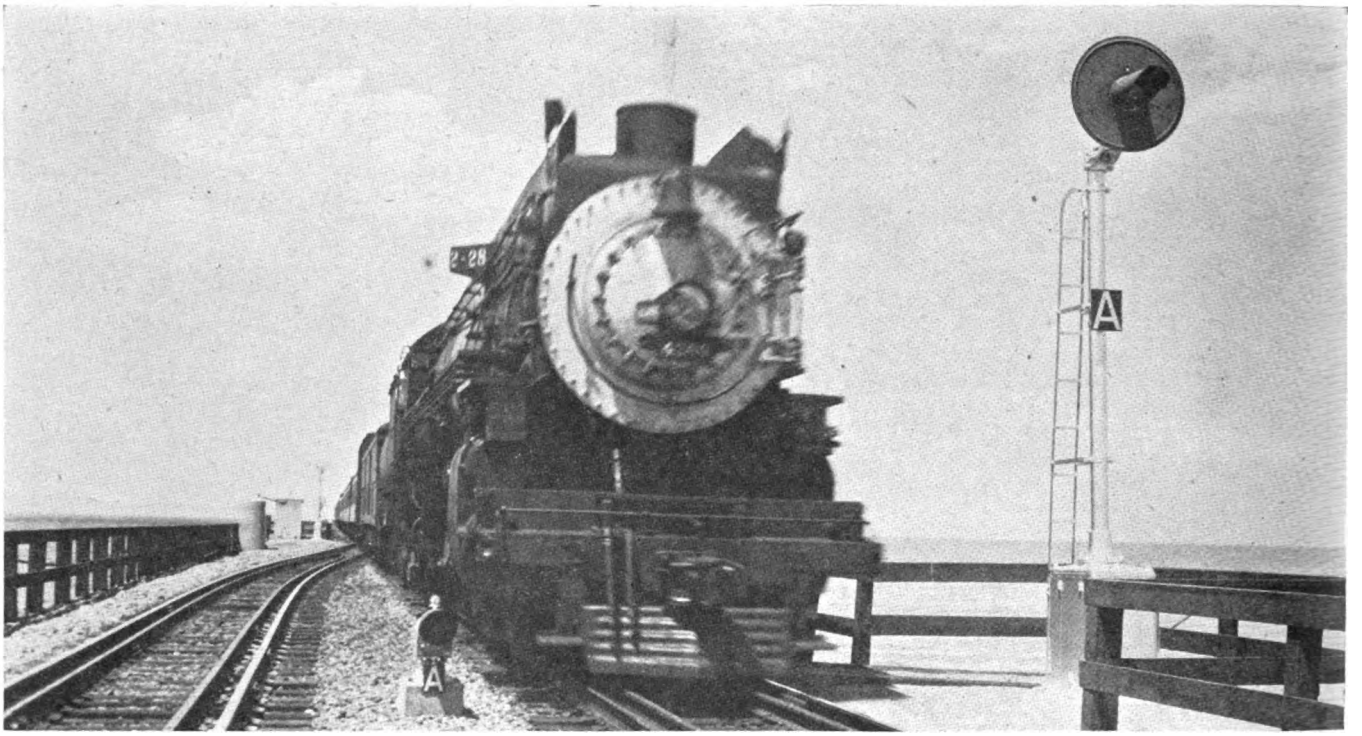
Of historical interest is the fact that the present line between Lucin and Ogden, including the causeway and trestle over the lake, is the so-called Lucin cut-off, completed in 1904 as a short-cut to replace the original line about 40 miles longer around the north end of the lake.

West from Ogden, double track extends for 28.7 miles to Bridge, from which point the railroad extends straight across the Great Salt Lake; the first 13.9 miles to Tresend is single track of which 11.9 miles is on a single-track wood trestle with a ballast deck, and the remaining 4.5 from Tresend to Lakeside being double track on a rock filled causeway. Single track extends west from Lakeside to Lucin, 55.9 miles, with 17.7 miles of double track between Lucin and Montello, which is the end of the subdivision from Ogden.

Under the previous practice of operating trains by timetables and train orders with automatic block protection, the 74.3-mile section between Bridge and Lucin was a bottle-neck between the sections of double track extending west from Ogden and east from Montello. The situation was aggravated by the fact that train speeds on the 11.9-mile trestle over the lake are limited to 30 m.p.h. for streamlined passenger trains and to 20 m.p.h. for all other trains. When a strong wind is blowing on the lake and if in a direction that would effect westward freight train movements, the tonnage of freight trains is re-



Map of the territory; dash line shows location of original route



Eastbound train at siding on trestle over the lake

duced, before leaving Ogden with the result that more trains must be operated which further increases the congestion and delay.

Previously on numerous occasions, westbound freight trains were held in the yard at Ogden because of congestion in the vicinity of the lake. Now, with the C.T.C., trains can be authorized to move promptly when they are ready to go. This is an additional time saving. Throughout this new C.T.C. territory the track is practically level except for a few short sections of grade ranging from 0.1 per cent up to about 0.4 per cent. The curvature is very light, with long sections of tangent track, ranging from 15 to 36 miles. The track is in excellent condition, using 113-lb. rail on tangents and 132-lb. rail on curves. The schedules include five passenger trains each way daily, and the streamliner City of Can Francisco each way three times each week. Freight trains are operated as required to handle the traffic, so that the total number of trains ranges from about 20 to as many as 40 daily.

When planning these improvements, a major objective was to facilitate train movements in the low-speed section on the trestle, and also to provide for run-around moves in the sections beyond each end of the trestle so that freight trains could be advanced and held short of the trestle or just beyond it while at the same time passenger trains could be moved.

The end of double track from Ogden is at the crossover layout at Bridge, the track on the north side extending west from Bridge to M.P. 752.2 being a siding. On the single-track trestle over the lake, sidings are located at Colin and Midlake, which are 2.8 miles and 8.1 miles, respectively, from Bridge. A passing track extends from Engle, M.P. 741, to Tresend, and double track extends 4.5 miles between Tresend and Lakeside. A siding on the south side of the main track extends from Lakeside to the west switch near M.P. 734.

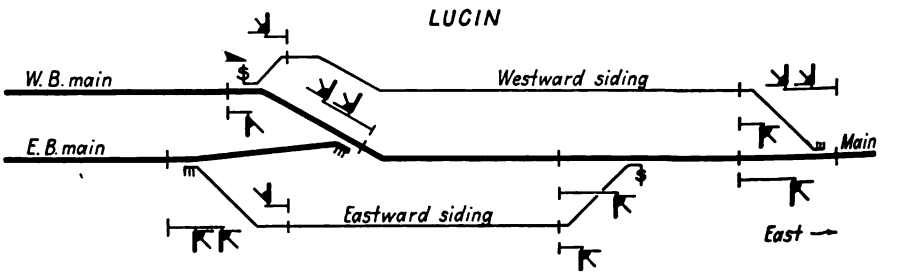
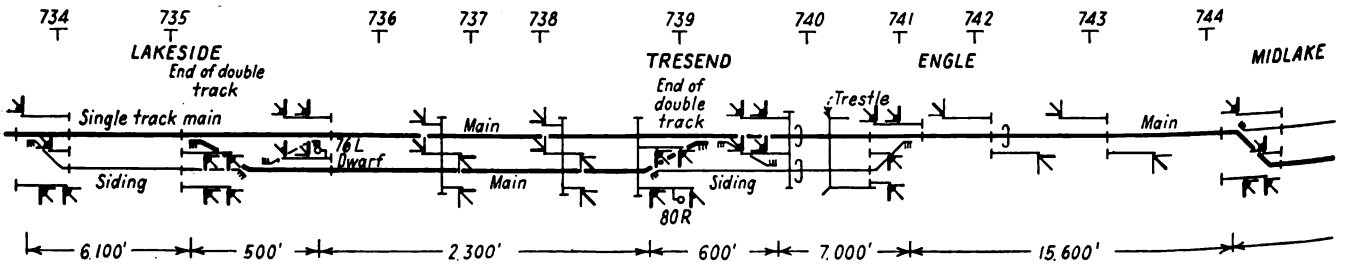


Fig. 1—Track and signal plan at Lucin

In each of the end-of-double-track layouts at Bridge, Tresend and Lakeside, there are two crossovers, which are arranged so that trains can move from the siding to either main track,



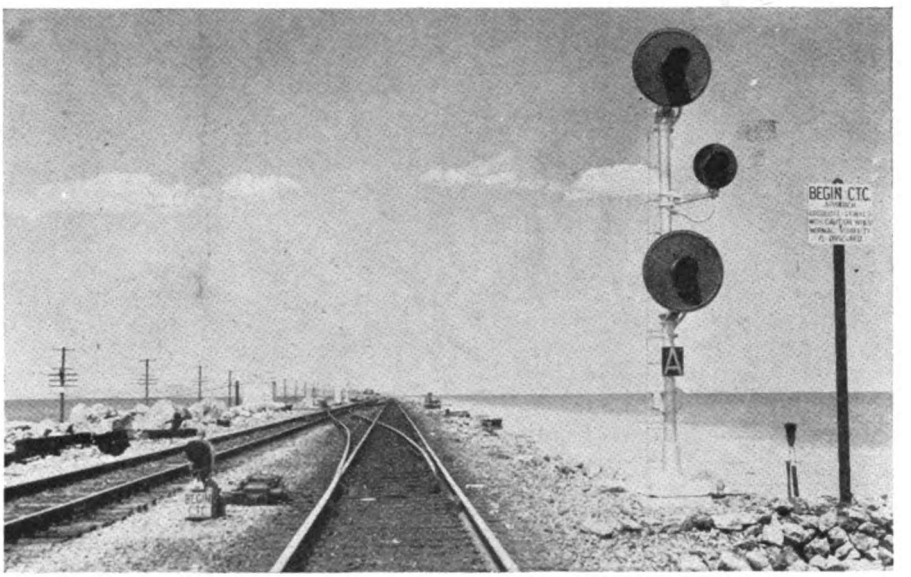
Track and signal plan of the Territory across

or from either main track to the siding or to the single track. Thus, there are five sidings between Bridge and M.P. 734. All these crossovers and siding switches are equipped with power switch machines and signals controlled by the C.T.C. system. On the double track between Tresend and Lakeside, both tracks are signaled for train movements in both directions. With these new signaling facilities the five sidings and sections of main tracks can be used to make various combinations of meets and passes, thereby keeping trains moving a greater percentage of the time which prevents delays in the slow-speed section across the lake.

West from Lakeside single track extends 55.9 miles to Lucin, and in this section power switch machines and C.T.C. signals were installed at both ends of 12 single sidings, including Strongknob, Olney, Hogup, Allen, Groome, Newfoundland, Beppo, Jackson, Teck, Pigeon, and two at Lemay. As shown in Fig. 1, the layout at Lucin includes two sidings and the junction of two tracks to the west, spring switch mechanisms being used at the east end of the eastward siding and the west end of the westward siding, with power machines on the three other switches, this entire layout being included in the C.T.C. installation. The entire C.T.C. territory between Lucin and Bridge, 74.3 miles, is controlled by a machine in the dispatcher's office at Ogden, which is 29.4 miles east of Bridge.

New Searchlight Signals

The old semaphore type automatic block signals in this territory were removed, the signals throughout the C.T.C. project being the H-2 searchlight type, for operation on 8 volts, d.c., and with 18-watt, 8-volt single-filament lamps. The signals at the crossovers and turnouts are located in the conventional arrangement to direct trains. At some locations on double track the signals are on bridges, but elsewhere the signals are on masts at the right of the track governed. In order to adhere to this practice at one end of every siding the siding is thrown over to 19-ft. centers to allow



View looking west with signal 100L at right

space for the station-leaving main-track signal between the siding and main, as for example the signal at the west end of Teck.

Special Signal Aspects Save Train Time

The turnouts are No. 20 with 30-points at the ends of double track at Lucin, Lakeside and Tresend, and the east end of the siding at Eagle, both ends of Midlake and the west end of Bridge. The turnouts are No. 14 with 24-ft. points at both ends of the siding at Colon and the end of double track at Bridge. The remainder of the turnouts are No. 12 with 24-ft. points.

The sidings are equipped with track circuits which enter into the control of the signals. Referring to Fig. 2, if switch 17 is reversed for an approaching train to enter the siding which is not occupied, then signal 18R is cleared to display the aspect Red-over-Green so that the engineman can pull his train into the siding promptly, whereas if there were no track circuits on a siding, the most favorable aspect that could be displayed would be Red-over-Yellow, requiring the engineman to pull his train into the siding at restricted speed prepared to stop short of train.

On this Southern Pacific project with track circuits on the sidings, if a siding is occupied by a short train, and the dispatcher wants a second train of the same direction to pull in on the siding behind the first train, he can clear the entering signal 18R, Fig. 2, to display the Red-over-Yellow aspect. The control of this aspect depends on the position of directional stick relays which require that the second train must enter the siding in

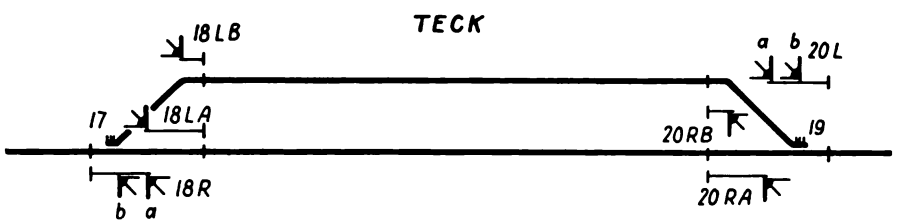
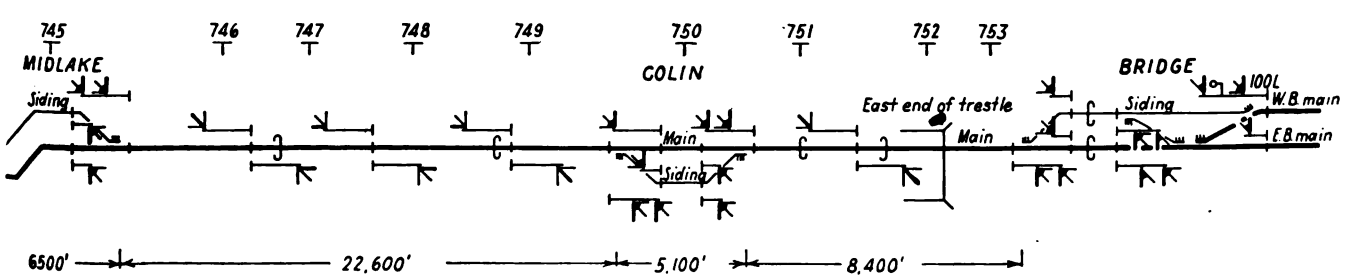
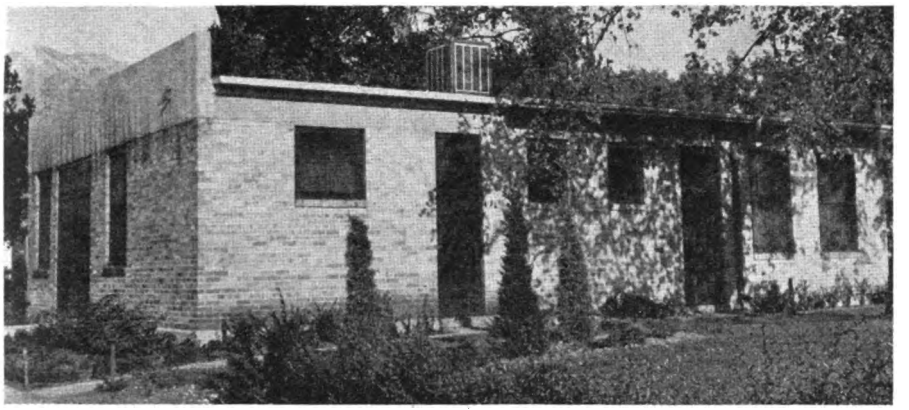


Fig. 2—Track and signal plan of the siding at Teck showing use of signals to save train time



the Great Salt Lake between Lakeside and Bridge

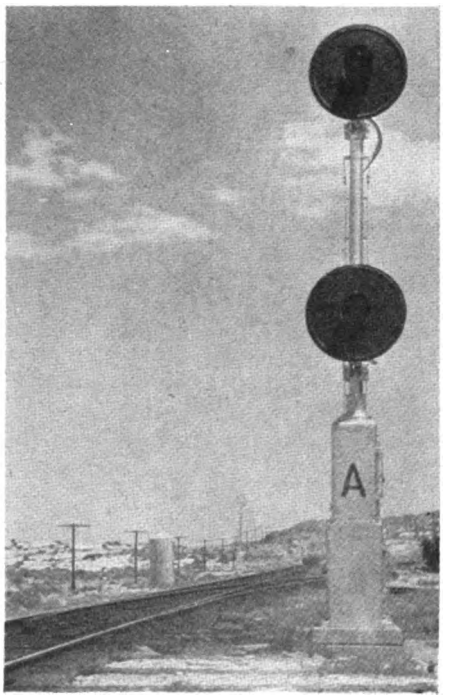


New building for C.T.C. office in Ogden, Utah

the same direction as the first one.

A station-entering signal cannot be cleared to direct a train to enter a siding which is occupied by an opposing train. In such a case an approaching train would encounter a Stop aspect Red-over-Red on the station-entering signal, and the head brakeman or conductor would go to the nearest wayside telephone so that the dispatcher could explain any special moves desired.

In all instances the lower unit displays the aspect governing diverging moves and this rule applies to all layouts. For example, as shown in the plan on pg. 89, signal 100L at Bridge displays Red-over-Green, for a train movement from the westward main track to be routed over the crossover to the single main track. If a westbound train on the westward track is to be routed to the siding, which is a continuation of straight track from the westward main, the aspect on signal 100L is Yellow-over-Red if the siding is unoocupied. For such a layout this leaves no conventional aspect as previously explained to be used to direct a westbound train to enter the siding at Bridge if the siding is occupied. Therefore, on this signal 100L there is a special lamp unit at the right of the mast. This unit has a yellow lens, and the lamp is normally extinguished. When a westbound train is to be directed to enter the siding which is occupied by another westbound train, the signal 100L is controlled to display an aspect Red-over-Red, with a Flashing Yellow, which indicates to the engineman of an approaching westbound train that he is to stop short of the signal and then pull his train into the siding prepared to stop short of a train which



Signal at west end of Lakeside

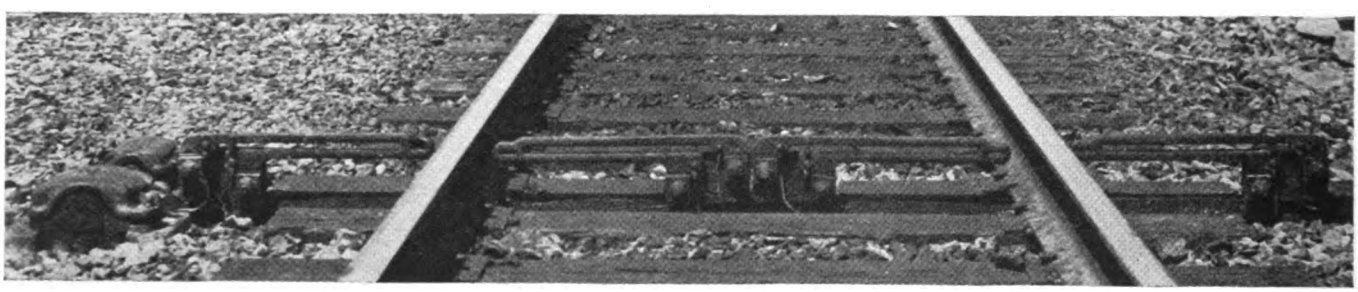
is occupying the siding. This same type of special flashing-yellow aspect is in service on signal 80R at Tresend and signal 76L at Lakeside.

An interesting practice on the Southern Pacific is that on a two-unit signal, if the line up is for a thorough move on the straight track with a green or a yellow in the top unit, then the lamp in the lower unit is not lighted, this being different from conventional practice of a red light in the lower unit. The reason for the Southern Pacific practice is that a proceed aspect should not include a red light because an engineman of an approaching train might see the red before he saw the green and thus cause confusion in his reactions. On the Southern Pacific the lamp in the lower unit is lighted in combination with that in the upper unit only when a diverging route is lined up, or as a red under a red for the Stop aspect. The lower unit will display red in the event that the lamp in the upper unit is burned out and the mechanism is in the "proceed" or "approach" position.

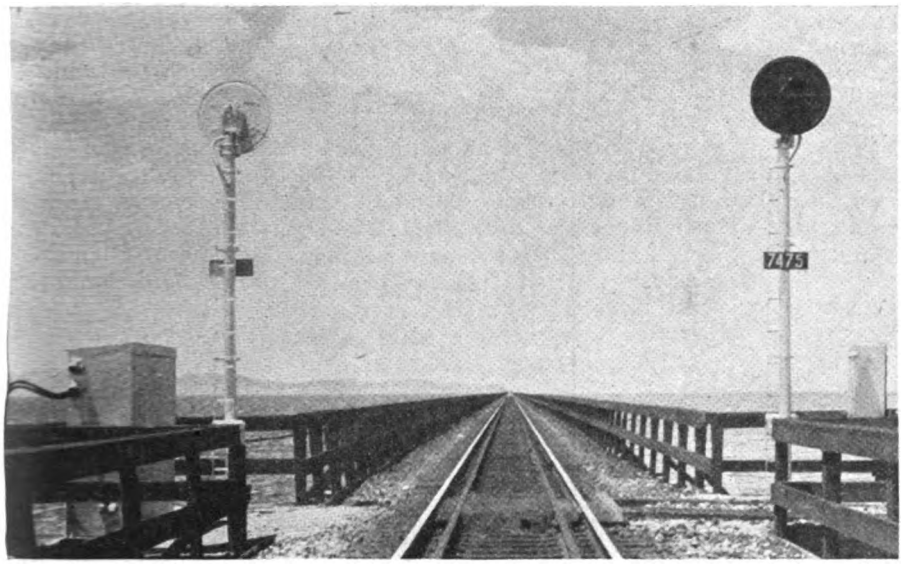
Dragging Equipment Detectors

A derailment on the trestle might cause considerable damage to the structure and thus block the railroad for several days before repairs could be completed. Therefore, as a means of reducing the chances for derailments, dragging equipment detectors were installed on each track in approach to each end of the trestle and at five locations on the bridge, thus totaling nine detector locations, as shown on the diagram.

As shown in one of the pictures, each detector location consists of a set of four cast-iron bracket arms mounted just below the level of the top of the rails. These arms are connected in a normally-closed circuit which energizes a relay. If a loose brake beam or other dragging equipment breaks a detector, the relay releases, and signals ahead of the train are set to display restrictive aspects to stop the train. These controls are arranged so that if the locomotive is less than train stopping distance from the first signal that it is to encounter, then that signal displays the yellow aspect and the next signal the red aspect. On the other hand, if the locomotive is more than train stopping distance from the first signal when the detector is operated, that



One of the dragging-equipment detector locations



Intermediate signal location on the lake

first signal displays the red aspect.

Each of the nine sets of dragging equipment detectors is repeated by a set of two lamps on the track diagram on the C.T.C. machine. Normally a green lamp is lighted, but if the corresponding detector is broken, the green lamp is extinguished and the red lamp is lighted, and a buzzer is sounded. When the train is stopped at the signal displaying a red aspect, and the head brakeman or engineer calls on the telephone, the dispatcher tells him that a dragging equipment detector has been operated, and, therefore, that the train must be inspected before proceeding again.

Automatic Block Controls

The track circuits are the d.c. neutral type with 4-ohm DN-11 relays. The local automatic signal control relays are polar Type DP-17, rated at 110 ohms. A separate two-wire normally energized line circuit is used for the control of signals for each direction, each line circuit checking, double-break, through track relays for the respective automatic block. If a station-leaving signal is cleared, energy is cut off of the line circuits for all opposing signals in the station-to-station block. Thus when one station-leaving signal has been cleared, the opposing station-leaving signal cannot be cleared, regardless of whether a control code is sent from the dispatcher's office.

Signals Check Each Other

The intermediate signals are double locations and the circuits are arranged so that the control of each signal checks the other signal in the stop position. The purpose of this is to detect improper operation.

The line controls of opposing station leaving signals are through contacts of relays controlled by the approach locking. If a proceed aspect is taken away by lever control, with the approach occupied, the line control of the opposing station-leaving signal is not closed until the expiration of the time release period. Thus the advantages of the Southern Pacific practice of using two two-wire circuits are that the route and direction are retained and compliance with Item 412 of the I.C.C. Rules is accomplished automatically without interconnections and extra relays in the C.T.C. machine. Also the two line circuits detect track occupancy of the station-to-station block as a whole, and, in connection with relays at an outlying handthrow switch, are used to detect track occupancy as a factor in the release of the electric lock.

Spacing of Intermediates

On the trestle and causeway the intermediate signals are spaced to allow trains to follow on comparatively close headway, thus increasing the capacity of the track and reducing train delays. On account of the low train speeds on the trestle, as explained elsewhere, the signal spacings of 4,000 ft. to 5,000 ft. insure more than adequate train stopping distance.

In the territory between Lakeside and Lucin where train speeds are normal, the intermediate signals, all of which are double locations, are spaced from 1.5 to 2 miles, depending on the variations required to divide the distance between two sidings into equal block lengths. In most instances there are two double locations of intermediates between two sidings.

Switch Layouts Well Constructed

The switch machines are the Type M-22A, dual-control, for operation on 24 volts d.c. As a reminder to trainmen, the selector lever, as viewed from the top when in the normal position, is painted white, but the other side, viewed when in the reverse position, is red. Three 1-in. by 9-in. insulated gage plates with Racor adjustable rail braces, were installed at each power switch layout. Two of these plates extend out under the switch machine which fits snugly between two toe plates, thus preventing lost motion between the machine and rails. The toe plates and riser plates at the rails are welded to the plates. The ties are dapped, and the plates bent so that the base of the machine is 4½ in. below the base of rail, and the top of the machine is only 2 3/16 in. above the level of the top of the rail where the rail is 7 5/16 in. high.

Roller Bearings Used

Each power switch is equipped with a set of two roller bearings which normally support the points free from the slide plates, thus easing the operation. A solution of oil and powdered graphite is applied to the plates as a lubricant. This solution resists weath-

The power switch machines are the dual-control type

ering, and will not accumulate sand and dust as badly as heavy oil or grease.

C.T.C. Code and Carrier

The C.T.C. controls are sent out from the office and indications are returned by the Union Switch & Signal Company multiple time code system, multiple application, using two

Carrier equipment at Lakeside

line wires throughout from the control office at Ogden to the west end of the territory at Lucin. The installation includes three separate arrangements of code sending and receiving equipment, each with a capacity to handle 35 field stations.

The control and indications for the first section between Bridge and Lakeside are handled by conventional d.c. codes. Also the two line wires on this section carry coded 16 k.c. frequency to the west end of Lakeside where it is converted to d.c. codes that are transmitted to the field stations on the 33 miles between Lakeside and the west end of Lemay. Likewise, d.c. indication codes from these field stations are transmitted to the west end of Lakeside where they are converted to 23 k.c. frequency for transmittal to the C.T.C. office. Also the line wires carry coded 14 k.c. frequency from Ogden to the west end of Lemay where they are converted to d.c. code for control of switches and signals at the field stations between Lemay and Lucin. Likewise d.c. indication codes from these field stations go to the west end of Lemay where they are converted to 20 k.c. frequency for transmittal to the C.T.C. office at Ogden.

Filters prevent interference between the d.c. codes and the high frequency codes, so that control codes can be sent to or indication codes received from any or all three of the sections simultaneously. A detailed explanation of the basic principles and circuits of coded carrier was published in the June, 1944, issue of *Railway Signaling*.

On the C.T.C. machine there is a set of two indication lamps to correspond with each field carrier location. For example, as long as the normal equipment at Lakeside is in operation, its corresponding green lamp on the C.T.C. machine is lighted. If the normal set becomes inoperative, the green lamp is extinguished and the red lamp is lighted and a buzzer is sounded. Then the dispatcher operates a special lever to send out a control which cuts the standby carrier equipment in service at Lakeside.

The C.T.C. code line circuit is used also for voice frequency telephones. Each maintainer has a handset which he can clip to the line circuit. He whistles into the mouthpiece which actuates an oscillator electronic tube in the office, which lights a lamp to indicate to the dispatcher that he is to cut in on the circuit and answer the call.

The C.T.C. Control Machine

No space was available in the offices at Ogden and, therefore, a new one-story brick building of fireproof construction was built for the dispatcher's office to include the new C.T.C. control machine and other signaling equipment required at this control office. The control machine is arranged with a center panel 5 ft. long, with a wing at each end 2.5 ft. long, so that a man can reach all the levers without moving from his chair. The machine has 40 levers for controlling switches and crossovers, 41 levers for controlling signals and 4 levers for controlling electric locks on 7 hand-throw switches.

The track-occupancy indication lamps on the track diagram are red for the OS sections at switches and yellow for other sections of main track and the sidings. The normal switch indication is green and the reverse is yellow. A red lamp above the center position of each signal lever is lighted when all signals controlled by the lever are indicating Stop. When the lever is thrown to the L position and the corresponding signal clears, a green indication lamp above the L position of the lever is lighted, or when thrown to the right and the signal clears, a yellow lamp is lighted.

The automatic train graph has 48 pens to record the passing of trains at a corresponding number of OS track circuits. At the right side of the chart, there is a special pen which records the wind speed as measured in miles per hour by a windmeter mounted on a telephone booth at Midlake. When the wind speed is more than 40 m.p.h., the tonnage of freight trains is reduced as previously explained.

Control at Little Mountain

The 28.7 miles of double track between Ogden and Bridge is equipped with automatic block signaling for right-hand running. At Little Mountain, about half way between Ogden and Bridge, there is a siding between the two main tracks, as shown in Fig. 4. The switches are equipped with hand-throw stands, and spring mechanisms in service on the switch used by a train when departing from the siding to the eastward main and on the switch departing from the siding to the westward main.

On the westward automatic signal 7695 in approach to Little Mountain, there is an "S" unit which consists of a lamp unit with a ground glass cover. Normally this unit is dark, but if the dispatcher wants a westbound train to stop and take siding at Little Mountain, he operates a lever and sends out a control that causes the lamp to be lighted in the special unit on signal 7695 so that it displays the letter "S". This directs that the train is to stop and take siding at Little Mountain. When the dispatcher is ready for that

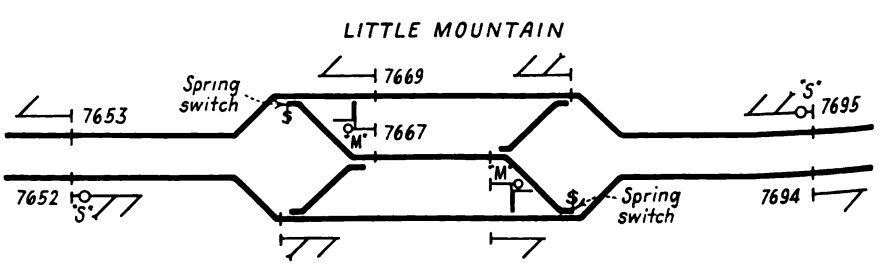


Fig. 4—Track and signal plan of Little Mountain

train to depart from the siding, he sends out a control that illuminates a unit which displays "M" on the leave-siding dwarf 7667 at the west end of the siding. This causes high signal 7669 to display "stop", and if the approach to signal 7669 is occupied then, after a properly determined time interval has elapsed, measured by a time-element relay, the leave-siding dwarf 7667 will clear, thus authorizing the train to pull out through the spring switch onto the westward main track and depart. For an eastward train the "S" unit is on eastward signal 7652 and the operation is correspondingly the same as explained above. As shown in the picture, the C.T.C. machine includes the track diagram and levers for the Little Mountain layout.

The instrument houses and cases on this project are of sheet-metal construction, and those located on or near the lake were given an extra coat of red lead inside and outside. At ordinary field stations the instrument houses are 5 ft. by 7 ft., and at special locations where extra equipment, such as carrier, is located, the houses are 6 ft. by 8 ft. or 8ft. by 10 ft. The cases at the intermediate signals are 4 ft. 11 in. long or 6 ft. 9 in. long.

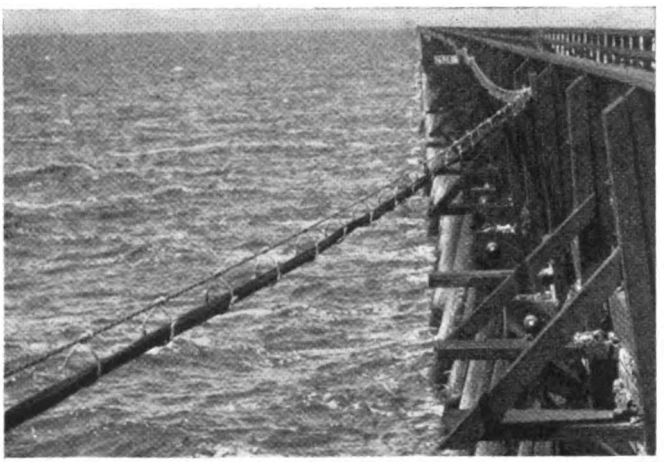
Power Supply

A single-phase 2,300 a.c. circuit extends from the east to Bridge where it is transformed down to 480 volts and is fed over two wires to the east end of Midlake. Another 2,300-volt circuit feeds from Lakeside to Tresend where it is transformed down to 480 volts to feed to the east end of Midlake. If either the supply from the east or from Lakeside fails, the other line can feed through by closing a switch at Midlake.

From Lakeside a single phase 5,500-volt 25-cycle power distribution line on two No. 6 copper wires extends west to Lucin. At the various locations the a.c. power feeds through transformers to supply the lamps and through rectifiers to charge batteries.

Each track circuit is normally fed by an RTA-104 automatic rectifier with three 500-a.h. Edison primary cells connected to take over the load if the a.c. fails, the normal discharge from the battery being about 10 m.a. At each C.T.C. field station there is a set of 12 Exide 72-a.h. storage cells, which, as a whole, feeds the power switch machine at 24 volts, and is split to feed signals at 8 volts and the code equipment at 16 volts. A separate set of 4 cells of the same kind of battery feeds the motor-car indicator circuits.

Semaphore type indicators, similar to those used on some roads as switch indicators, were installed at various locations to furnish information to men on motor-cars concerning the approach of trains. As a general rule, the indicators are located on curves or other places where a man cannot have a good view down the track to see approaching trains. The limits of control are such that having seen an indicator displaying "clear", a man traveling about 15 m.p.h. on a motor-car has plenty of time to reach the next indicator or get out on straight track where he can see train. The line controls for these indicators are No. 9 bare galvanized iron wire, formerly used for signal line controls. Separate batteries are used so that these indicator circuits are in no way connected with the signal controls except that they break through contacts in the track relays.



Automatic signal line circuits and a.c. power circuit on the trestle are in cable

Pole Line Construction

On 11.9 miles of the trestle the automatic signal line circuits and a.c. signal power circuits are in cable supported from a three-strand bronze messenger attached on the south side of the trestle. On this trestle the two C.T.C. code wires is open wires on pins and insulators on crossarms, supported by brackets on the north side of the structure. On the remaining 7 miles the water is shallow and the poles are set in the lake, the C.T.C. code line, automatic control, and power circuits being in open wires. On the lake and each side for a total of 23 miles the code line wires have special insulation to withstand the salt action. On open pole line the four automatic signal line control circuits are on No. 10 Copperweld wire with insulation and braid. The two C.T.C. code wires are No. 8 Copperweld with double braid. The two wires of the 110-volt a.c. power distribution are No. 8 bare copper.

The cables from the line poles to instrument housings are No. 14 aerial cables, ranging up to 37-conductor. The wiring in the instrument cases and houses is either No. 14 or No. 16. The underground cables are No. 14 for control circuits, No. 9 for lamp feeds, No. 6 for switch motor feeds, and No. 10 for track circuit connections. The switch control relays are located in the sheet-metal houses, so that a six-conductor No. 6 cable, as well as a 10-conductor No. 14 cable, extends to each switch machine. The underground cables have non-metallic mummy-type covering.

Thyrite type arresters are used on the code line and on the signal line circuits, one set of these arresters being located in a box on the pole under the crossarm and a second set in the instrument house or case. The arresters in the box on the pole are connected to two 5/8-in. by 6-ft. Copperweld rods. The arresters in the house or case are grounded to the rail. At ordinary locations on single track there are four track connections extending into the instrument house. Three of these are connected to arresters the same as the incoming line circuits, but the fourth track connection is attached to the ground post of all the arresters including those for the line circuits and the three other track wires. Also arresters are provided at all track cuts, the ground posts in each instance being connected to the same rail extending in the same direction. Lightning charges coming in on the line wires are dissipated to the track through several track circuits because the lightning discharges through arresters at consecutive cut section locations. Lightning which comes in on the rail, passes through the location and is dissipated on the rail beyond; rather than affecting the track relays. Southern Pacific experience proves that these results are obtained on their installations.

This installation of centralized traffic control was planned and installed by signal forces of the Southern Pacific under the direction of R. D. Moore, signal engineer. The major items of signaling equipment were furnished by the Union Switch & Signal Company.