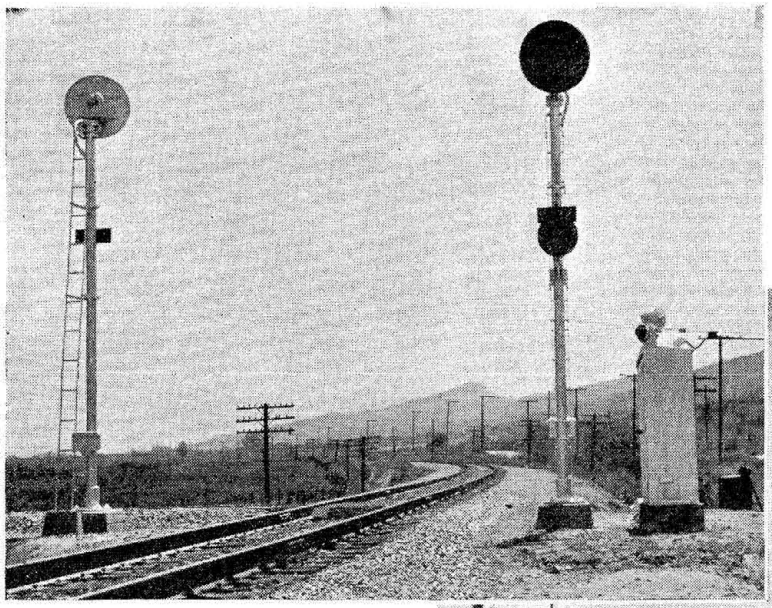
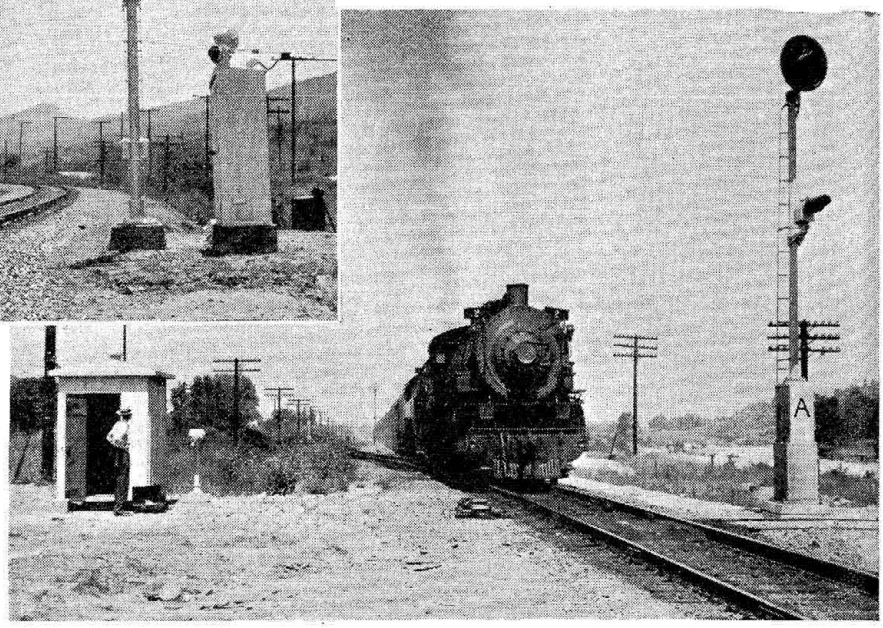
Southern Pacific





Intermediate signal with lower normally-extinguished green lamp unit. Right—Eastbound train at the east end of the Redlands siding

Project between Colton, Cal., and Indio, increases track capacity on long heavy grades where helpers are required

THE Southern Pacific has installed centralized traffic control on 72 miles of single-track main line between Colton, Cal., and Indio, Colton being 57 miles east of Los Angeles on the 2,497-mile Sunset Route between New Orleans and San Francisco.

Previously when train movements were authorized by timetable and train orders, about 100 to 125 train orders were issued daily for the Colton-Beaumont section, and about 180 train orders were issued daily for the Beaumont-Indio section. In some instances, train orders could not be issued fast enough to take advantage of changing conditions and, therefore, trains lost time needlessly. The track-occupancy lamps on the C.T.C. control machine indicate the locations of and progress being made by trains, so that the dispatcher can control the signals on a minute-to-minute basis, thereby arranging for very close meets. This factor, together with the use of power switches so that trains need not stop to enter or depart from passing tracks, saves a lot of time. A study shows that the average time of westbound freight trains has been reduced from 8 hr. 26 min. to 7 hr. 9 min., a saving of 1 hr. 15 min. The average time of eastward trains has been reduced from 7 hr. 2 min. to 5 hr. 27 min., a saving of 1 hr. 35 min. The helper locomotives which operate between Indio and Beaumont reduced the average time for each round trip from 9 hr. 28 min. to 7 hr. 56 min. The helpers which work between Colton and Beaumont reduced the average time for each round trip from 4 hr. 52 min. to 3 hr. 52 min. Therefore, these crews can now make two round trips in one trick, whereas the best they could do before was one trip.

Why the C.T.C. Was Installed

The centralized traffic control was installed on the Colton-Indio section as a means for increasing track capacity in territories where train speeds are slow on account of long heavy grades and where the number of train movements are increased by the return of helper engines to the bottom of the grades.

At Colton, the Southern Pacific interchanges freight traffic with the Union Pacific, the Atchison, Topeka & Santa Fe, and the Pacific Electric. Also the Southern Pacific has two branch lines out of Colton, and local trains operate out of Colton to the Redlands branch which connects with the main line at Bryn Mawr, 5.3 miles east of Colton. For these various reasons, many of the through freight trains set out and pick up cars at Colton.

The elevation above sea level is 943 ft. at Colton, from which point the railroad ascends a grade of about 1.5 per cent for 23 miles to Beaumont, at an elevation of 2,559 ft. East from Beaumont the railroad descends at a grade of about 1.9 per cent for 20 miles to Palm Springs, and from there to Indio about 28 miles the grade continues to descend eastward at rates varying between 0.4 and 1.8 per cent. Indio is 20 ft. below sea level and, Salton, which is 27 miles east of Indio, is 202 ft. below sea level.

Balloon Track Saves Time When Turning Helpers

In order that switching operations could be carried on at the east end of Colton yard without interfering with train movements on the main line, a yard lead tail track was extended eastward to connect with the main line at switch 109, as shown on the plan of Colton.

When the helper locomotives return light from Beaumont to Colton they are turned before returning to the yard to be made up in other trains.

Installs C.T.C. on 72 Miles of Single Track

This turning is done on a "balloon" track. When a westbound light engine approaches Colton, the dispatcher uses the C.T.C. control to reverse the east end switch No. 109 and the "balloon" track switch No. 107, so that the locomotive is routed to the balloon. The leaving end of the balloon is connected to the tail track by a spring switch so that the helper locomotive need not be stopped to return to the tail track.

A Long Siding at Loma Linda

A long siding, with a capacity of 258 cars, extends between switch 105 at Colton and switch 115 at Loma Linda, with a set of two crossovers at the middle so that trains can enter or leave at this mid-point or at the ends of the siding. The principal purpose for this Loma Linda layout is to hold westward trains when the Colton yard is not ready to accept such trains. In other instances, eastbound trains are pulled out of the yard and into this Loma Linda siding to meet a westbound train that may be slow in pulling into the yard, and, in the meantime, the eastbound train can depart from Loma Linda, whereas if it had been held in the yard it could not depart. Railroad restaurants are located at the east end of Loma Linda and at the center crossovers, so that train and engine crews can eat their meals while waiting, thereby saving time at other places on the road.

The new track arrangements at the east end of the Colton yard and at Loma Linda were planned to prevent congestion at these locations, and then thought was given next to changes required to keep trains moving on the road.

Passing Tracks Lengthened

Prior to 1941, the capacities of the passing tracks ranged from 65 to 78 cars, and, therefore, the first phase of the program to get more traffic over this division was to lengthen these passing tracks to hold longer trains. As a general rule they were lengthened to about 6,450 ft., which provides capacity for a train of 100 cars including a caboose and three locomotives with an allowance of 10 car lengths extra for train stopping distance.

Between Loma Linda and Beaumont there are six single passing tracks, at Redlands, Ordway, El Casco, Hinda and Nicklin. At Beaumont a special track arrangement is provided, as shown in the diagram, so that the helper locomotives can be cut off of the trains and at the same time other trains can pass.

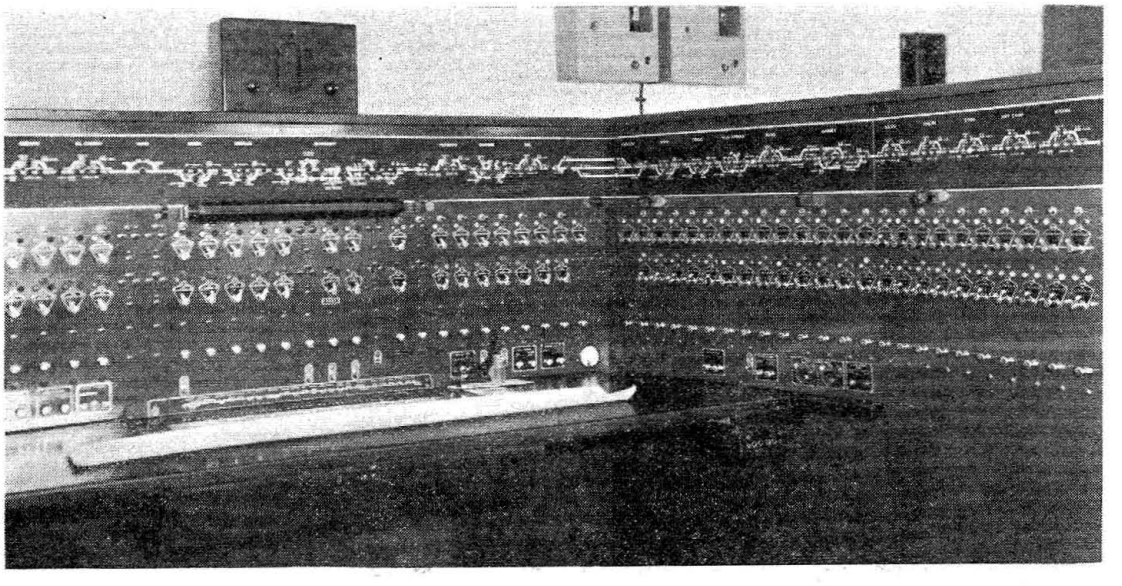
On the east side of the grade between Beaumont and Indio, there are 13 passing track layouts, all of which are single except at Cabanzon and at Garnet where there are two sidings, one on each side of the main track. The extra siding at Cabanzon is provided at this location because eastbound freight trains are required to stop here for approximately 10 minutes to allow the wheels and brake shoes to cool, as well as to permit time for trainmen to inspect the train.

The maximum permissible speed is 60 m.p.h. for passenger trains, and 40 m.p.h. for freight trains. On account of the grades and curvature in the Redlands canyon on 15.7 miles between Redlands and Beaumont, the speed of passenger trains is limited to a maximum of 40 m.p.h and freight trains to 35 m.p.h. eastward and 25 m.p.h. westward. Between Beaumont and Garnet, 26 miles, the speed of passenger trains is limited to 40 m.p.h., and freight trains to 20 m.p.h. eastward and 35 m.p.h. westward.

Volume of Traffic Increased

As the war program developed, a large volume of both passenger and freight traffic was thrown on to this section of railroad. The schedules include 5 passenger trains each way daily, and on the average there are 3 to 5 extra passenger trains each way daily. The number of through freight trains varies from 7 to 8 each way daily. On the average the number of train movements, including light engines, totals from 50 to 60 daily.

The through passenger trains are operated largely by Class-GS locomotives which have a tonnage rating of 2,000 tons eastward between Colton and Beaumont, and 1,925 tons westward between Indio and Beaumont. If a passenger train has more than



The C.T.C. control machine is in the office at Beaumont

10 cars, which is the case in practically all instances these days, a helper locomotive is required for each train.

A considerable number of the locomotive used on through freight trains are the Class AC, rated at 2,125 tons eastward from Colton to Beaumont, and at 2,050 tons westward from Indio to Beaumont. As a general rule, each eastbound freight train is made up at Colton with about 4,000 tons or a maximum of 99 cars, using three locomotives, one at the head end, one two-thirds of the way in the train and the third at the rear ahead of the caboose. On arrival at Beaumont, the crest of the grade from either direction, the trains are stopped while the helper locomotives are cut out, and the train then proceeds eastward to Indio with only the one road locomotive. Similarly, helper locomotives are used on westbound trains between Indio and Beaumont, and then a single locomotive can handle the train from Beaumont west to Los Angeles.

diverging train movements can be made at speeds up to 25 m.p.h. which is not much less than the maximum freight-train speed on the main line on much of this territory.

The passing tracks are equipped with track circuits. When a power switch is reversed and a station-entering signal, such as signal 11 in Fig. 2, is clear for a train to enter, the aspect is Red-over-Green, to enter a passing track which is not occupied; or Red-over-Yellow, to follow a leading train which is occupying the passing track. If the dispatcher wants a train to enter a passing track which is occupied by an opposing train, the signal displays the Red-over-Red aspect and the head brakeman or conductor goes to the telephone so that the dispatcher can explain the special circumstances.

If the sighting distance to a station-entering signal, such as signal 11, is adequate, the signal in approach displays the single yellow, Approach, aspect, as advance information when the station-entering signal is displaying the red-over-red, the red-over-green, or the red-over-yellow aspect. However, if the sighting distance to a station entering signal, such as signal 11, is short, an engineman would have to approach it prepared to stop if he got only a yellow on signal 10. In such instances, when signal 10 is cleared to display red-over-green to enter a non-occupied passing track, then signal 10 displays yellow-over-green. This gives an engineman advance information so that he can run his train up to and through the turnout at 25 m.p.h., thus saving time.

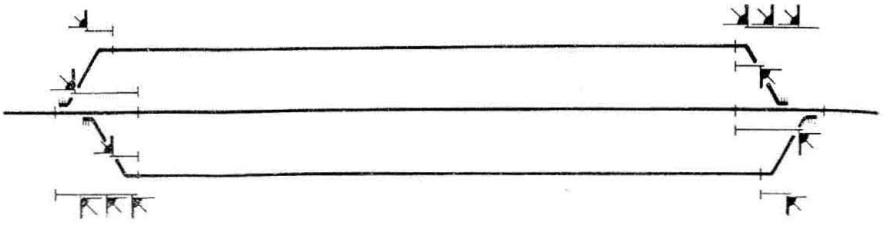


Fig. 1—Track and signal plan of double siding layout at Cabanzon

No Red With a Green

A special practice on the Southern Pacific is that on a two-unit signal, such as station-entering signal 5, if the line up is for a through move on the main line with a green aspect in the top unit, then the lamp in the lower unit is not lighted, this being different from the conventional practice of a red light also in the lower unit. The thought on the Southern Pacific is that a clear aspect should not include a red light because an engineman might see this red light before he saw the green and thus cause confusion in his mind. Thus on the Southern Pacific, the lamp in the lower unit is lighted in combination with that in the top unit only when a diverging route is set up, or as a red under a red for the absolute stop aspect. The lower unit will display red in the event the mechanism of the top unit is in the proceed or caution position and its light is out.

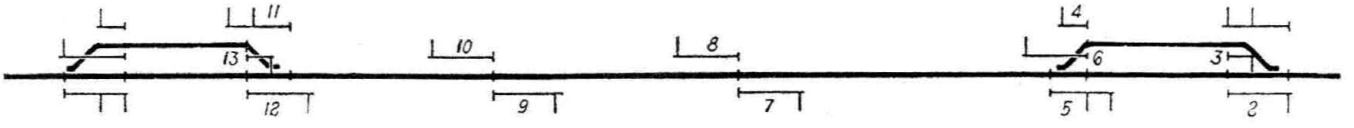


Fig. 2—Typical layout of tracks and signals

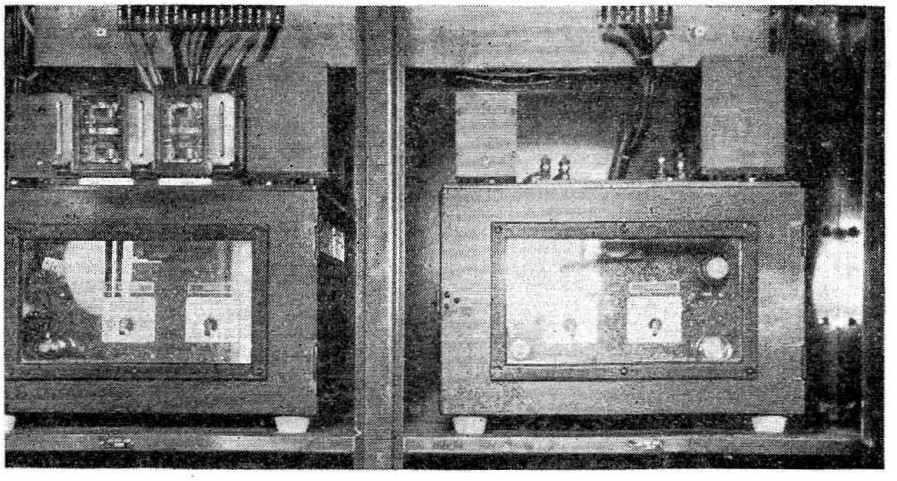
Prior to the recent improvement program, this territory had been equipped for many years with lower-quadrant two-position automatic block signals controlled by overlap circuits. This signaling was removed, all of the signals in the new installation being of the searchlight type. Likewise most of the relays, line wire and pole line are new, so that as a matter of fact, it is practically a new installation.

Special Signal Aspects Save Train Time

The turnouts at the ends of the passing tracks are either No. 12 or No. 14 with 24-ft. points, so that

D-C. Neutral Track Circuits

The track circuits are of the d-c. neutral type using DN-11 neutral relays rated at 4 ohms. The maximum track circuit length is 4,500 ft. The length of main track opposite a siding is cut into two track circuits, and each



The C.T.C. coded carrier equipment in the case in the office at Beaumont

The switch layouts are equipped with heavy insulated gage plates and adjustable rail braces

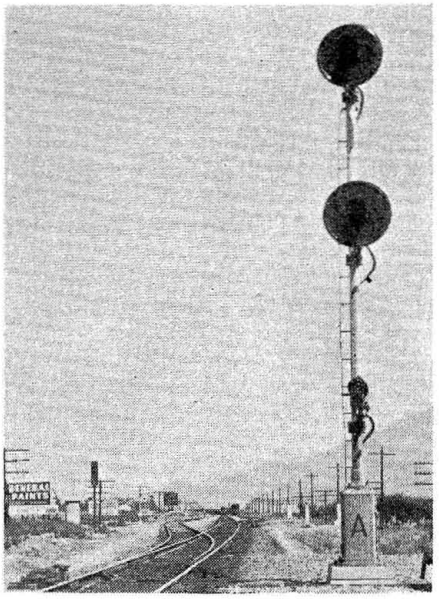
passing track is cut into two track circuits, except where unfavorable ballast conditions prevail, the sidings are cut into three track circuits.

On these sections of main line, as well as on the passing tracks, the track relays are on the ends of the circuits toward the switches. The purpose for this track circuit arrangement is to provide a "two-track-circuit" release of the locking. A train must occupy the OS switch detector track circuit, then occupy the next proceeding track circuit, before the locking is released. The switch is, of course, always locked when the OS track section is occupied. This procedure prevents operation of the switch if the OS circuit should be inadvertently shunted and a switch control sent out which, under some other methods of control, may release the locking with a train approaching and permit the switch to be operated.

On each turnout, a series connected fouling circuit is used so that a check is made for broken rail or open bonding. The connections are such that if any of the four insulated joints in the turnout fail, the battery will be shorted, thus causing the relay to be released.

Line Control Circuits

The local signal control relays are the polar Type DP-17 polar rated at 110 ohms. A separate two-wire normally-energized line circuit is used for the controls of signals for each direction. Each line circuit checks through contacts of the track circuits in its respective automatic block. The conventional arrangement of absolute permissive block stick relays provide for the clearing of intermediate signals for a following train. These A.P.B. circuits also include the absolute control of opposing station-leaving signals for a station-to-station block between passing tracks. If a station-leaving signal is cleared, energy it cut off of the line circuits for all opposing intermediate signals as well as the opposing station-leaving semi-automatic signal. Thus if one station-leaving semi-automatic signal has been cleared, the opposing station-leaving semi-automatic signal cannot be cleared, regardless of whether a control code is sent out from the office. Thus the established route and traffic direction is automatically retained. Furthermore, the line controls of opposing station-leaving signals are taken through relays controlled by the approach locking so that if a Proceed aspect of a station-leaving signal is "taken away," the line control circuit of the opposing station-leaving signal is not closed until the expiration of the time release period. Thus, with the two two-wire signal line control circuits, the route and direction are retained and, furthermore, compliance with Item 412 of the I.C.C. Rules, Standards and Instructions is accomplished automatically, without interconnections and extra relays in the control machine.



Signal at Cabanzon double siding

Signal Line Circuits Used in the Approach Locking Controls

Automatic approach locking is provided, the control of which is extending through contacts of the H relay of the signal for the reverse direction, and the control of this relay, for an opposing train movement extends from one passing track to the next. Thus the signal line control serves also in the approach locking without extra line circuits for the locking. If a signal at the next siding has been cleared, or if that signal has been accepted and passed by a train, the signal or switch, if the signal has been cleared at the given passing track, cannot be changed or operated until a delay period has expired, this period being determined by the operation of a DT-10 time relay.

Signal Protection at Hand-Throw Turnouts

At the main-line turnouts which are not equipped with power switch machines, but which are operated by hand-throw stands, a high dwarf signal is located opposite the clearance point to govern moves to the main line, and the switch is equipped with an electric lock. Also a hand-throw derail is in service at the fouling point on the turnout. A telephone is provided at each of these locations so that the conductor of a train on the siding can inform the dispatcher when the train is ready to depart. Also this telephone is used for the dispatcher to inform the conductor when the dispatcher sends out a C.T.C. line code control to act as a part in effecting a release of the electric lock on the main-line switch.

Providing the dispatcher has not sent out controls to clear either of the semi-automatic signals admitting trains to the section including the hand-throw switch, the two two-wire line control circuits between passing tracks are normally energized.

Referring to Fig. 3, the electric lock 3415WL is located in the block of eastward signal 3414 and westward signals 34La and 34Lb. For this reason, the line controls for these signals

are also used for the control of the electric switch lock 3415 WL and signal 3415 on the turnout, through the medium of relays 3415 WAR and 3415 EAR. Thus these relays check the opposing signals at stop and their respective approach locking relays, 32RMR and 34LMR, in their energized position, as well as track occupancy within the block. The dispatcher's control of this electric lock is through code controlled relay WLSR and its repeater 3415WLSPR.

For a Move from the Siding, Block Unoccupied

For a move from the siding to the main track, past signal 3415, with signals 32Ra, 32Rb, 34La and 34Lb displaying Stop aspects. the operation is as follows:

The dispatcher, upon telephone request from the conductor, would give permission and send a code to reverse relay WLSR (sheet 5).

With the door push button contact closed by the opening of the electric lock door, relay 3415WLSPR would be energized, opening the circuit for the 3415NWPR (sheet 5B), which in turn opens the line controls to de-energize relays 3414HR and 34LHR (sheet 5). A front contact of 3415WLSPR closes the circuit for 3415WAR. Relay 3415EAR is energized through a front contact in 3415WAR (sheet 5).

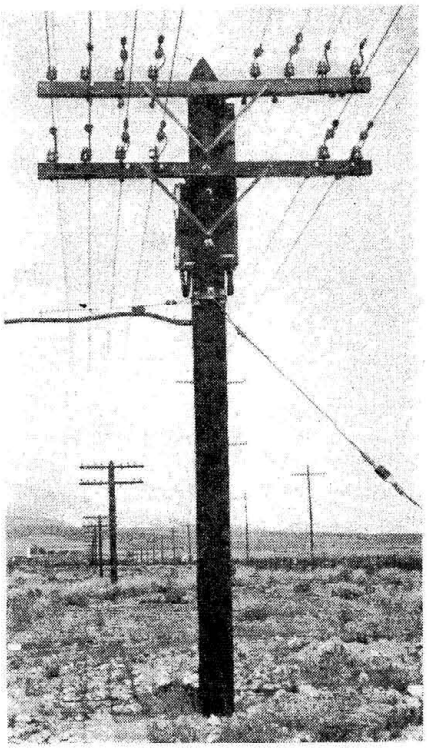
On sheet 5B, the relay 3415TESR is energized through front contacts of 3415WLSPR and 3415EAR. This closes the last contact in the circuit of the lock coil 3415WL, which is energized through front contacts of 3415WLSPR, back contact of 3415 TER, front contacts of 3415TESR and the door push button.

On sheet 5B, when both switch and derail are reversed by hand, signal armature 3415G is energized through back contacts of 3415NWPR, front contacts of 3415WAR and 3415EAR, through reverse contacts of switch circuit controllers SW (switch) and DER (derail).

Signal light 3415E is controlled through a back contact in 3415LTR which is de-energized when the switch is unlocked or when the switch or derail is reversed.

Move from Siding with Block Occupied

Should the same move be desired while the block between opposing "A" signals is occupied, the procedure is the same except that 3415TESR will not pick up immediately because the circuits of 3415WAR and/or 3415 EAR will be open. A long time interval is thus introduced into the circuit of 3415TESR, after which it can be energized through the front contacts of (DT-10) relay 3415TEIR. This relay is energized from a back contact of 3415TESR, which controls a stick circuit of that relay so that when



View of new pole line

3415TESR picks up it removes energy from 3415TEIR. This energy is controlled over a front contact of 3415WLSPR. From this point on the operation is the same as before. The long time interval is predetermined according to the distance between the opposing "A" signals and the electric lock.

From Main Line to Siding

For a move from the main track to the siding, over switch 3415 reversed, the circuits function in a similar manner, except with the 300-ft. track circuit occupied, a short time interval is introduced to pick up 3415TESR through the front contacts of relay 3415TER. However, when 3415 TESR is energized, the circuit for 3415WL is held open by the check contact of 3415TER, which will close at the end of the cooling time of that relay which is thermal type.

The energy for 3415TER is received from a back contact of 3415 TESR, which controls a second stick circuit of that relay so that when 3415TESR picks up, it removes energy from 3415TER. The source of this energy is over a back contact of 3414ATR. From the circuits it will be noted that the short time interval will start to operate without code being initiated, but the lock will not release until code has been initiated.

Opening the electric lock door will not cause 3415NWP to open the line circuits unless the dispatcher has coded WLSR to reverse. Through 3415NWPR, the line controls of 3414HR, 3414bHR and 34LHR have a definite check on the latch and normal contacts of the electric lock, switch circuit cotrollers SW and DER, 3415TESR, 3415WLSPR and 3415TEIR.

A sealed emergency manual release is also provided on each lock, which when operated to release the lock will continue to hold the opposing "A" signals at stop until emergency release has been reset and sealed.

To Follow a Main-Line Train

If the train on the turnout had been waiting for a train on the main line to pass, the signal on the turnout can be cleared to display the yellow aspect after the through train has passed beyond the first automatic signal, or to display the green aspect after the receding train has passed beyond the second automatic signal. In this instance, the feed back over the line circuit is made complete by the A.P.B. directional stick features, so that the signal on the turnout can be cleared when a "receding" train is occupying the station-to-station block.

A fact which may well be emphasized is that by using a separate two-wire signal line control circuit for each direction, these same line wires serve also for approach lock circuits as well as for controls of electric locks and signals governing moves from hand-throw turnouts to the main line.

New Pole Line Construction

The previous automatic block signaling included d-c. neutral track circuits and d-c. neutral two-wire line control circuits, one such line circuit being for eastward signals and a second circuit for westward signals. These line circuits were on bare No. 9 galvanized iron wire and were on a single arm on an old pole line of light construction with long spacing between poles. In view of the fact that this old pole line was in need of extensive rebuilding and was not adaptable for the new requirements, an entirely new pole line was built throughout the C.T.C. territory. This new line was built with creosoted fir poles 20 to 25 ft. high, and 8 in. minimum at the top, spaced 150 ft., i.e., 35 to the mile. Ten-pin creosoted crossarms are used, and in order to save metal the pins are made of wood.

On the new pole line, the two new wires for the C.T.C. line code are No. 10 Copperweld with weather-proof covering. The two two-wire circuits for the automatic controls of signals are on new No. 9 galvanized iron wire with weather-proof covering. The same kind of line wire is used for the line circuits required for approach locking, and RGPR controls which extend beyond C.T.C. limits. All these circuits are of the two-wire type, no wire being common to any two circuits. The new a-c. power distribution circuit is on two No. 8 bare copper wires at 240 volts, except on 6 miles between Salvia and Edom where the circuit is 460 volts on No. 4 wire. The old No. 9 bare galvanized iron wire, previously in service for signal controls, was reused in the line circuits for the control of wayside motor car indicators, track occupancy, and also for line circuits in the controls of highway crossing signals.

One C.T.C. Control Machine

The entire territory from Colton to Indio, 72.3 miles, is controlled by one C.T.C. machine in an office at Beaumont which is 23 miles from Colton and 49.3 miles from Indio. A new one-story building of fireproof concrete construction was built to include separate rooms, one for the control machine, one for certain operating officers and one for repairing and housing coders, relays, etc.

The new control machine was located at Beaumont because this is the top of the grade from both directions and, therefore, all trains stop here to cut out helpers. The C.T.C. machine is made up of five panel sections arranged in a "U" shape so that the dispatcher can reach any of the levers without leaving his chair. The control machine has the conventional arrangement of switch and signal levers with indication lamps. The maintainer's

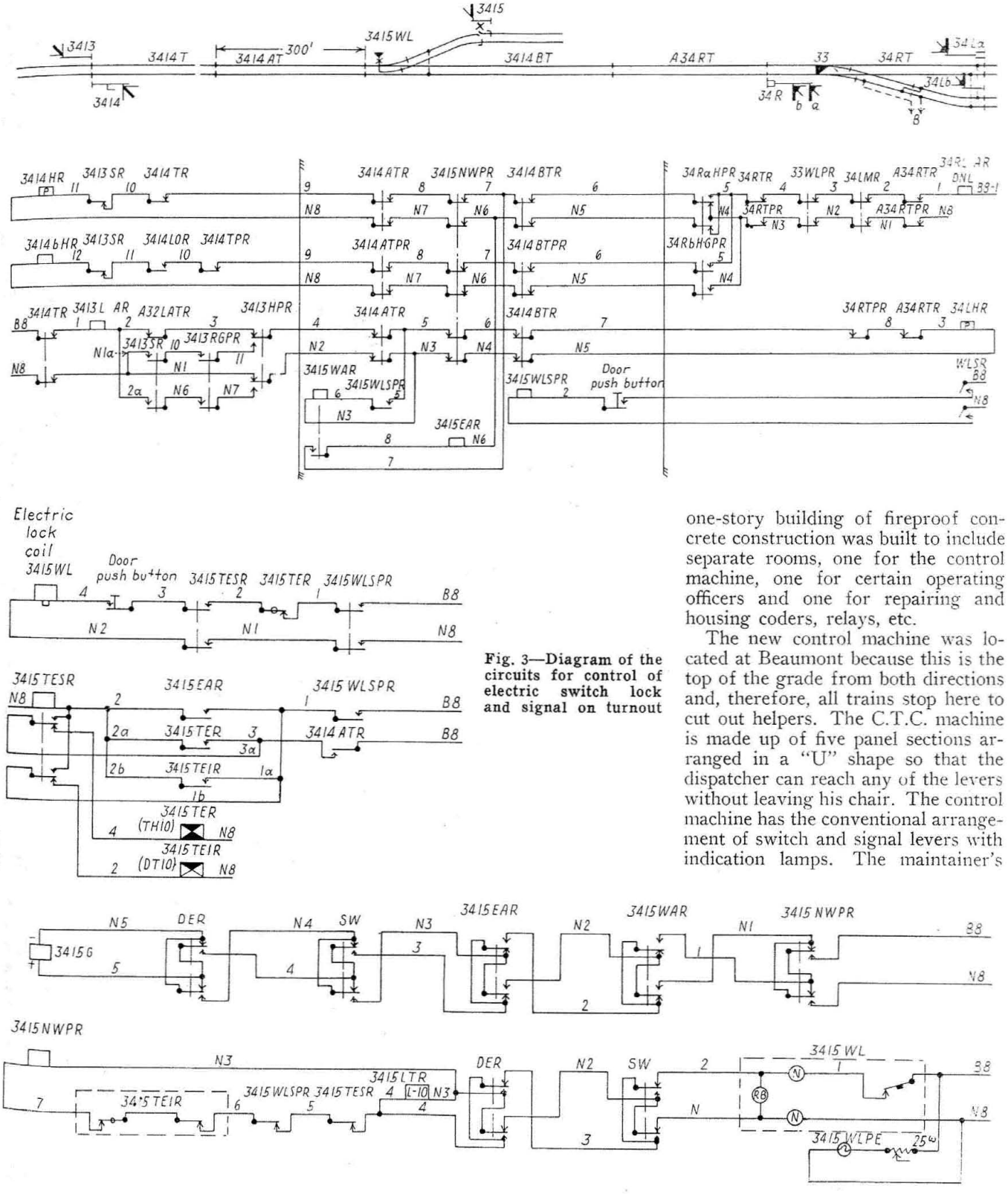
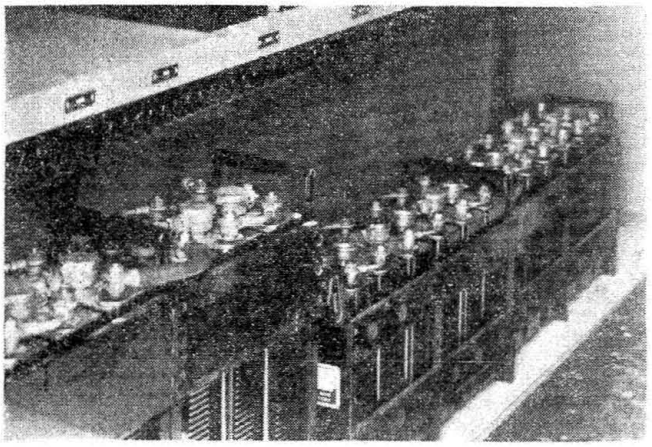


Fig. 3—Diagram of the circuits for control of electric switch lock and signal on turnout



Storage batteries in the sheet-metal house at a typical C.T.C. field station

call lamps at the various field stations are controlled by toggle switches which are mounted above the switch and signal levers.

On the illuminated track diagram, there is a track-occupancy lamp for (1) each OS section at a switch, (2) each section of main track opposite a siding, (3) each siding, (4) and each section of main line between sidings. The desk portion of the machine includes an automatic train graph with 52 pens, each of which records train movements at the corresponding power switch location in the field. Each morning the graph sheet is torn off on the line representing the previous midnight. A separate short form is used to record the names of the enginemen and conductors, as well as the tonnage, loads, empties, etc., and this form is pasted to the section of graph for the corresponding day, which then consists of the official record of train movements.

The C.T.C. controls are sent out from the office to the field stations and indications are returned by the Union Switch & Signal Company multiple time code system, multiple application, using only two line wires throughout the territory. This project includes three separate arrangements of time code sending and receiving equipment, each with a capacity to handle a maximum of 35 field stations. The control and indications for the 23-mile section between Colton and Beaumont are handled by conventional d-c. codes. Also the controls and indications for the 20.6-mile Beaumont-Palm Springs section are handled by conventional d-c. codes on two line wires. Also on this Beaumont-Palm Springs section, the same two line wires also carry coded 12 kilocycle frequency, which is transmitted to Palm Springs where it is converted to conventional d-c. codes, which are transmitted to the local field stations on the 28.7 miles between Palm Springs and Indio for the control of signals and switches. Likewise, from these field stations, d-c. indication codes are transmitted to Palm Springs where they are converted to 18 kilocycle carrier current for transmission to Beaumont.

At the office and at the field stations, filters are provided to prevent interference between the d-c. codes and the high frequency codes. For this reason, controls to/or indications from the Beaumont-Palm Springs section can be handled independently of and simultaneously with those for the Palm Springs-Indio section. A detailed explanation of the coded carrier system, including diagrams of typical circuits, was given on page 314 of the June, 1944, issue of *Railway Signaling*.

Power Switches Well Built

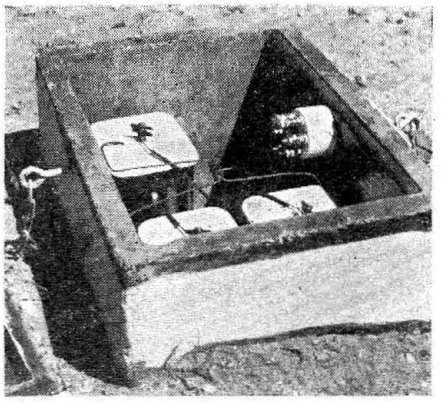
As a part of the C.T.C. project, Type M-22A dual-control low-voltage d-c. switch machines were installed at the passing track switches, at the two crossovers at Loma Linda and at the crossovers at Beaumont. As a reminder to trainmen, the selector lever as viewed from the top when in the normal position is painted white, but the other side is painted red.

At each power switch, three 1-in. by 9-in. insulated gage plates were installed with Racor adjustable rail braces. Two of these plates extend out under the switch machine which fits snugly between two toe plates, thus lost motion between the machine and the rails is prevented. The toe plates and the riser plates at the rails are welded in place on the plates. As shown in the view, the ties are daped so that the base of the machine is 4½ in. below the base of rail, and the highest part of the machine is 2 3/16 in. above the top of the rail where the rail is 7 5/16 in. high.

The turnouts are No. 12 and No. 14, with 24-ft. points. In order to facilitate operation by minimizing friction, each set of switch points is equipped with a set of two roller bearings which normally support the points free of the slide plates. The weight of cars or locomotives works against spring action to push the points down on the slide plates. Furthermore, a solution of oil and powered graphite is applied to the plates as a lubricant. This solution resists weathering, and will not accumulate dust and sand as badly as heavy oils or greases.

Motor Car Indicators

On account of the numerous train movements and the short sighting distances, indicators, which show whether a train is approaching, were installed at numerous points on this territory so that track forces, maintainers and others using motor cars can know when they can proceed with safety. These indicators are similar in construction and appearance to those ordinarily used as switch indicators on some roads. The locations and the spacings of the indicators are based on the practice that having seen an indicator displaying clear, a man on a motor car has time to proceed at about 15 m.p.h. to the next indicator and set his car off the track before any train traveling at maximum speed might arrive. When the track within the limits of control is not occupied, the corresponding indicator is normally energized to display Clear. Thus the operator of a motor car is not required to stop to push a button before gaining the information.



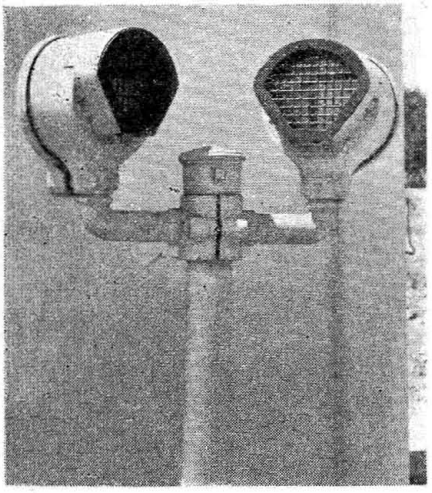
Primary battery on track circuits

In view of the fact that new wire with the weather-proof covering was installed for all signal control circuits as a part of the new C.T.C. project, the old bare iron wire, previously used for the line controls of the old semaphore signaling, was available for the controls of the track car indicators. The line controls for the indicators and track occupancy are extended through front contacts of the relays of track circuits. Where it was possible, the track-occupancy control circuits extending between sidings, as well as those extending through the

sidings for both main and siding indications, were equipped with two 250-ohm series line relays, one on each end, and used for the control of the wayside track car indicators. One line wire is used as common, and the number of control line wires at a given place on the pole line depends on the distance over which the controls of various indicators must extend. Except for special condition, a total of not more than four line wires are required. An important point is that this indicator system is separate and distinct from the automatic block or C.T.C. systems, separate batteries being used to feed the indicator line circuits so that line crosses or grounds cannot affect signaling circuits.

Power Supply

At the various switch and signal locations, the 110 or 220-volt a-c. circuit is extended to a W-10 transformer and and ANL-30 power-off unit in the instrument housing. At each power switch, a set of 18 cells of Edison B4H storage battery is provided. Six of these cells, charged by an RT42 rectifier, are used for feeding signal control circuits and as reserve



Motor car indicators

for signal lighting, and the other 12 cells feed code equipment. The 18 cells in series supply energy to operate the power switch machines.

At each intermediate signal location, a set of 6 cells of the B4H type are used to feed control circuits and as reserve for lamps. Each track circuit is fed by three cells of Edison 500-a.h. primary battery, connected in multiple. At the control station the code line "A", west to Colton, is fed by a set of 74 cells of Edison N2 type battery, and code line "B", east to Palm Springs, is fed by a set of 69 cells of Edison N2 type battery and a set of 12 cells of Edison A4H type battery feed the coding equipment. This battery also provides stand-by service for the model board lamps in the event of a power outage. Stand-by service is also provided for the Telechron motor operating the train graph, which normally is connected to the commercial power supply. In the event of a power outage, a DN-11P relay, connected to the low voltage side of a transformer, is deenergized, which, through back contacts, closes the circuit for a tuned alternator. This alternator is similar to equipment used for stand-by service in coded track circuits, operates from 16-volts d-c. and delivers 110-volts a-c. to the train-graph motor.

Insulated Wires and Cables

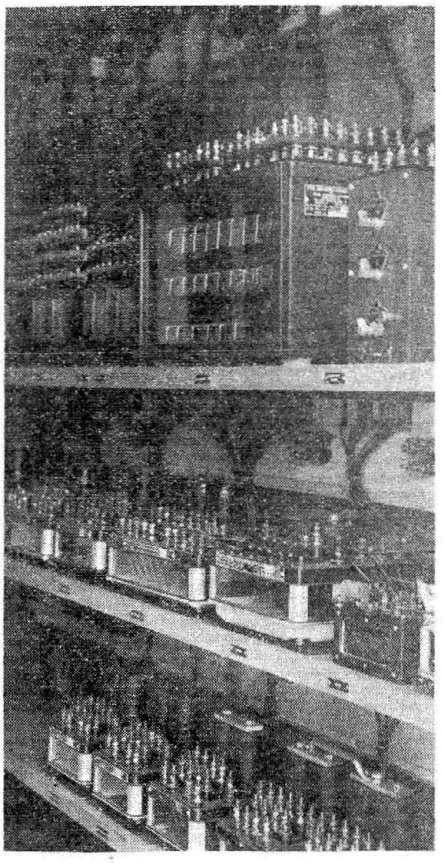
The drops from the line poles to the instrument housings are in multiple-conductor No. 14 aerial cable ranging up to 37-conductor. The insulated wiring in the instrument housings is either No. 14 or No. 16. The underground cable is No. 14 for controls, No. 9 for signal lamp circuits, No. 6 for switch feeds and No. 10 for track circuit connections to the track. 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 protective coverings and were furnished by the Kerite Insulated Wire & Cable Company.

Lightning Protection

Thyrite-type arresters made by the General Electric Company are used on the code line and on the signal line circuits, one set of these arresters being located in the instrument housing and another set in a box on the pole under the crossarm. The special purpose of the arresters on the pole is to drain off static and provide protection to the drop cables from lightning surges.

Ground connection for the arresters in the instrument houses is obtained by connecting to one of the track leads. Normally there are four tracks leads entering the instrument house; three of these leads are also connected to Thyrite lightning arresters, and the fourth lead is connected to the ground post of all lightning arresters, including the three for track leads.

By providing lightning arresters at all track cuts and always using the track lead that connects to a certain rail and extending in the same direction, the rail actually becomes a condenser of large capacity, since a charge will continue to dissipate through several track circuits by discharging through a lightning arrester at each consecutive track cut. With this arrangement, lightning coming in on the rails from either direction is influenced to pass through the location and be dissipated on the rail beyond, rather than affecting the track relays. Experience on the Southern Pacific has proved that this arrangement is effective. General Electric Company pellet-type arresters are used on the 220-volt a-c. power distribution circuit.



Relays at a field station

Two Copperweld ground rods, 5/8-in. by 6-ft., are driven at the line pole and one such rod is driven at the instrument housing at each C.T.C. code location. The rod at each code location is used to ground the lightning arresters on the combination code line and dispatcher's line, since it was considered desirable to avoid connecting the ground for the dispatcher's phone circuit to the rail ground connection used for the other circuits. A 9/32-in. hole is drilled through the rod, 1 in. from the top, the ground wire being connected to the rod by driving a channel pin in this hole.

This installation of centralized traffic control was planned and installed by the 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.