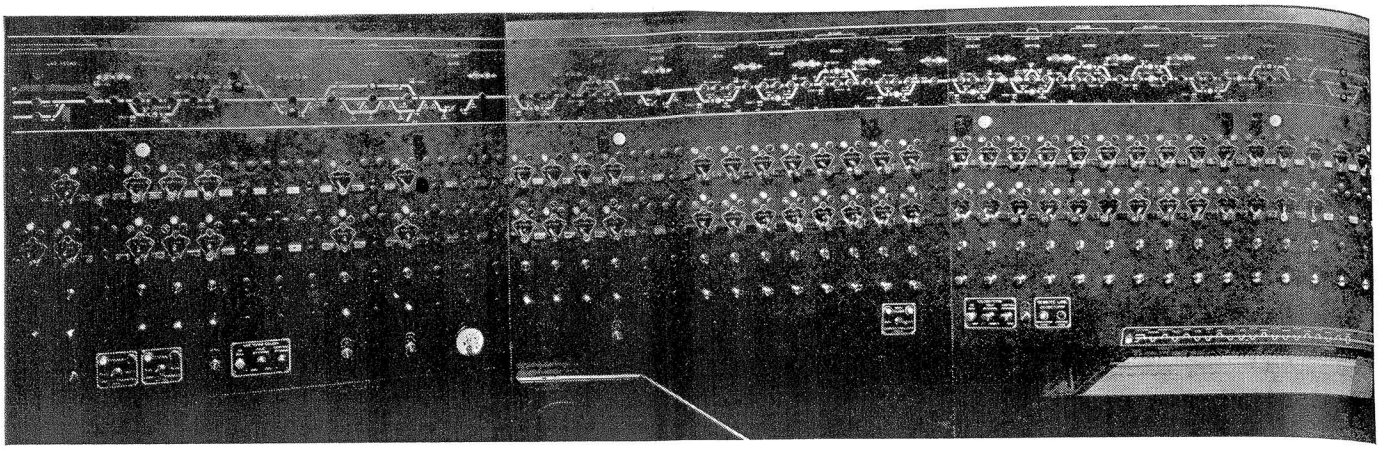
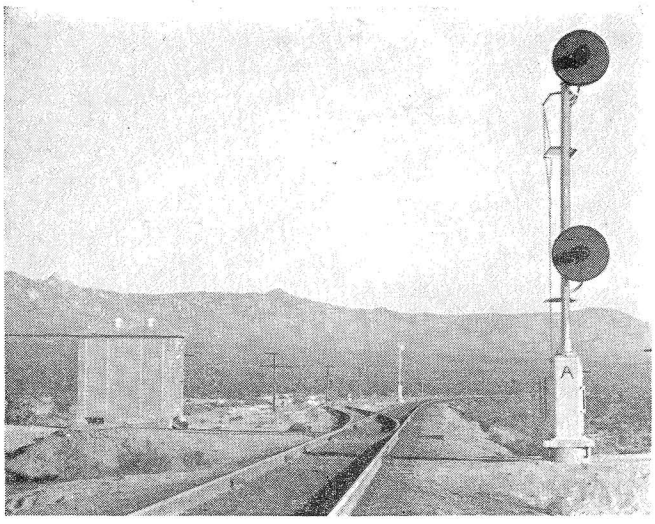


A composite view of the five sections of the C.T.C. panels, totaling 15 ft., which

Union Pacific Installs C.T.C. on 175 Miles of Single Track

On June 16, the Union Pacific completed the last section of a centralized traffic control project on 175.6 miles of single-track main line between Daggett, Cal., and Las Vegas, Nev., on the route between Los Angeles, Cal., and Salt Lake City, Utah. The first operating sub-division extends between Los Angeles and Yermo, Cal., which is 4.6 miles east of Daggett, so that the new C.T.C. territory includes 4.6 miles of the first sub-division, as well as the entire 171 miles of the second sub-division between Yermo and Las Vegas.

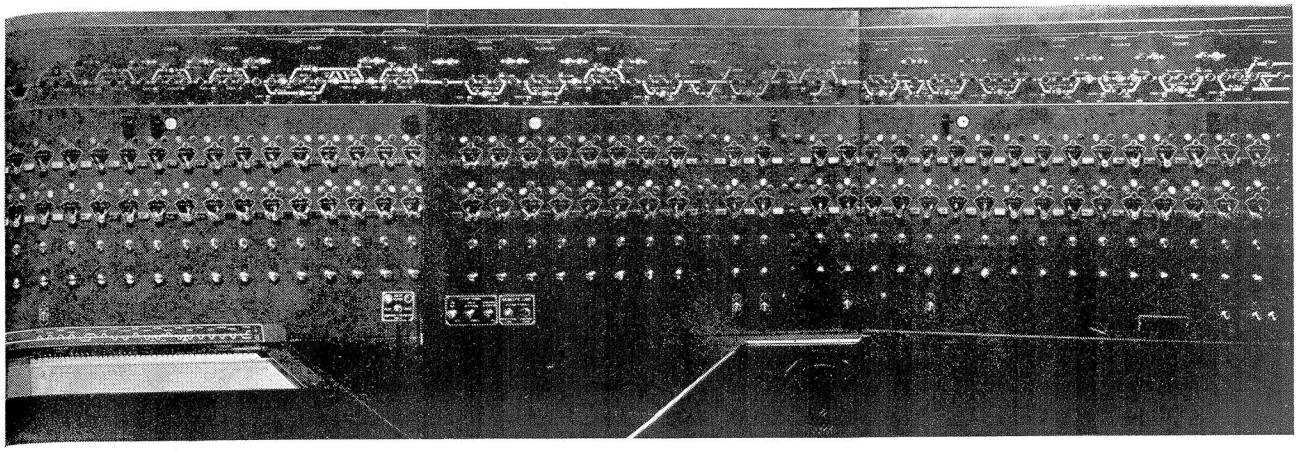
The line is single track for the entire 625.4 miles between Daggett and Salt Lake City, but the section between Yermo and Las Vegas was chosen to be equipped with centralized traffic control because of the long heavy grades which necessitate slow train speeds and reduce track capacity. The country is mountainous desert. On the 171 miles there are only about 7 miles of level track, this being in nine short sections. The grades range up to 1 per cent on approximately 65 miles, and are 1 per cent on approximately 80 miles. Helper locomotives are required on 18 miles of 2.2 per cent ascending grade eastbound between Kelso and Cima. Elsewhere the grades in either direction do not exceed 1 per cent, the tonnage ratings for locomotives being based accordingly. In order to expedite important westbound traffic, helpers are used on some westward trains between Las Vegas and Cima, or on the 20 miles of 1 per cent ascending grade between Desert and Cima.



Power switch and semi-automatic signal layout at east end of Chase siding is typical

The heavy curvature is mostly located on the 1.0 per cent grade between Bard and Erie, there being five 5-deg. curves and four 6-deg. curves, as well as one 3-deg., two 2-deg., three 1-deg., and one 1-deg. 15 min. curves in this 11 miles. Between M.P. 189 and 194 there are three 3-deg., two 4-deg. and two 5-deg. curves. On the remainder of the sub-division the curvature is comparatively light, exceeding 1 deg. in only a few instances. The 18 miles of 2.2 per cent grade between Kelso and Cima is on a sloping floor of a desert valley, and includes nine 30-min., six 1-deg. and two 2-deg. curves.

Between the yards at Las Vegas and at Yermo there are 38 station layouts which include passing sidings for trains, all single sidings except two sidings, one on each side of the main line, at Cima which is the summit of the heavy grades, and two sidings at Kelso which are normally used for the passing of trains, in addition to other



are set in a "U" shape to form one machine to control the entire 175-mile territory

sidings used to set out or pick up cars when adjusting tonnage. For many years, train movements on this sub-division have been authorized by time table and train orders, automatic block signal protection having been installed in 1927.

The locomotives are assigned to the division as a whole, and are operated through in either direction between Los Angeles and Caliente, Nev. At present, the assignments include about 30 locomotives of the 4-6-6-4 type, and about 30 locomotives of the 2-10-2 type. The mallet locomotives handle from 2,300 to 2,900 tons, and the 2-10-2 locomotives handle about 1,800 tons on the long 1 per cent grades. Helpers are used on all trains when ascending the 2.2 per cent grade.

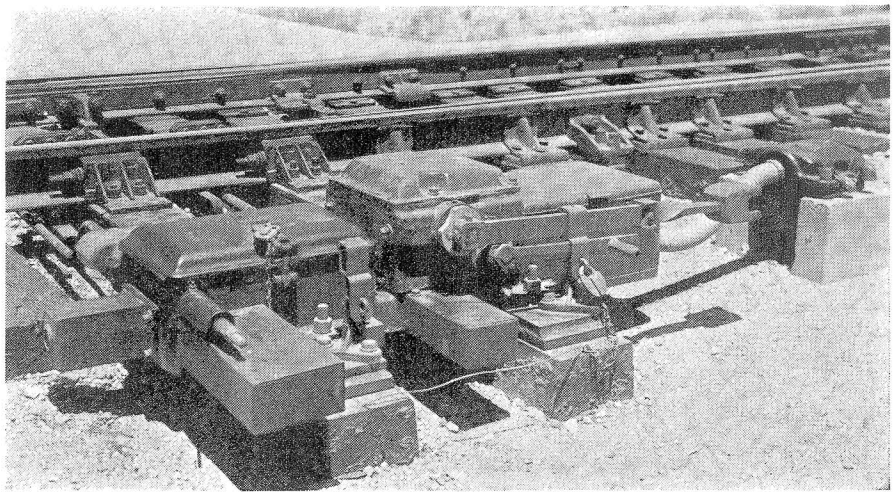
Longest continuous C.T.C. project includes entire operating sub-division which is controlled by one C.T.C. machine located at one end, and made possible by use of carrier current to cut C.T.C. line codes into three separate operating sections

From Normal to War-Time Traffic

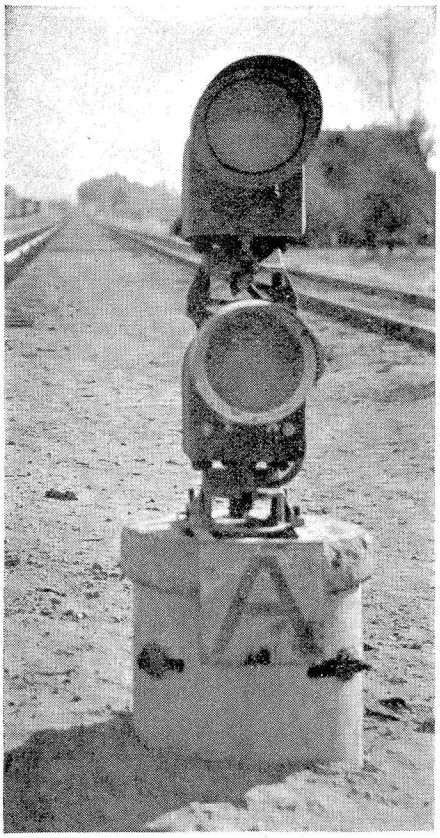
Prior to the war, the traffic on this sub-division included three passenger trains each way daily in addition to a streamliner passenger train each way every third day, and the schedules called for three freight trains eastward and four westward daily. During 1941 and 1942, freight traffic increased, not only in volume but also in urgency for delivery. In a typical seven-day period in June, 1942, the freight tonnage moving eastbound averaged 15,026 tons daily, involving 212 loaded and 131 empty cars, and 6.7 trains daily. During the same period, the westbound traffic averaged 12,122 tons daily, involving 203 loaded and 59 empty cars, and 6.9 trains. In other words, by June, 1942, the volume of passenger as well as freight traffic, measured in cars, tonnage or trains, was approximately 50 per cent above normal. Delays were becoming so serious that corrective measures had to be taken, and it was decided, therefore, to install centralized traffic control.

This construction program was adopted none too soon, because traffic continued to increase during the last half of 1942 and the first half of 1943. During a typical seven-day period in June, 1943, the freight traffic eastbound averaged was 193 loads and 301 empty cars, totaling 17,796 tons daily, requiring 7.2 trains. During the same period the westbound traffic averaged 23,011 tons daily, consisting of 395 loads and 70 empty cars and requiring an average of 9.6 trains. An important point is that between June, 1942, and June, 1943, the number of loaded cars westbound increased 95 per cent, and the number of empty cars eastbound increased 130 per cent. Likewise passenger traffic increased rapidly, the Challenger trains being run in two sections in each direction daily, while in numerous instances the Pacific Limited is also operated in two sections. Furthermore, on two or more days each week, from four to six extra trains are operated for troops and equipment.

During the last six months of 1942, the train operations on this sub-division were approaching the stage of congestion. With constantly increasing traffic and numbers of trains, the dispatchers could not issue train orders fast enough to keep the trains moving. As a result, freight trains lost so much time on passing tracks that practically all the crews exceeded the overtime limit of 13 hr. 41 min., and, in numerous instances, double crews were required to prevent violation of the 16-hour limit. Under such circumstances, helper locomotives lost hours waiting to return light from Cima to Kelso or to Las Vegas, and road locomotives were in service too long, all of which resulted in a short-



Dual-control electric switch machines at siding switches



age of power. Likewise, loaded cars were, of course, given preference, and, as a result, empty cars accumulated in yards and on sidings until the division as a whole was congested.

Some of the Benefits

In the meantime, the centralized traffic control was under construction, the section including the heavy grade between Kelso and Cima being placed in service December 6. Other sections, ranging from 10 to 20 miles in length, between Cima and Las Vegas, were placed in service during January, February and March. The construction crews then returned to Kelso and worked west to Yermo, completing the final 10-mile section between Harvard and Yermo on June 16.

As each section of the new C.T.C. was placed in service, a corresponding saving in train time was made. Whereas 14 locomotives were formerly required for helper service at Kelso, this work is now being done by 7 locomotives. Freight trains, in general, are now covering the 171 miles in either direction in less than 10 hours, as compared with anywhere between 13 and 16 hours before. In brief, the centralized traffic control made it possible to handle approximately 95 per cent more loaded cars westbound and 130 per cent more empties eastbound in a seven day period of June, 1943, than in a similar period in June, 1942, and at the same time to reduce the average time of all freight cars on this sub-division approximately three hours. The important point is that all traffic is kept moving, the congestion and serious delays formerly encountered on this sub-division having been eliminated.

Operation of Switches in C.T.C.

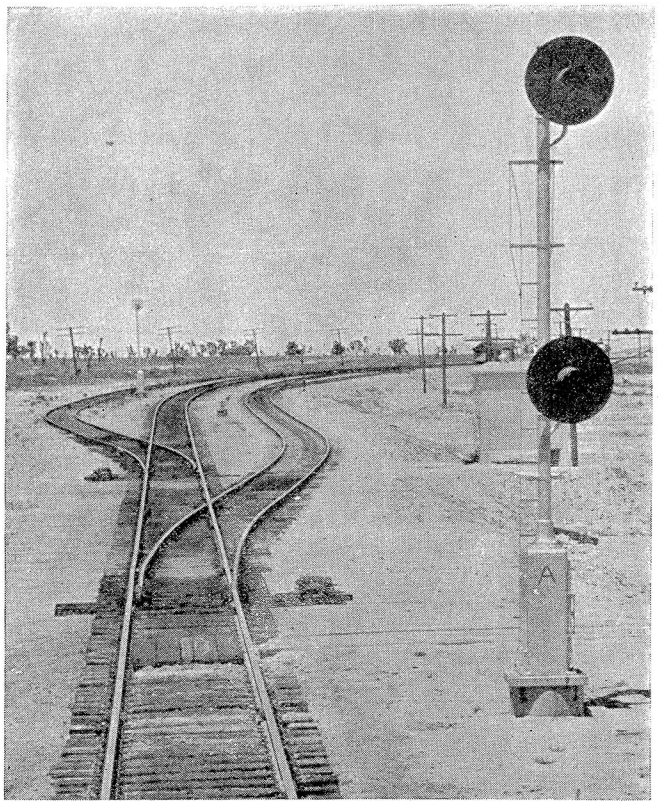
On this project, dual-control electric switch machines were installed at both ends of 32 sidings. The operated sidings were extended to 6,500 ft. in length, giving 120-car capacity. Also, power switches were installed at the east main-track switch at Boulder Junction, at one yard entrance switch at the west end of Las Vegas yard and at the each yard switch at Yermo, thus totaling 67 power switches. Each power switch is equipped with two spring-type roller bearings to facilitate operation of the 131-lb. points.

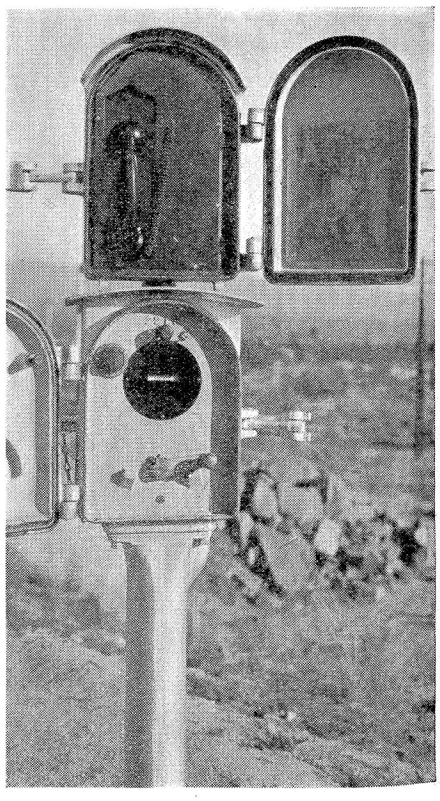
At all of the power switch locations, new searchlight-type semi-automatic signals were installed, dwarf type on the sidings, one-unit high signals for the departure signal on the main track, and two-unit high signals for the entering signal.

For through movements on the main track, red, green and yellow indications are displayed and red-over-yellow for movements into sidings. No signal protection is provided for movements on the sidings between the "OS" sections.

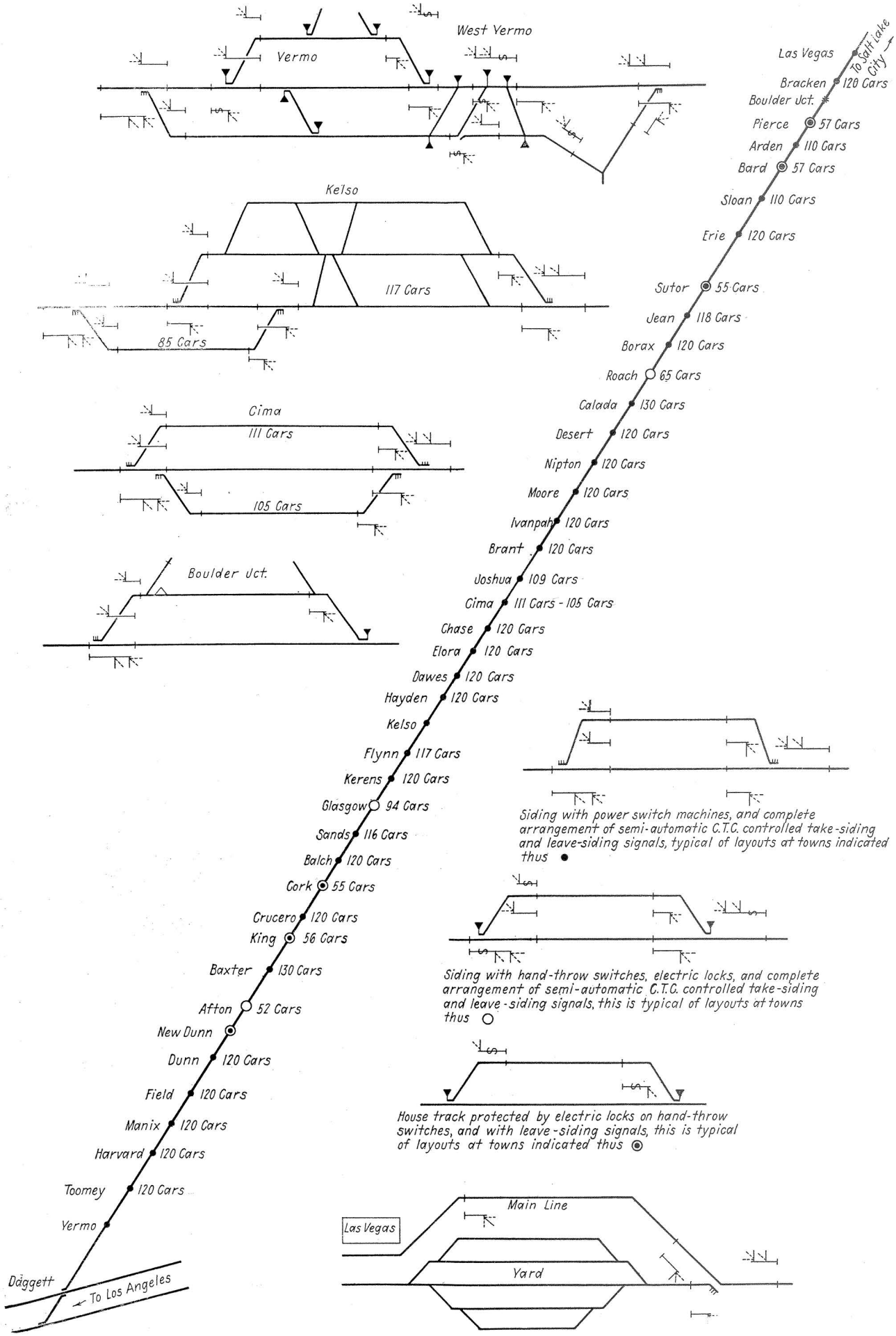
At three sidings, Afton, Glasgow and Roach, where the capacities were 94, 52 and 65 cars, respectively, no extensions were made, as these sidings are not to be used as regular passing sidings, except in emergencies. No power machines were installed on the switches at these sidings, but they were equipped with electric locks and C.T.C. controlled semi-automatic signals.

At Pierce, Bard, Sutor, Cork and King sidings, no extensions of tracks were made, as these sidings are used only for the storage of cars and for serving some industries. Electric

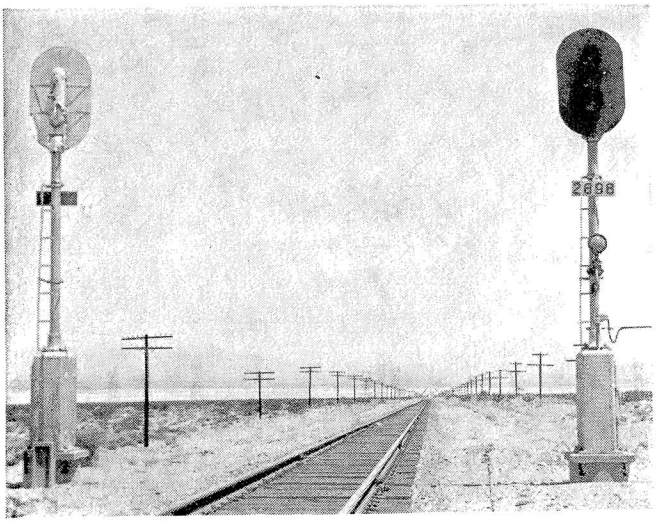




Upper left — Two-unit searchlight dwarf near Kelso. Left—West end of the double siding layouts at Cima. Below—An electric switch lock with a telephone in the upper case as used at handthrow switch



Overall layout of stations on entire 175-mile sub-division with sketches of typical switch and signal arrangements at stations



The automatic signal in approach to west end of Roach, note operative lamp on mast. Below—Signal at west end of the siding at Roach with "S" lamp in the lower unit to indicate the electric switch lock is unlocked

locks were installed on the switches and derails on these sidings, but no semi-automatic signals were located at the switch locations. All electric locks on the entire installation are lever-controlled from the C.T.C. control machine.

Signaling Arrangements

The automatic block signaling, which had been in service on this division since 1927, included color-light signals which were controlled on the over-lap principle. These were changed to the A.P.B. system using the color-light signals already in service. Practically all of the signals were re-located.

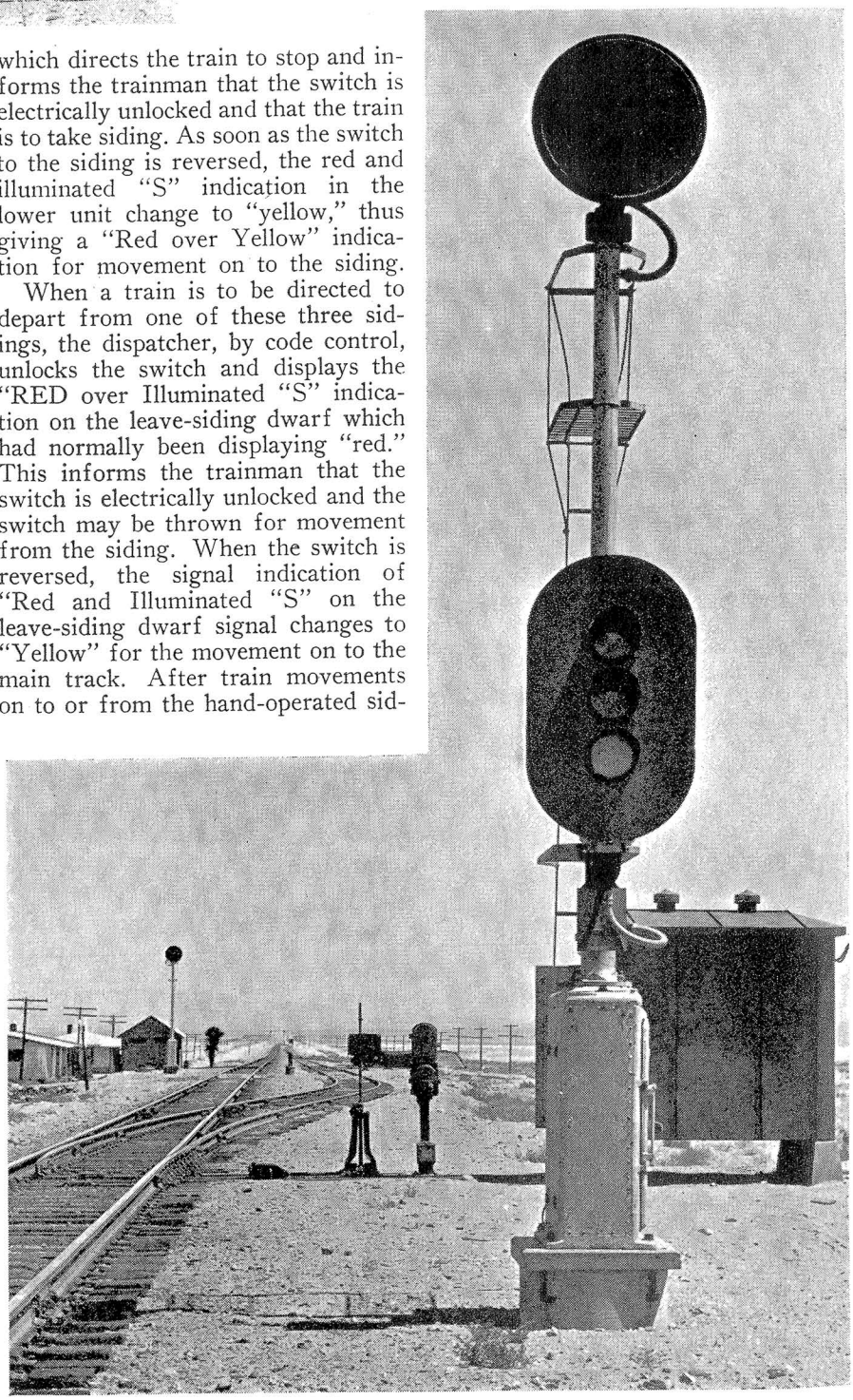
At the power switch locations, the old masts and cases were used for the high signals but new searchlight units were installed in place of the three-color light heads, and searchlight-type dwarf signals were installed. Thus the C.T.C. controlled signals are distinctively different from the automatic intermediate signals. All signals are located at the immediate right of the track governed, the passing sidings being thrown over to 19-ft. centers at one end to permit the installation of the ground-type station-leaving signal between the main track and the siding.

The aspects displayed are according to A.A.R. Standard Code practices, with certain additions applying to special locations. At the sidings equipped with electric locks and C.T.C. controlled semi-automatic signals, i.e,;—Afton, Glasgow and Roach, the lower unit of the station-entering signal and the leaving-siding dwarf signal are three-unit color-light signals which display R-Y-S (Red-Yellow-"S") indications. When a train on the main track is to be directed to take siding at these locations, the dispatcher, by code control, unlocks the switch lock and displays "Red over Red over Illuminated "S," which directs the train to stop and informs the trainman that the switch is electrically unlocked and that the train is to take siding. As soon as the switch to the siding is reversed, the red and illuminated "S" indication in the lower unit change to "yellow," thus giving a "Red over Yellow" indication for movement on to the siding.

When a train is to be directed to depart from one of these three sidings, the dispatcher, by code control, unlocks the switch and displays the "RED over Illuminated "S" indication on the leave-siding dwarf which had normally been displaying "red." This informs the trainman that the switch is electrically unlocked and the switch may be thrown for movement from the siding. When the switch is reversed, the signal indication of "Red and Illuminated "S" on the leave-siding dwarf signal changes to "Yellow" for the movement on to the main track. After train movements on to or from the hand-operated sidings, trainmen must restore the switches to normal position.

Since the hand-operated sidings at Pierce, Bard, Sutor, Cork and King do not have semi-automatic C.T.C. controlled entering and leaving signals, trains are directed to enter these sidings only by message. Movements to these sidings are made by the trainmen when necessary, but only by permission of the dispatcher.

Each electric lock on the entire installation is equipped with a C.T.C. telephone, located on the lock itself. When it is desired to enter one of these sidings, the train stops short of the switch leading to the siding and a



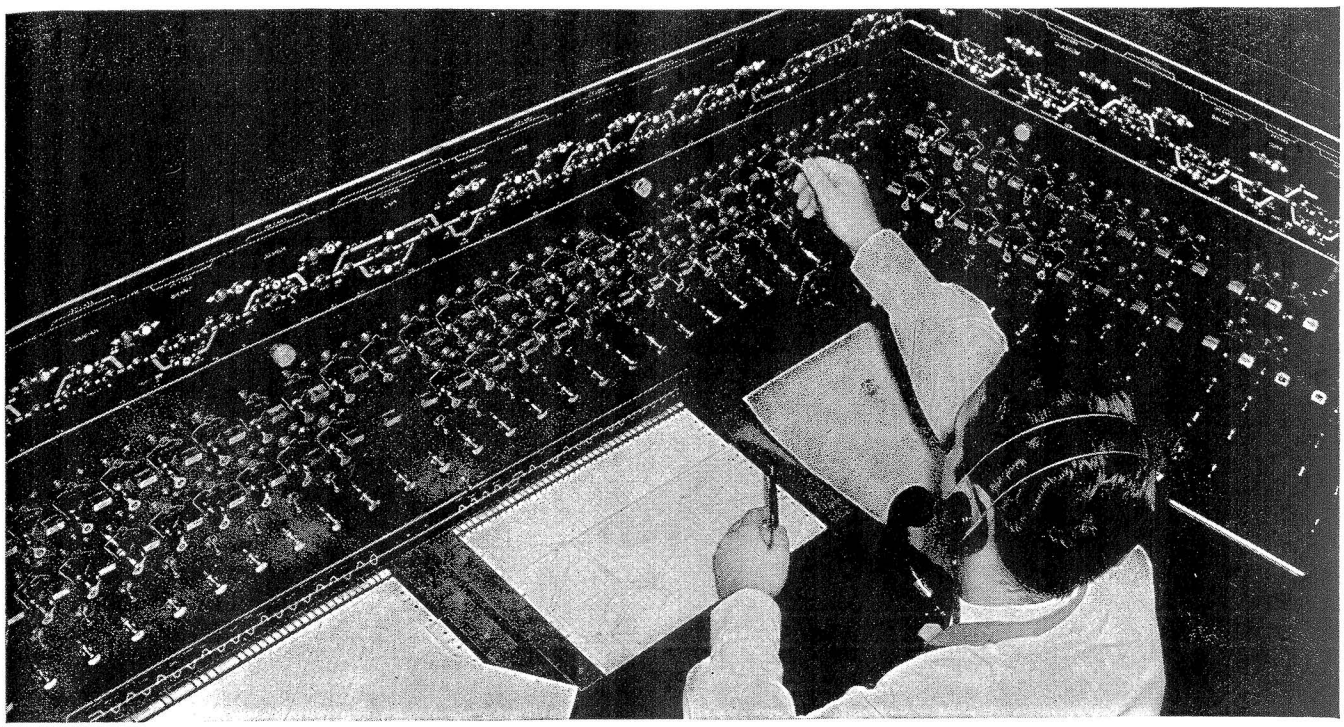
trainman contacts the dispatcher on the telephone located on the lock, and requests an "unlock" to permit him to operate the switch. The dispatcher, by code control, then unlocks the switch, although a three-minute time interval must elapse between the control unlock and the actual unlocking of the electric lock on the switch. The unlocking of the lock sets all intermediate signals governing train movements toward the siding at "stop" as well as checking the station-leaving signals at stop at the controlled sidings on each side of the siding to be used. The three-minute time interval is designed to prevent the unlocking of switches in the face of approaching trains, giving adequate time for a train to stop in case an "unlock" control is sent out in advance of it.

Each of these sidings has an "R-Y-S" dwarf signal at the clearance point to govern trains moving from the siding on to the main track. If a train on one of these sidings desires to move to the main track, a trainman contacts the C.T.C. dispatcher on the telephone at the switch lock and requests permission to move. The dispatcher must protect the movement by means of the station-leaving signals at the cotrolled sidings on each side of the hand-operated siding displaying Stop before he can code the "unlock" to the hand-operated siding; if no train is on the main track, the "unlock" can then be given immediately for the movement from the siding. The "Red over Illuminated 'S'" indication is given on the dwarf signal as soon as the code is sent to the siding, the same as at the sidings at Afton, Glasgow and Roach, and on receipt of this indication the trainman may reverse the switch, after which the signal indication changes to "yellow" for the movement on to the main track.

The C.T.C. Control Machine

When planning this C.T.C. project, one objective was to include the entire sub-division between Las Vegas and Yermo, thus permitting the dispatcher in charge of the C.T.C. machine to authorize train movements on his entire territory by signal indications, and, of equal advantage, permitting enginemen to cover their entire runs by signal indication and without written train orders. For these reasons, the C.T.C. system between Las Vegas and Yermo, 171 miles, is all controlled from one machine located in the dispatcher's office at Las Vegas. The switch at the west end of the yard at Yermo, as well as electric locks on certain hand-throw switches and the signals for authorizing train movements on the 4.6 miles between Yermo and the junction with the Santa Fe at Daggett, are controlled by a separate C.T.C. machine in the office at Yermo. This machine is handled by an operator under the direction of the dispatcher of the first sub-division, who is located at Los Angeles. Thus the operation of the two sub-divisions is separate. On account of switching moves and cutting in helpers on eastward trains at Kelso, the yard area at this station is not within C.T.C. territory. Arriving trains hold the main track and proceed according to signal aspects controlled semi-automatically. When trains are ready to depart from Kelso, Las Vegas and Yermo, they get a Form-A clearance, authorizing them to enter C.T.C. territory, where they are governed by the signal aspects displayed. The operators at Kelso and Yermo keep the dispatcher informed concerning switching moves so that he will know when trains are ready to depart.

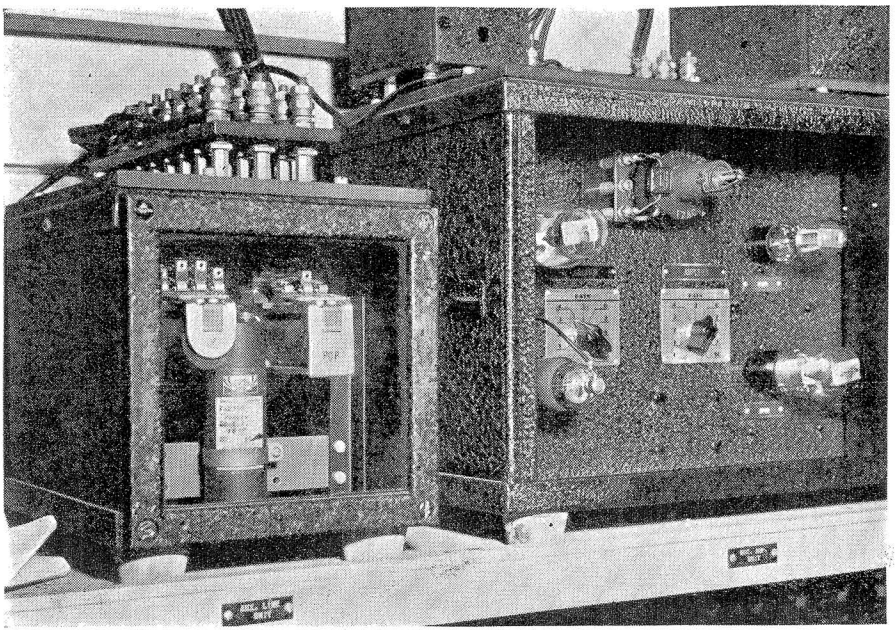
The C.T.C. machine at Las Vegas is made up with a center panel 5 ft. long, and a set of wing panels on each side, the total length of panels for the entire machine being 15 ft. The "U"-shaped floor space inside the machine is wide enough to permit two dispatchers to work side by side, each handling approximately half of the machine, or, if the number of train movements decreases decidedly, one dispatcher can operate any of the levers on the entire machine.



A view of part of the C.T.C. control machine showing the graphic train recorder

Indication Lamps

A special feature of this machine is a set of indication lamps and arrows which indicate the direction for which traffic is established between any two sidings. If the set-up is eastward, a green lamp is lighted, while if the set-up is westward, a pink lamp is lighted for the corresponding section. The diagram includes lamps which repeat the occupancy of all sections of main



Carrier equipment at west end of Flynn

track, as well as the passing tracks, so that the dispatcher has information at all times of the location and progress being made by trains.

The desk portion of the control machine includes a graphic train recorder with a pen for each of the 70 "OS" sections at the switches of the sidings and for one switch each at Yermo and Las Vegas. Each time that a train occupies an "OS" section, the corresponding pen is moved ⅛ in. to the right. By connecting these "OS" recordings with lines, a complete graphic record is made of all train movements. Conventional arrangements of indication lamps are provided in connection with the signal and switch levers.

If a semi-automatic signal is cleared, and the proceed aspect is then taken away, no opposing or conflicting signal can be cleared and the power switch involved cannot be operated for three minutes, which allows time for any train which may have been approaching to stop short of the signal, or if it overruns the signal the occupancy of the "OS" section will lock out the signals and switch. This time locking is controlled automatically at the field stations by time-element relays.

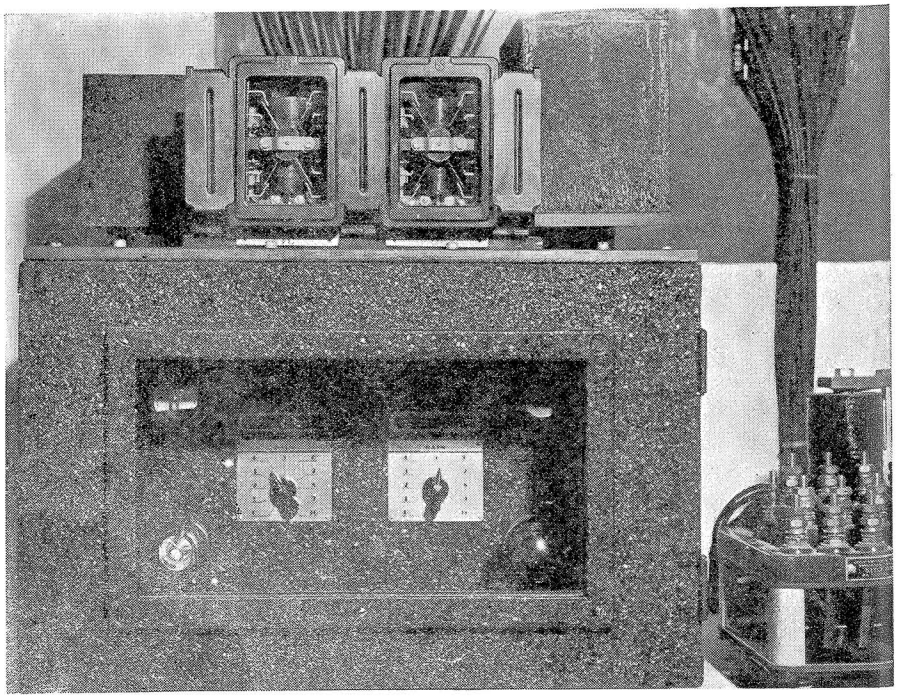
Coded Carrier for C.T.C. Line

The C.T.C. control machine is located in the dispatcher's office at Las Vegas which is the extreme east end of the project. The controls are sent to the field stations and the indications returned by means of the Union Switch & Signal Company multiple time code system, using two No. 6 bare 40 per cent Copperweld line wires between Las Vegas and Yermo. The new and interesting feature of the project is the use of coded carrier current for handling the coded controls to and indications from the field stations on two sections of the territory which are remote from the office.

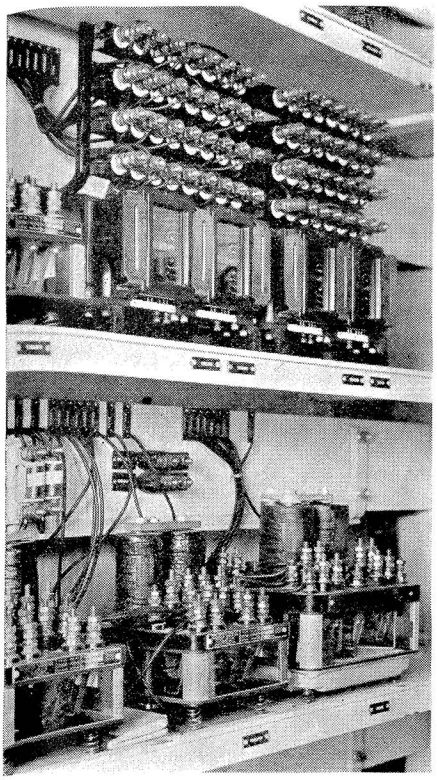
On the 47 miles of territory between the control office at Las Vegas and the west switch at Calada, the control of the power switches, semi-automatic signals and electric locks at 18 field stations, as well as the return of indications, is handled by ordinary d.-c. impulses in the same manner as on previous C.T.C. projects. This system is complete in itself, separate code sending and receiving apparatus being provided in the Las Vegas office.

The control of the switches and semi-automatic signals at 28 field stations on the 56 miles between Calada and the west switch of Flynn is handled by a different coding system which includes separate code sending and receiving apparatus at Las Vegas. This second system utilizes frequencies of 13 kilocycles to send out control codes and 19 kilocycles to return indication codes. These high-frequency codes are superimposed on, and transmitted direct in one direction or the other between Las Vegas and Calada on the same pair of wires that are used also by the conventional d.-c. line codes to and from the field stations in the Las Vegas-Calada section. At Calada, the high-frequency control codes are converted into conventional d.-c. codes to be transmitted to the field stations in this section. Incoming indication codes from the field stations of this section are conventional d.-c. to Calada, where they are converted to 19 kilocycle frequency codes for transmission to Las Vegas.

Furthermore, in the office at Las Vegas there is a third set of code sending and receiving apparatus, forming a third system which controls the 26 field stations in the 68 miles between Flynn and Yermo, codes at 11 kilocycles being used for outgoing control codes, and at 17 kilocycles for incoming indication codes. Codes at these frequencies are transmitted direct between Las Vegas and Flynn, being superimposed on the same two wires that carry the conventional d.-c. codes and the other



One unit of the carrier apparatus at Las Vegas



Relays in typical field house

carrier frequencies. At Flynn, the 11-kilocycle control codes are converted to conventional d.-c. codes for transmission to the correct field stations, and likewise the conventional indication codes are converted at Flynn to 17 kilocycles for transmission to Las Vegas.

At the various field stations and at Las Vegas, filters are used to prevent interference between conventional d.-c. codes and the high-frequency codes. These filters permit the same two line wires to be used also for a telephone circuit, which is connected to a loud speaker on the dispatcher's desk, and to telephones at all power switch locations and at all electric locks at hand-throw switches.

When a person at any of these field locations wants to call the dispatcher, he listens on the line and if it is not busy, he announces himself to the dispatcher. If the dispatcher wants to place a call for a maintainer at any field station, he positions the special toggle switch on the C.T.C. machine, and sends out a code which causes a lamp to be lighted on the track side of the relay house at the corresponding field station.

This is the first C.T.C. installation where the field station disconnect equipment has been placed in service. The purpose of this arrangement of apparatus is to permit the dispatcher to locate definitely a particular field station which may not be operating in a normal manner and which may be affecting the operating of the entire line circuit. There is a field station disconnect button on the machine for each of the three sections of this installation. In the event of an irregular line operation which is suspected as being due to a faulty field station, the dispatched depresses the field station disconnect button for the particular section involved. This results in the removal of d.-c. line battery from the one section. This results in all field stations being placed in an inaction condition as far as their ability to transmit indication codes is concerned. The field stations are returned to the active condition by the dispatcher sending control codes to them. Each station returns to the active conditions when it receives its own control code.

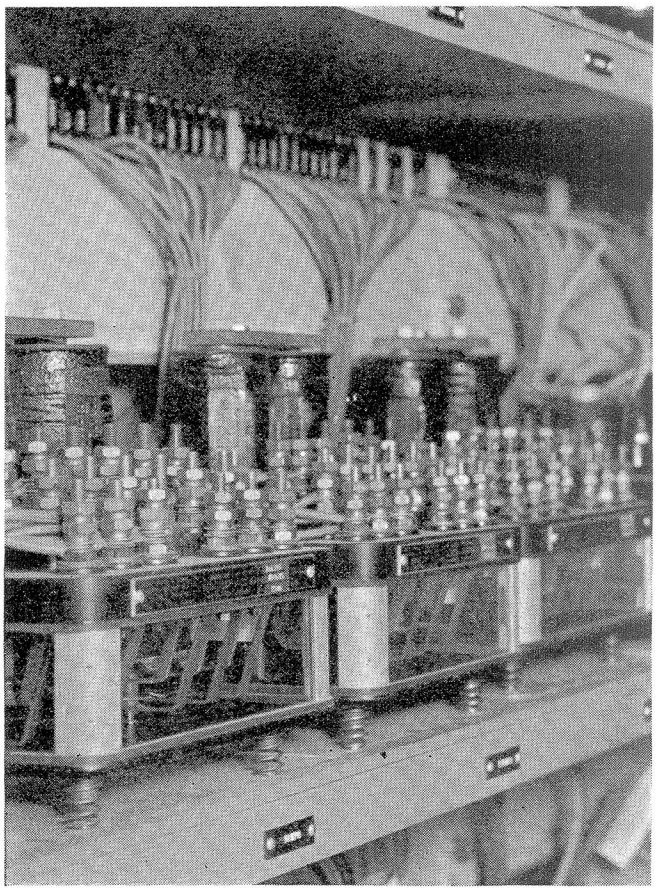
The dispatcher is able not only to determine the exact location of a station which has a fault, but also to restore the remainder of the system to normal operation. This will result in a considerable saving of maintainer's time and delay to trains which otherwise might occur. This apparatus is particularly useful on C.T.C. lines, such as on this installation where the distances are very great and many of the field stations are in locations which are relatively inaccessible.

A carrier repeater is in service on this installation as a standby unit at Calada. The purpose of the repeater is to amplify the coded carrier control and indication codes for the carrier circuit between Las Vegas and Flynn. One of the main advantages of this unit is that it permits the operation of this carrier circuit even though there be a broken wire between Las Vegas and Calada and another broken wire between Calada and Flynn. It will be evident that the field station disconnect equipment which was described previously will function in the event of a broken line wire. This means that all field stations of a given section on the remote side of a break in the line will be placed in the inactive condition. The relay at Calada which responds to this condition places the carrier repeater in service. Thus the carrier repeater at Calada is placed in service automatically in response to a break in the line between Las Vegas and Calada. Another control for the carrier repeater is provided by means of a control code from the machine at Las Vegas. This may be used to place the carrier repeater in service in the event of a broken wire between Calada and Flynn.

The carrier circuit between Las Vegas and Calada is of such length that quite satisfactory margins exist in regard to operating through a break in the line without the need of a repeater between these points.

Local Signal Controls in the Field

An interesting fact with reference to track circuits in this project is that

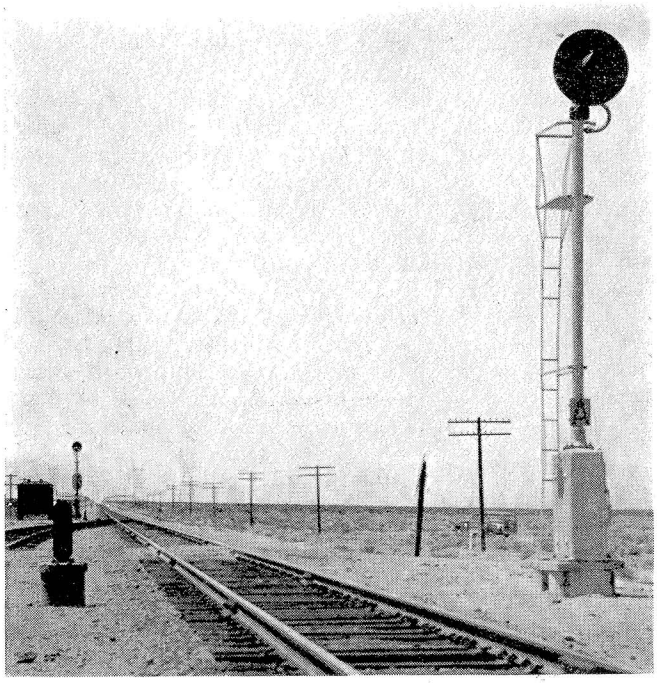


The wires from relay terminals each go through a separate hole in the back panel with the tag around the wire tacked to board

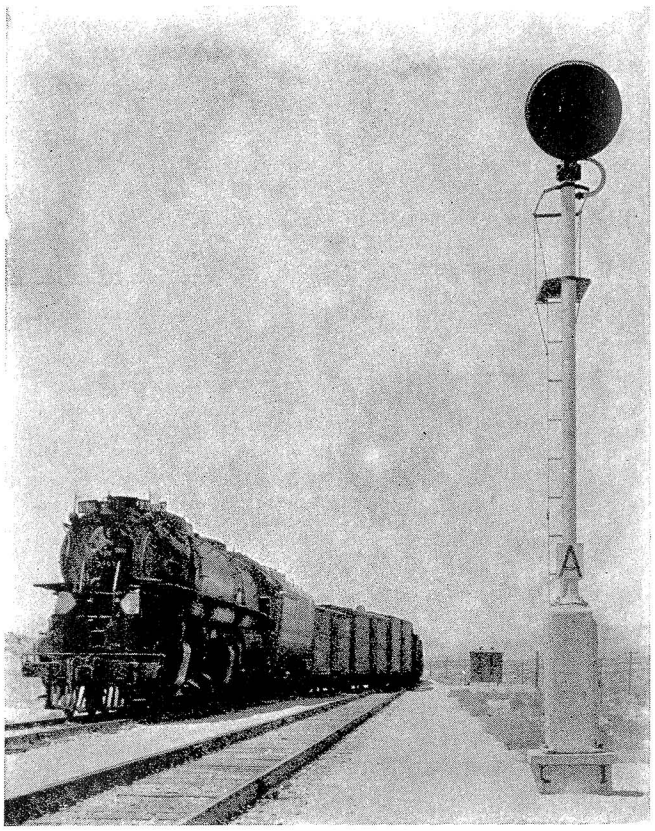
there are no interlockings or highway crossing protection within the centralized traffic control limits. One automatically controlled wig-wag is in service at a street crossing between the Las Vegas station and the west switch, but the C.T.C. territory actually begins at the signal at the west switch.

The previous automatic block signaling included d.-c. track circuits with 4-ohm neutral relays. The same track circuits are used in the new C.T.C. except that numerous changes were made in the locations of signals and cut sections. The maximum length of track circuits is 4,500 ft.

The line control circuits from the previous automatic block were on No. 9 bare galvanized iron line wire, a minimum of three and a maximum of five such wires being required at various places between certain signals in a station-to-station block.



Dwarf and high signals at the west end of the Roach siding at which there is a handthrow switch and electric lock



A freight train heading into a siding for meet with a passenger

Two-Wire Circuit

As a part of the C.T.C., one two-wire line circuit serves to control the signals for one direction or the other between any two passing tracks. The direction for which the circuit is to be set up is determined when the control code from the office is sent out to the field station of the semi-automatic station-leaving signal to be cleared. The use of this two-wire circuit on the Union Pacific required new 250-ohm retained-neutral polar relays at each signal location, in addition to the 670-ohm DN-12 neutral line relays which were included in the former signaling.

In view of the fact that only two of the previously existing line wires were required for the new circuit, this left from one to three wires available for special circuits to control indicators for warning maintainers and other men on motor cars concerning the approach of trains.

The indicators are of the semaphore type and are normally clear. When a man on a motor car sees a "clear" aspect on one of these indicators, he knows that he has time available ahead of trains to go to a certain point. If the indicator is at "Stop," he knows there is a train coming within a certain distance. The indicator circuits are separate from the signal circuits and are fed from different batteries so that there will be no chances for crosses or grounds to affect the signal control circuits.

Approach Lighting of Signals

With the exception of the leave-siding dwarfs, the lamps in signals are normally extinguished, being lighted by approach control circuits. In most instances, the approach lighting is accomplished through contacts of a DN-22A, 40-ohm relay which is in series with the signal control line circuit. This results in two 40-ohm approach-lighting relays being in series with each 250-ohm line control relay, regardless of the direction for which traffic is established. For the head-block signals, the 40-ohm approach-lighting relay is in series with the HD circuit and in conjunction with the traffic-direction code-stick relay. For the station-leaving signal, the 40-ohm relay is in series with the line circuit in conjunction with the opposing HD circuit.

The electric lamps in the searchlight-type signals are the double-filament type, rated at 13 + 3.5 watts at 10 volts. The lamps in the colorlight type signals are single filament, rated at 18 watts, 10 volts. A one-tenth ohm "light-out" relay is connected in series with the filament in the green unit of each colorlight signal. If the controls are such that the green should be displayed, but the filament has failed, the "light-out" relay is de-energized, which results in the display of a yellow aspect, thus eliminating the necessity for trains being stopped due to a "light-out."

Power Supply System

The installation of automatic block signaling in 1927 included the construction of a pole line with a 2300-volt, single-phase, 60-cycle power

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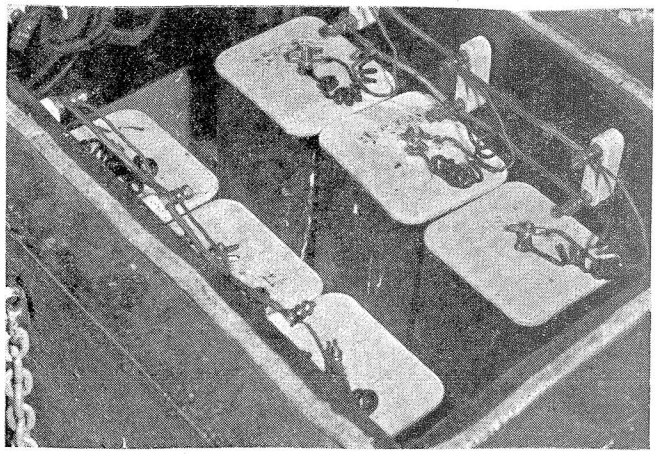
C.T.C. on the U.P.

(Continued from page 480)

distribution circuit on two No. 6 hard-drawn bare copper line wires, this circuit being retained as a part of the new C.T.C. system. In the previous layout, there was one 1-Kva.2300/110-volt line transformer at each passing track, with local 110-volt power circuits on line wires to the other end of the siding and out to the distant signals. These local 110-volt line circuits were eliminated. The previous 1-Kva. line transformers were used as far as they went at the new power switch locations, and new General Electric 0.75-Kva. line transformers were installed at the remainder of the head blocks. New 0.1-Kva. line transformers were installed at intermediate signal and track cut feed locations.



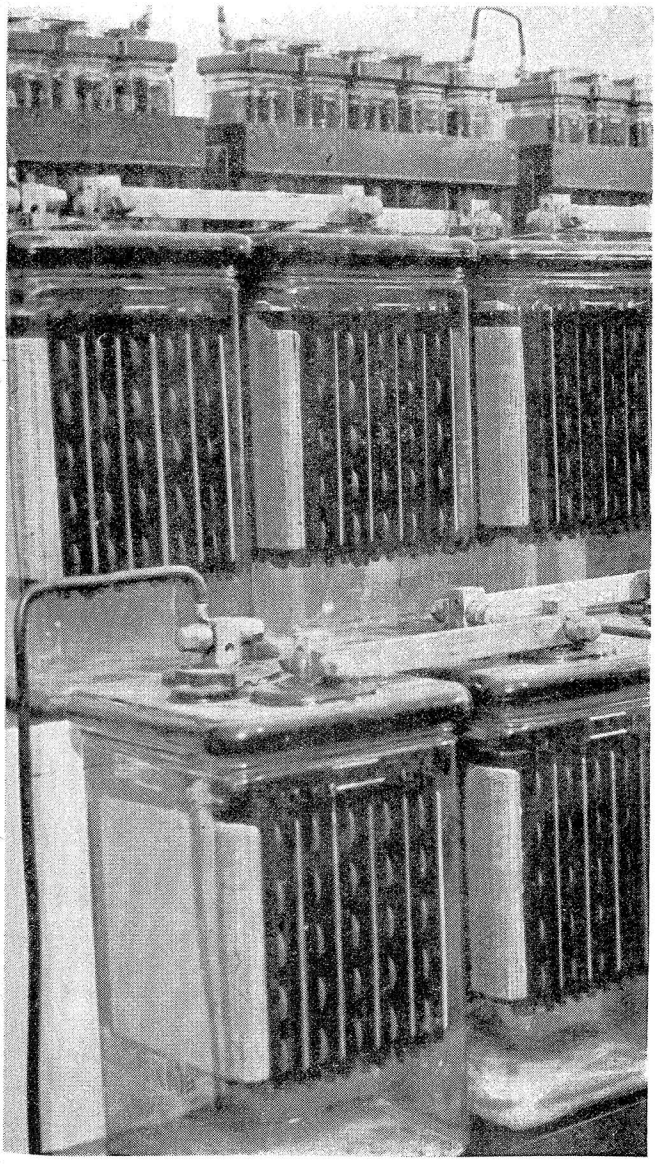
An automatic rectifier is connected to each set of primary cells on each track circuit, takes all but 10 m.a. of the load.

Battery Arrangements

In the previous signaling, each track circuit was fed by three cells of Edison 500-a.h. primary battery in multiple, with an average life of about 6 months. As a part of the change-over, an automatic rectifier was connected across each set of track battery to take all but about 10 m.a. of the load. At this rate, each set of track cells should render a life of at least three years.

At each intermediate signal location, there is a set of eight cells of Edison B4H storage battery which is on floating charge from a rectifier, this being the same battery formerly in service at such locations.

At each of the power switch locations there is a new set of 13 cells of Exide DMG0-9 storage battery which is used as a whole to operate the switch machine, and 8 cells of this battery feed the C.T.C. code apparatus.



Storage battery for feeding the C.T.C. coded line circuits, local code equipment, and the various relays that are located in the Las Vegas office

Construction by Railroad Forces

Construction crews, consisting of a foreman and 20 or more men, went through the territory, each doing a certain kind of work, such as: (1) Pole line reconstruction; (2) Underground cable; (3) Temporary work at passing track extensions, signal charges, etc.; (4) Set switch machines, electric switch locks; (5) Install signal foundations, erect signals and remove old signals; (6) Wiring connections.

The sheet- metal houses at the passing track switches were wired complete with instruments in place, at the factory. The cases at intermediate signals, electric lock locations and track cuts were wired in the field. The old concrete signal foundations were discarded. The new concrete signal foundations are of the sectional portable type, each foundation consisting of a hollow cylinder, with a concrete slab at the bottom and the top. New 131-lb. rail had been laid through this entire division within the last four years, and when this rail was laid the joints were bonded with mechanically-applied rail-head bonds, both the Ohio Brass Hammer-head and the A.S.&W. Co. Tiger-Weld type being used.

The centralized traffic control project was planned by the late F. W. Pfleging, and installed by signal forces of the Union Pacific, under the direction of L. D. Dickinson, general signal engineer, the major items of equipment being furnished by the Union Switch & Signal company.