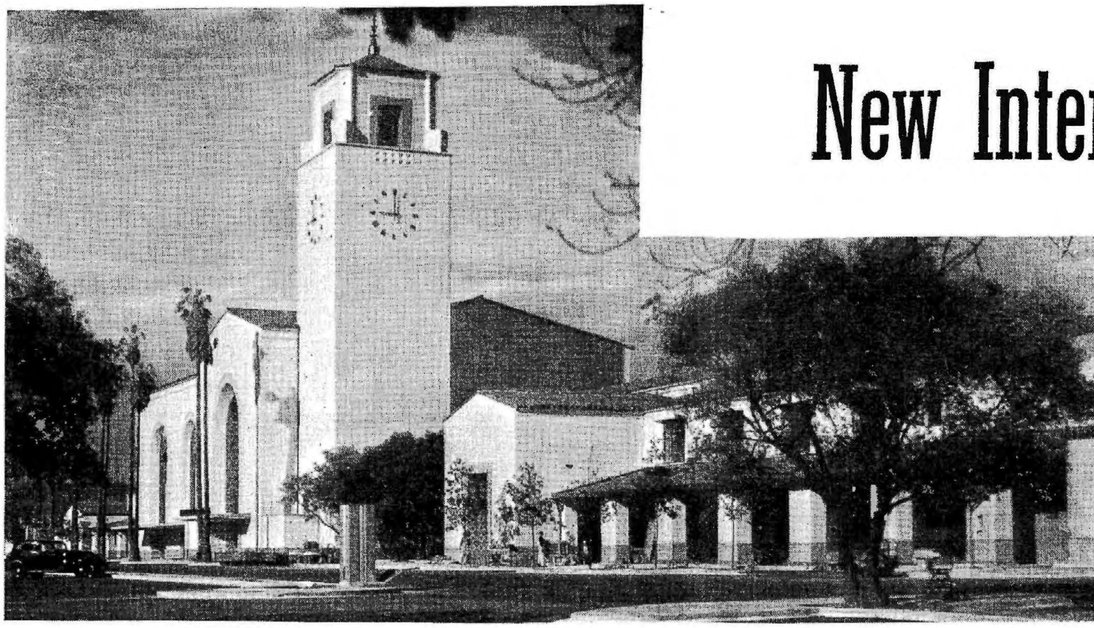


New Interlocking at

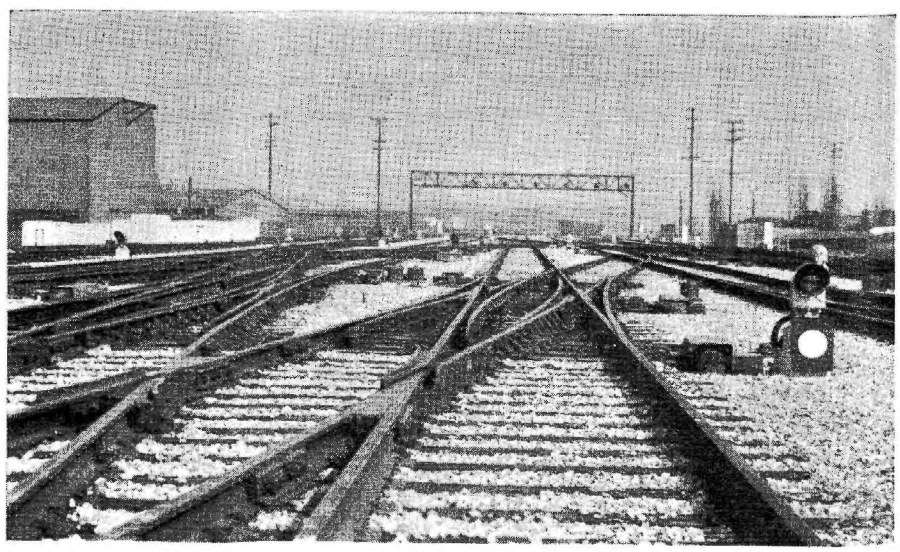
The new station is of Mediterranean architecture in white-faced concrete with Mission tile roofs and typical California landscaping

THE new Los Angeles Union Passenger terminal, which now handles the passenger trains of all the trunk lines entering that city, including the Southern Pacific, the Atchison, Topeka & Santa Fe, and the Union Pacific, was placed in service on May 7. The terminal, which is an entirely new project, is located about two blocks west of Los Angeles river, and faces Alameda street between Aliso street on the south and College street on the north, the new layout being about one mile north of the present Southern Pacific and Santa Fe stations.

A six-track lead, in addition to one switching track, enters the station layout from the north, and, through an arrangement of crossovers, double-slip switches and single switches, the lead connects with the station tracks in such a manner that trains can be routed from any track in the lead to any station track or vice versa. The tracks of the station and approach are elevated above street level, and the layout in the station includes 16 tracks for arrival and departure of trains, 3 tracks for running locomotives around trains, and 5 tracks for serving mail, express and baggage stations. All these tracks are stub ended at the south end. In addition, two tracks extend into a proposed working post office building, and one track extends into a small yard for parking a total of 19 private cars in the area to the north of the post office building.

Operating Problem

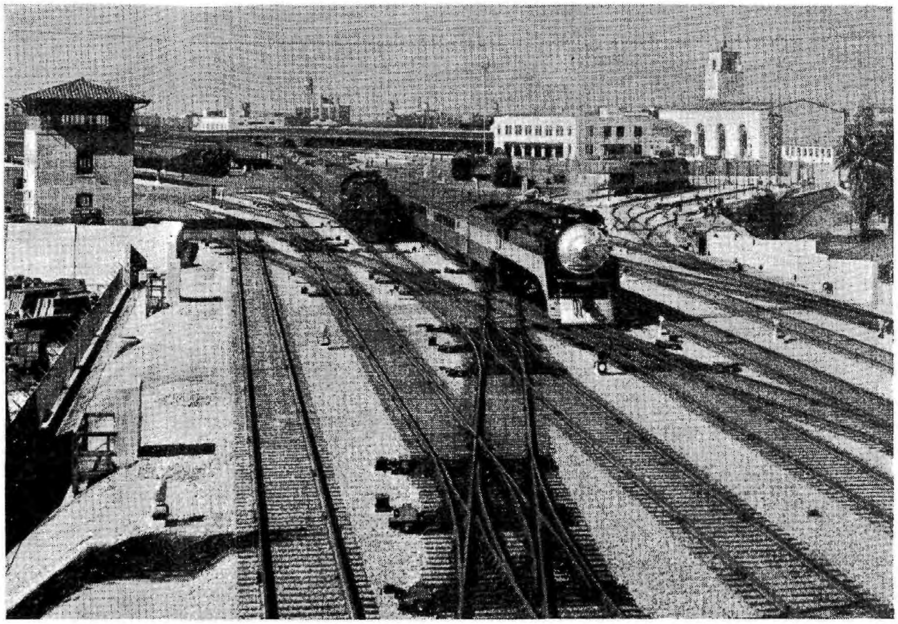
A total of 36 through passenger trains are scheduled to arrive at Los Angeles, and an equal number to depart, on certain days. Some of these trains, such as the Santa Fe Chief and the Union Pacific streamliner "City of Los Angeles," operate every second or third day. The problem of designing the track layout and the interlocking was further complicated not only by the stub-end layout, requiring that all moves in and out must be made through the north end throat, but also by the fact that the arrivals and departures of trains are bunched in certain morning and evening hours. A total of 60 train and switching moves have to be made through the interlocking between 8 a.m. and 9 a.m., in addition to switching service to set on and take off the head-end cars. During this hour, the Southern Pacific has four trains arriving and two departing, the Santa Fe and the Union Pacific each have two arriving and one departing. The through steam-operated trains, when arriving, pull into the station. Three of the arrangements of arrival tracks are laid out in sets of three; the two outside tracks are adjacent to platforms, and the middle track is provided so that the locomotive can be cut off and switched to this middle track to be run to the roundhouse of the road involved. A switch engine then pulls the passenger cars out of the station to the coach yard. Then another switch engine pulls the head-end cars out through the interlocking onto the switch lead track No. 19 and then back to the



The dwarf signal at the right governs over two tracks, the straight track and also the crossover

Los Angeles

New passenger terminal includes a 155-lever electro-pneumatic plant with special signaling layout, special track indication markers, and numerous interesting details of construction and operation



View of throat showing interlocking tower at the left—Train at right is Southern Pacific's Daylight Limited departing for San Francisco

tracks on the west side where the mail, baggage and express buildings are located. Thus for each arriving train there are, in some cases, as many as seven moves through the interlocking, and approximately the same number of moves are required for certain departing trains.

The Interlocking Machine

One interlocking of the electro-pneumatic type with a Union Model-14 machine controls the operation of the switches and signals in the entire station layout, the tower being located east of the tracks north of the station layout. The interlocking machine has a frame of 155-lever capacity, 138 working levers being used. Fifty-four levers control 104 switch machines on 45 single switches and 20 slip switch layouts including movable-point frogs; 50 levers control 83 interlocking signals.

The standard arrangement of lever-indication lamps is provided. The illumination of the switch lever lamp indicates that the lever is unlocked, and, therefore, may be operated. When a signal lever is operated, the indication lamp is lighted until the signal operates to display the aspect in correspondence with the position of the lever.

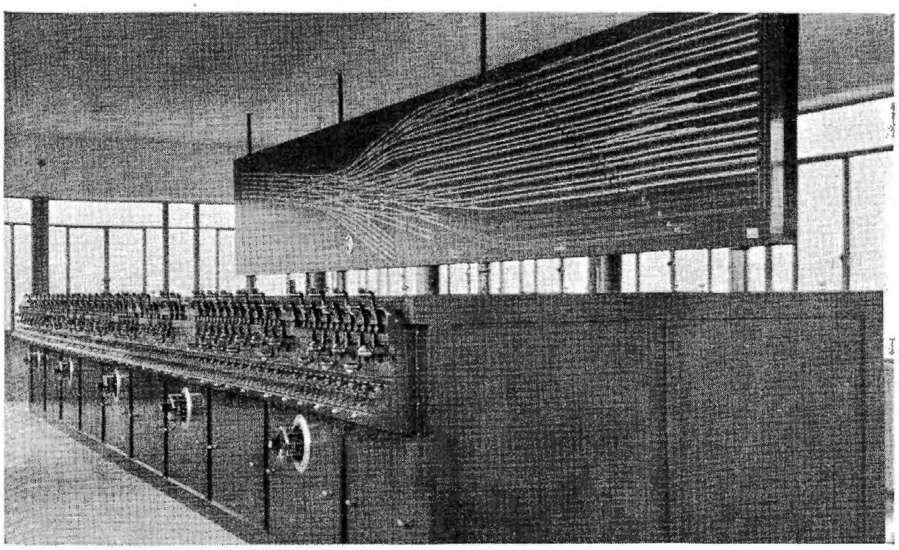
An illuminated track diagram mounted over the machine is equipped with lamps which indicate the occupancy of the various track sections in the station layout and approaches.

An unusual feature is that the clockwork time releases are mounted beneath the levers in the front of the machine case. Special frames of 1-in. angle iron were constructed inside the machine case on which to mount these releases. The center of each release is 22 in. above floor level, and the knob is 5½ in. from the face of the case. An aluminum ring, attached to the metal case, fits around the glass cover of the release, thus presenting a neat appearance. Colored marks on the machine, alongside of the levers, show which sections of the machine are governed by each of the five releases.

Signaling Arrangement

The six-track lead from the north end of the station layout extends around a 9-deg. curve, 700 ft. long to Mission Junction interlocking, the distance between the home signal bridges of the two plants being 950 ft. All train movements into or out of the passenger terminal interlocking must also pass through the Mission Junction interlocking. In order to utilize the six-track lead between the two plants to the best advantage in handling a peak of either inbound or outbound moves at certain times, these six tracks in the section between the home signals of the two plants are signaled for train movements in either direction. The signal bridge just north of the interlocking tower at the terminal, therefore, has a southbound high home signal for each of the six inbound tracks, and, on the other side of this bridge, there is an outbound high signal for each of the six tracks.

The set up for the control of the



View of interlocking machine and illuminated track chart—Note position of clock-work time releases in front panel of machine case below levers direction of traffic on any one or all of the six tracks between the station interlocking and the Mission Junction interlocking is controlled by traffic locking between certain levers in the machines in the two towers, thus requiring the co-operation of the two towermen to clear signals.

The point of importance is that no track, either in the incoming six-track lead or any place within the terminal interlocking, is set up for single-direction operation. As a result, the signaling throughout is of equal importance and significance for either direction of train movement. Except for the signals on the bridge north of the tower as mentioned previously, the signals throughout the terminal are dwarfs. All signals are of the searchlight type and display three aspects—red, yellow or green.

The use of dwarf signals, in contrast with signals on masts or bridges, made it possible to locate the signals so that the track layout could be utilized to the best possible advantage in routing trains and making switching moves without interfering with other routes unnecessarily. By locating the signals as shown on the diagram, a switch engine pulling a string of cars out of a station track can get beyond a signal, for a move back into another track, just as soon as the last car is beyond the switch or crossover to be used for the back-up move. Thus the switching moves tie up a minimum of the track layout, permitting other routes for incoming or outgoing trains to be lined up.

In some respects, these signals serve as automatic block signals for the routes within the interlocking limits. Each signal is located immediately to the right of the track governed, with unobstructed view and range of aspect sufficient for enginemen to observe and be governed by the signals without likelihood that an engineman will overlook the signal for the track or route being used. The maximum authorized speed over switches within the plant is 15 m.p.h.

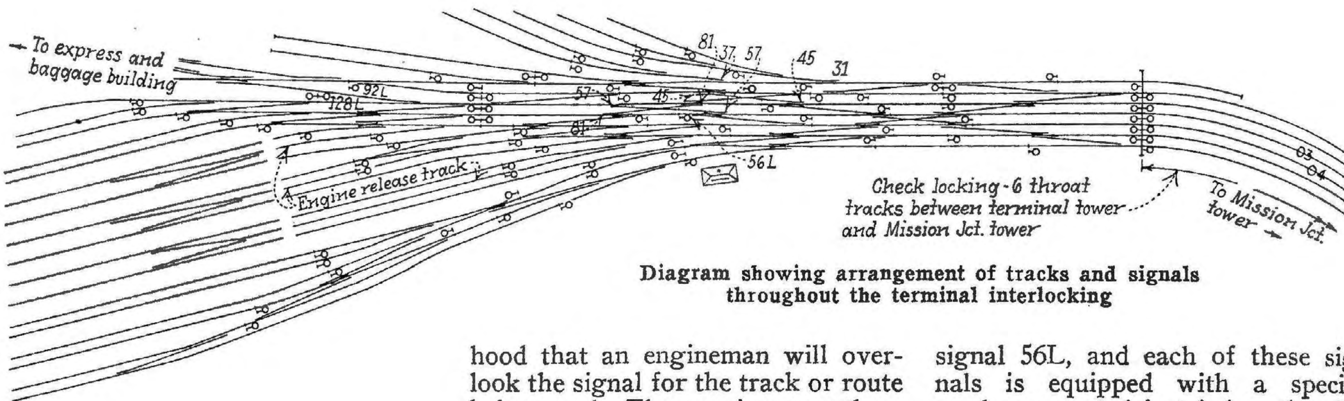


Diagram showing arrangement of tracks and signals throughout the terminal interlocking

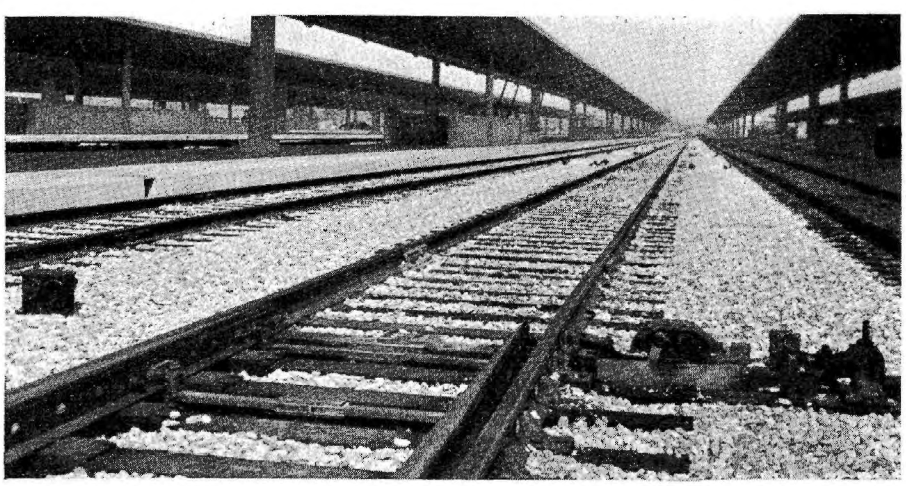
One Signal Governs Two Tracks

The tracks throughout the throat are located on 15-ft. centers. In a double-slip layout, such as shown in the track diagram of the slip including crossovers 57, 81 and 45, there is not sufficient clearance to locate an eastward signal at the immediate right of the track being used by an eastbound train being routed from track 03 to 04 via crossover 57. One signal, No. 56L, therefore, serves two tracks, not only for an eastbound train approaching on the straight track 04, but also for an eastbound train using crossover 57. In all cases when such a crossover movement is being made, the section of track 04 must be unoccupied in order to get the route for a crossover movement. Therefore, the view of signal 56L is not obstructed from an engineman being routed over the crossover. As a matter of fact, the rails of the crossover and the main track are so closely adjacent that the signal appears to be adjacent to this track regardless of whether the engineman is on the crossover or the through track. Six of the dwarf signals on this plant are located in positions corresponding to that of signal 56L, and each of these signals is equipped with a special marker mounted just below the signal. This marker consists of a rectangular black background enclosing a circular white spot 8 in. in diameter. A special rule in the time-table explains the significance of these markers. It was thought advisable, at least at the beginning of operation, to have these signals identified.

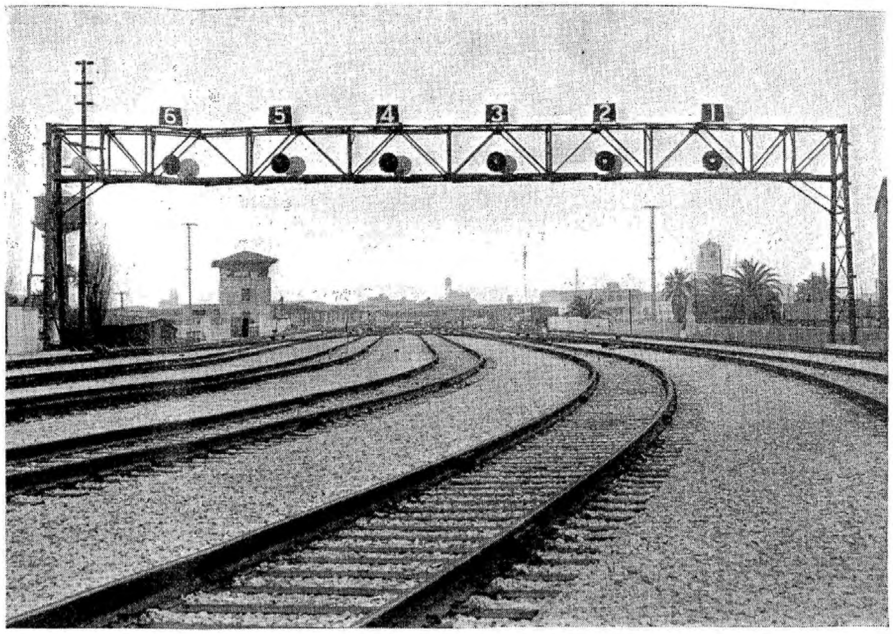
Close-In Yellow for Station Tracks

In order to close in a second train on a station track which is occupied, as well as to facilitate switching moves, the last southward dwarf signal in a route to a station track can be cleared to display a yellow proceed aspect, when the station track involved is occupied. It may be noted in each instance that the last southward signal leading to a station track involves no conflicting routes.

Special control is used in connection with signals governing over switches 31 or 37 which lead into the private car tracks. To prevent movements being made into the private car tracks, the operator is required to push a button before the switch can be reversed, and press the



View of electric switch lamp and an oil-buffer spring switch on one of the engine-release tracks



On the home signal bridge entering the terminal, a large illuminated sign above each signal indicates the number of the track governed

button again to clear the signal. The second operation to clear the signal was necessary in the event that the switch was reversed from a previous move.

The signals governing the moves out of the private car tracks, and the post office tracks, also have a special control feature in which the mechanical-stick push buttons can be used to make the signals non-slot. This feature is to be used when the operating engine is unable to clear the track circuit ahead of the signal while making a movement onto these tracks, and receives a signal (non-slot) to leave by. When the mechanical-stick push buttons are used, the approach locking is rendered ineffective, and the signal lever is locked at the normal indication position until the time release has been operated for a 30-sec. period.

Signals 92L and 128L control movements coming out of interlocked territory where no approach locking can be used. Therefore, the normal indication locks on these levers are controlled through 30-sec. thermal time-element relays as a means of introducing a delay from the time the signal is placed at stop until a switch can be moved.

Track Markers Aid Enginemen

In consideration of the fact that trains are to be run in either direction on the tracks of the six-track lead, it was anticipated that an engineman of an inbound train would have difficulty in determining which track he was on when leaving Mission Junction interlocking, and if he did not know, he would not know what signal to accept as he rounded the curve and saw the signals on the home signal bridge at the terminal interlocking. In order to eliminate any such confusion, two types of markers are used. Located at the right of each track near the end of tangent track west of the Mission Junction plant, there is a marker displaying a figure designating the track number, 1, 2, etc. This marker consists of a cast-iron disk 10 in. in diameter, with an 8-in. raised figure, made with a 1-in. stripe and painted white on a black background, the marker being inclined 45 deg. and mounted on top of a post to place the sign 8 in. above the rail.

The home signals at the terminal are, of course, lighted constantly, and an engineman, knowing what track he is on, could count the signals from one end and determine the signal governing his route. However, smoke might obscure one of the signals and the engineman might make a mistake. To eliminate such errors, an illuminated numerical marker is mounted above each of the inbound home signals on the bridge. Each of these markers consists of a case, 20 in. wide and 28 in. high, enclosing electric lamps behind a flat flashed opal cover glass on which the number is painted, using a 4-in. strip with the number 28 in. high. The four 40-watt lamps in each sign are normally extinguished, but are lighted when a train is occupying the corresponding approach track circuit. The rear of the inside of the case is painted white to form a reflecting surface.

Check Locking Control

Levers 2, 4, 6, 8, 10 and 12, when thrown to the left, clear the outbound signals on the bridge for these respective tracks. In order to operate one of these levers to the left, a release must be effected by the towerman at Mission Junction operating a lever. Likewise, before the towerman at Mission Junction can clear an opposing signal, the towerman at the terminal must operate his lever, corresponding to the track involved, to the right, thus effecting a release for the lever at Mission tower. On the track diagrams, in the lines representing the tracks between the two plants, an amber light and arrow indicates the direction for which the check locking is set up. Furthermore, on the diagram at the terminal, a green lamp in each track to the left of the symbol representing the bridge, is illuminated when the towerman moves his lever to the left position; this gives the towerman a quick check to see that he has lined up a route corresponding with the traffic direction which is established on that track.

Train Starting System

When a train on a station track is ready to depart, the conductor pushes a button located in a box on one of the posts on the platform. This causes a green lamp to be lighted on the line representing that track on the illuminated track diagram in the tower, and a green light above the conductor's button is lighted. If conditions are such that the towerman cannot line up the route and clear the signal at once, the towerman pushes a button below the signal lever, which causes the green lamps at the conductor's box and the track diagram to be extinguished, thus informing the conductor that the train cannot depart at once. On the other hand, if the leverman can get the route, the green lamp at the conductor's station remains lighted and the conductor is thus informed that the signal has been cleared and the train is to pull out on schedule.

Well Equipped Operating Room

The tower is of reinforced poured concrete construction, with concrete floors and a Spanish tile roof. The tower is 24 ft. wide and 58 ft. long, and has a basement and three floors.

The operating room occupies the entire third floor of the tower, with French type metal frame windows on all four sides. Venetian blinds are provided on all windows. The ceiling is covered with sound-absorbing material, and the cement floor is covered with linoleum.

A loud-speaker telephone system extends from this tower to Mission Junction tower. A microphone is located at three different points along the front of the machine, and when a leverman wants to talk, he pulls to the right on a small rod extending along under the lever-indication lamp cases.

A separate telephone circuit extends from another loud-speaker system to outlets on each of the other floors of the tower, at each switch machine, each outlying signal and each outlying case. By use of a portable pocket-sized telephone, the maintainer can "come in" on the loud speaker and carry on whatever conversation is necessary with the leverman. The outfit used for this purpose is a Remlar two-way desk-type speaker.

Equipment in the Tower

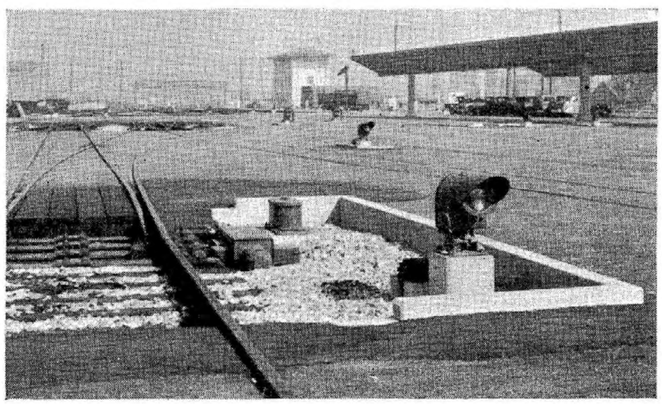
In the basement of the tower, a room 7 ft. wide along the entire length on the track side is equipped with cable racks made of 2-in. angle-iron frame supporting wooden cross-pieces. The underground cables enter this room through ducts and extend along the racks and then up through the floor to the terminal room above. An emergency gas-engine generator set is located in the basement, and the remainder of the space is used as a store room.

On the ground floor of the tower, a room 7 ft. wide along the entire length of the building on the track side is used as the terminal board room, and the remainder of this floor is used as a work shop and office. The terminal board is 32 ft. long, being made up of 1-in. Johns-Manville transite ebony board, each section being 90 in. wide and 42 in. high, mounted on a 2-in. angle-iron frame. Bakelite-based A.A.R. terminals, in blocks of six, are mounted on this board with No. 12 screws. Each incoming cable wire comes into the terminal through an individual hole in the board, and the wire going out and up to the relay room passes through another hole in the board. A separate panel at the left end is used as a switch and meter board for the incoming and distribution circuits of the 110-volt power supply. The insulation on the wiring on this switchboard is of the fireproof type known as Delta-Bestom.

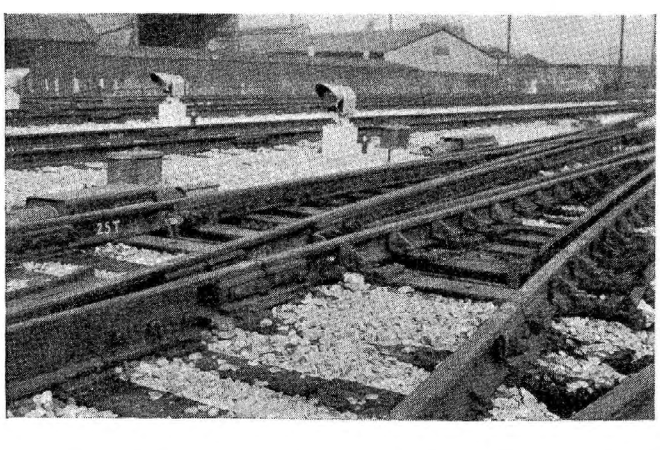
The second floor is used as a relay room. The relay racks are made in sections 8 ft. in length and 9 ft. high, and are set end to end to form a row the length of the room with space at each end. Racks are set back to back with 12-in. wiring space between. The vertical distance between shelves is 18 in., and the shelves are 12 in. wide. The upright corner frames and cross braces for the racks are ¼-in. by 2-in. by 2-in. angle-iron. The supports for the front and rear of the shelf are ½-in. by 2-in. strap iron. Each shelf is made of 16-gage galvanized sheet iron, 2 in. of each edge being bent down and bolted with ⅜-in. stove bolts to the supporting iron frame. Each shelf is covered with corrugated rubber matting cemented to the sheet metal surface. The back boards at the rear of the shelves are made of asbestos board. At the bottom there is a board 6 in. high. At the top there is a board 9 in. high, the space between being left open to facilitate running the wires until the job is finished; this space then is covered by another asbestos board. The wires from the terminal board to this rack run directly to the relay terminal posts with no terminals on the board in the racks except for instances where it is necessary to tap off of a circuit, in which case a bakelite based terminal is used on the boards. All the wiring interior of the tower for control circuits is No. 14 stranded with 3/64-in. insulation. A total of 230,000 ft. of this wire was used. Raco B-wire eyelets are used at all terminal connections.

The top board at the rear of each shelf is drilled with three rows of small holes for wires. Wires going to the front contact posts of relays are brought through the top holes; those going to the back contacts, through the center row of holes; and those going to the heel contacts through the bottom holes. The tags were printed on a machine; the letters were filled with white lead, wiped clean and then a coat of Valspar varnish was applied to the entire tag to make it moisture proof. A tag is slipped over each wire and held in place around the hole against the board by means of two No. 16 escutcheon pins driven in holes which are drilled in the board with an electric drill using a No. 53 bit.

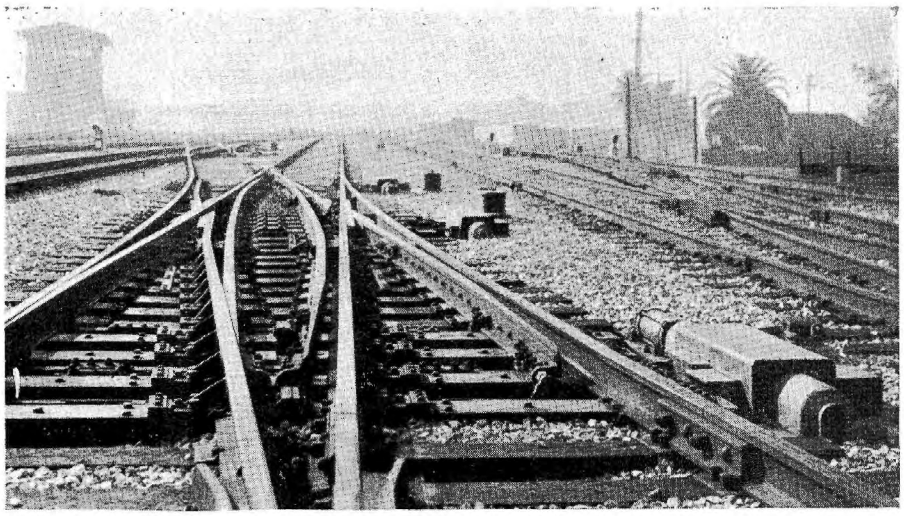
The chases for running wires from the terminal board in the basement up to the relay room and on up to the interlocking machine are made of asbestos board bolted at the corners to 2-in. angle iron. No wood is used any place in the relay room and, therefore, the equipment racks, etc., are practically fire proof. Nevertheless, granting that there is some small chance for fire to originate in the relay room, as a special pre-



Some of the signals and switches are located in the platform area used for trucking



Typical view of tracks and signals in the m.p.f. section of plant



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

caution, two "smeller tubes" consisting of 2-in. pipe extend from the relay room up through the floor to the operating room as a means of conducting odors from the relay room to the towerman, so that he can see or smell any smoke. The tops of these tubes are 48 in. above the level of the floor adjacent to the rear of the interlocking machine, and persons not knowing their purpose may drop lighted cigarette or cigar stubs down these tubes. In order to catch these stubs, a basket 1 ft. square with 2-in. sides, made of galvanized sheet iron, is mounted below the bottom of each tube. The relay room as a whole can be closed and locked by a door at the south end.

The transite boards forming the rear wall of the cases and the chases are ¾ in. thick, and were received in large-sized panels 4 ft. by 8 ft. The switch boards and terminal boards in the basement, mentioned previously, are made of 1-in. ebony transite board. Including all of the transite board, a total of 3,583 sq. ft. was furnished by the John-Manville Company for this installation. Sawing this asbestos board and drilling holes in it is difficult work, unless proper equipment is available. A local company in Los Angeles, equipped with saws and gang drilling machines, made up the boards to specifications, a special feature being that the holes on the front sides of the board were reamed on a slant slightly to present a neat appearance.

The neutral relays are all of the DN-11 type, and the switch repeater relays are the DP-17 type. A total of 1,201 relays were installed at this interlocking. Shock-absorbing springs are used under each relay.

In order that the maintainer can quickly locate relays which are de-energized, in case of trouble, a 12-volt, 3-c.p. lamp is mounted on the board behind each track and repeater relay, and this lamp is controlled through a back contact of the relay so that it is lighted whenever the relay is released.

Signal and Lamp Checks

The signals on this plant are the H-2 searchlight type, with permanent magnets, and operate on direct current. Twenty-degree convex lenses with a hot spot are used on the dwarfs, and flat inclined deflecting cover glasses, which prevent external light being reflected back and facing out the cold color of the indication, are used on the bridge signals. It was found that, in the signals which face the south, the sunlight, when the sun was low, would reduce the distinctiveness of the colors, and to correct this the inclined cover glasses were used to advantage.

Each signal is equipped with a double-filament, 3.5-13-watt lamp, with a fixed resistance of from 0.2 to 0.9 ohms in series with each lamp to secure uniform illumination of all signals. The lamps are fed at 7 volts during daylight and reduced to 5 volts at night. The dimmer circuit is controlled by a tumbler switch on the interlocking machine which picks up a relay causing resistance to be cut in series with the signal lighting circuit.

An ANL-2 relay is connected in series with the lamp circuit of the signals on the bridge. If the main filament of any signal lamp burns out, the relay is released and a lunar white indication lamp on the track diagram is lighted so that the towerman can call the maintainer at once. The signal armature circuit is selected through front contacts of the ANL-2 relay so that the signal cannot be cleared until the lamp is replaced and the ANL-2 relay again energized.

Switch Machine and Layouts

The switches are operated by A-5 electro-pneumatic switch machines with CP valves. The cylinders in the machines for operating single switches are 5 in. in diameter, those for slips are 6 in., and for m.p.f. 7 in. Insulated gage plates 1 in. by 9 in. are used on the switch layouts; four of these plates are used on each single switch, four on the switches at the end of a double slip, and five under the movable-point frogs. The gage plates are milled out ¼ in. to provide a seat for the rail, and, therefore, no slide plates are required. Fixed rail braces are used. The gage plates extend under the switch machines. The ties are dapped 5 in. so that the switch operating rods, the lock rods, and the point-detector connecting rods are straight. The point detectors are of the latch-out type, i.e., if dragging equipment should spring a point open and operate the detector, and then the point spring back to position, the detector keeps the circuit open until the maintainer inspects the switch and resets the detector. The switch feet for the front rods are forged steel and are bolted to the points and to the rod, being so designed as to prevent "rolling" of the points.

In the layouts of station tracks with three tracks in a set where the middle track is used to get locomotives off of trains, there is a crossover from one outside track to the middle track, and the connection from the middle track to the other outside track is merely a turnout. The switches on the outside tracks are operated by hand-throw stands, and the switch on the middle track is equipped with a Pettibone Mulliken oil-buffer type spring switch mechanism, so that when making a move to this track, only one switch stand has to be operated.

By planning the layout of the rails ahead of time, the locations of the insulated rail joints were arranged so that double-rail track circuits are extended throughout the whole plant, including the double slip switches, without any dead sections. The rail is 112-lb., and the armored type of continuous insulated joints furnished by the Rail Joint Company were used. The joints are bonded with Ohio Brass Company Hammerhead bonds applied in the side of the head of the rails.

Air and Power Supply in Duplicate

The compressed air for operating the switch machines is distributed in a piping system consisting of a 2-in. pipe along each side of the track layout, with several cross connections of 2-in. pipe, all interconnected and equipped with valves so that the failure of any one section of pipe will not cut off air from any of the secondary 1-in. leads to a switch machine. All pipe was primed and painted with tar, and buried in soil before the ballast was laid.

Compressed air is furnished by duplicate compressors in the power plant of the Union terminal, and the a-c. power for the motors on these compressors is supplied from two independent sources.

The electrical supply for the interlocking is all alternating current. The track circuits are fed from W-20 transformers with four secondaries, the feed to each track circuit being at about 1.5 volts. For track circuits within 600 ft. of the tower, the relays are in the tower. Connections from the end of each track circuit extend to the tower where the a-c. circuit is connected through an RQ-5 rectifier to operate a DN-11, 4-ohm, d-c. track relay.

The signal control, lock circuits, switch control circuits, etc., are fed pulsating direct current from rectifiers, an RPQ-61 rectifier, rated at 10 amp., being used to feed 8-volt circuits and an RPQ-121 rectifier, rated at 15 amp., being used to feed 14-volt circuits. An RQ-21 rectifier feeds the train starting circuits. An emergency rectifier of each type is provided. Thermal overload cutouts, General Electric Type 65x217, mounted on the power switchboard, are used in the d-c. load circuits, the cutout in the 8-volt circuit being rated at 10 amp., and the one in the 14-20-volt circuit at 16.6 amp.

Alternating current supply comes to the interlocking on independent circuits from two sources of supply, so that it is unlikely that both will fail simultaneously. If the normal source of power fails, the automatic switches cut over to the second source. If both a-c. power sources fail, the towerman, by pushing a button, can start a gas-engine-driven, 12-k.v.a., 115-volt generator set which will supply the necessary a-c. power for operation of the plant until the normal sources are again available. The four-cylinder gasoline engine will start and get up to normal speed of 1,800 r.p.m., and take the load in a period of about 7 to 9 seconds. The 12-k.v.a., 115-volt, a-c., single-phase alternator will deliver 52 amp. at 80 per cent power factor. The complete unit was furnished by the LeRoi Company of Milwaukee, Wis. The voltage delivered by the set is regulated by a rheostat on the switchboard panel.

The a-c. power from the outside source, or from the standby set, is distributed through the plant and sectionalized into four sections, and any power interruption in any section is indicated by a white light on the track model. The indication and power-off stick relays are controlled through DN-22 P relays, located in the outlying relay shelters where the track circuits receive their source of power The power-off stick relays prevent the signal-lever locks from being picked up in the event that power is interrupted and again restored, by opening the controls for the signal lock circuit. In order to energize the stick relays, a 30-sec. time release must be operated.

The 110-volt a-c. power distribution throughout the plant is on a three-wire circuit in order to minimize the line drop, No. 6 conductors being used. Two separate distribution circuits extend throughout the plant so that if a failure occurs the emergency circuit can be placed in service by throwing switches at the power panel in the tower and at the field locations.

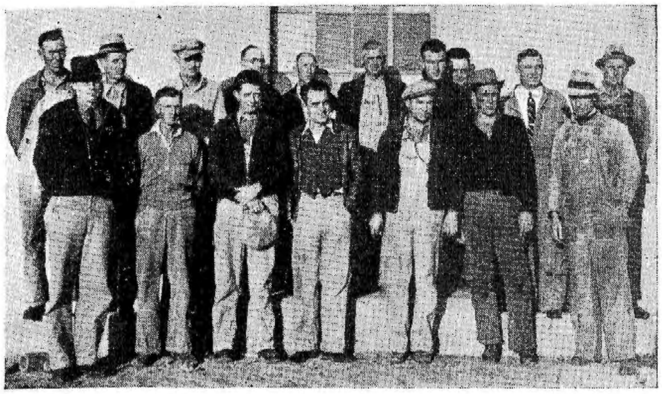
Cable rack in tower basement

Underground Cable Used

All the wiring distribution outside of the tower is in underground cable made up with protection which includes no metal. About 50 per cent of the cable, furnished by the Kerite Insulated Wire & Cable Company, has mummy finish, and the remainder, furnished by the Okonite Company, has Okosheath outside covering. A total of 54,000 ft. of cable was used.

Some of the main through runs of cable are in 4-in. transite conduit laid in concrete, and the remainder of the cables were laid in the dirt of the fill before the ballast and track were laid. The 110-volt distribution circuits are in separate three-wire cables. The wires from the tower to track circuits are No. 10, and the remainder of the circuits are No. 14. The majority of the larger cables include ten No. 10 and nine No. 14 wires, and other combinations of make-up were used as required. The connections from outlying cases or junction boxes to the rails are in single-conductor No. 9, using Union bootleg outlets with two 34-in. stranded galvanized iron connections to two ⅜-in. pins in the rail.

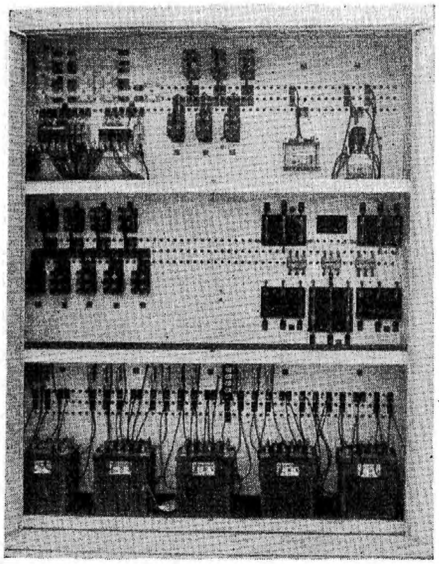
All wiring was thoroughly tested before plant was put in use



Construction forces during final part of the program—Foreman C. H. Travis left front

The tools and equipment furnished for maintenance of this plant included a Megger, rated at 500 volts and 100 megohms, reading from zero to infinity, a Weston ohmmeter reading from zero to 10 megohms, a Weston a-c. volt-meter with reading for several scales, 0-25, 0-110, etc., and a Weston d-c. volt-ammeter with a wide range of scales.

After the installation was completed, every wire and cable was tested with a Megger. In one instance, a pick had damaged an underground cable causing a ground reading 10,000 ohms. In another instance a cable which gave evidence of having been scratched showed a ground of 30,000 ohms. In order to locate these high resistance faults, a Wheatstone bridge connection was used in a Varley loop test and the Megger, with an output of 500 volts,



Instrument case at outlying location

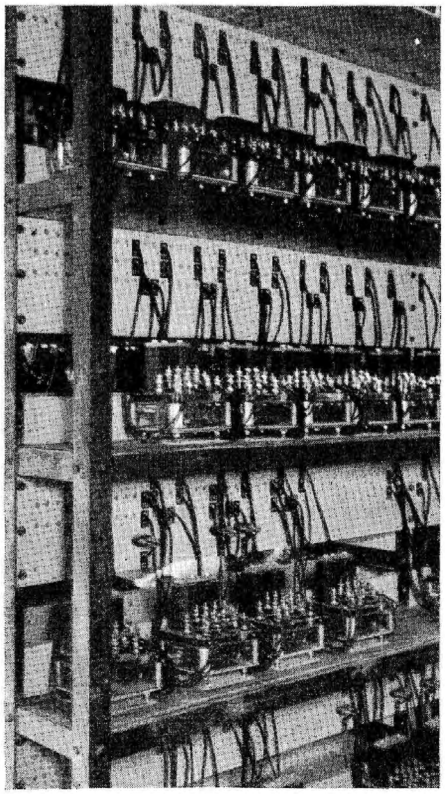
was used instead of a battery in this test. The faults were located to the exact foot, thus resulting in a minimum of digging. In another case a nail had been driven through a cable which caused a dead short that was easily located by the Varley loop test.

When making these cable tests it was found that in some instances there were slight grounds on the cables going to the switch control valves at the points where clamps, made of sheet metal, had been used to support the cable where it came up out of the ground to the terminals. By removing these clamps and using a section of the outer covering of the Okosheath cable, held by a section of plumber's clamp strip, these grounds were eliminated.

The coils of all relays and transformers were tested for resistance and for grounds, and tests were made of the operating characteristics of the relays. The circuits were checked in detail and a complete operating test was made of the entire plant.

Signal School Conducted

The signalmen employed on the construction of this plant came from the signal departments of the three owner roads. Some of these men had no previous experience on large modern interlocking plants, and in order to help them in the installation of circuits, as well as to qualify them for maintenance work, these men organized a voluntary school, which was in session from 7 a.m. to 8 a.m. each morning for three months. This school session was on the men's own time, as the working hours began at 8 a.m. J. F. Herbert, a signalman from the Southern Pacific, with considerable interlocking experience, was selected as the leading instructor, and he was assisted by other men on the job, including C. H. Travis, V. C. Cone, and V. L. Gill. A few of the first lessons dealt with the fundamentals of electricity and magnetism. Other lessons were each devoted to a study of the construction, operation and maintenance of relays, transformers, rectifiers, switch machines, signals and the interlocking machine. Typicals of each of the various types of control, locking and power distribution circuits were, in turn, drawn on a large blackboard and explained in detail, giving each man an opportunity to present questions.



The relay racks in the tower are made of angle-iron and transite board

The Los Angeles Union Passenger Terminal is owned by the three roads using this terminal, and the interlocking was planned by a committee consisting of representatives of the signal departments of these roads, including R. D. Moore, signal engineer of the Southern Pacific; E. Winans, signal engineer of the Coast Lines of the Atchison, Topeka & Santa Fe; and A. H. McKeen, signal supervisor, and F. W. Pfleging, signal engineer, of the Union Pacific. The detail plans, engineering, handling of materials, and construction was handled under the direction of the Southern Pacific, with A. G. Kaemper, chief signal draftsman, in charge. The field construction was under the general jurisdiction of A. J. Barclay, construction engineer of the entire terminal project, and under the direct supervision of Mr. Kaemper. D. C. Miller was construction foreman from the time the work started in January, 1938, until October 1, 1938, at which time Mr. Miller was promoted to assistant supervisor on the Southern Pacific. After October 1, C. H. Travis was foreman until the installation was completed. The major items of material, including the interlocking machine, switch machines, relays, rectifiers, etc., were furnished by the Union Switch & Signal Company.