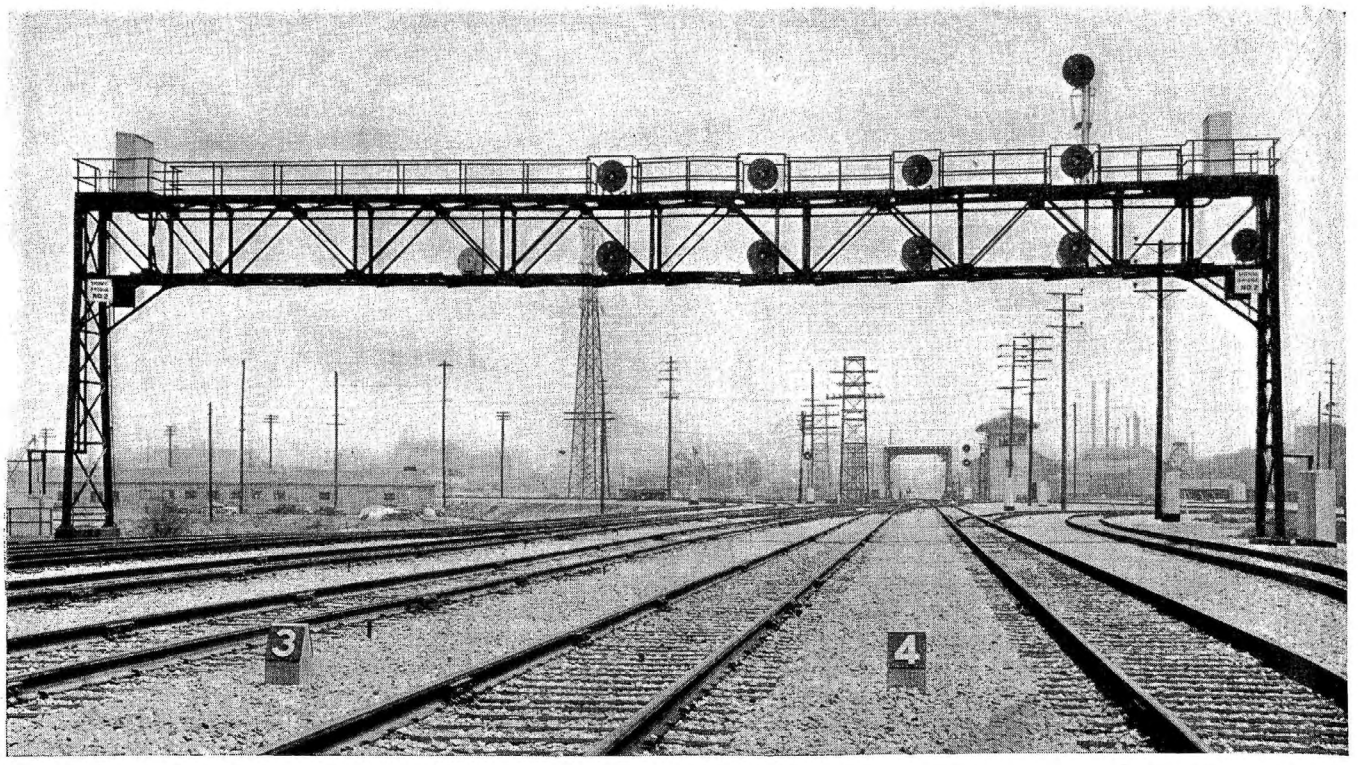


Mission Tower Interlocking at Los Angeles

Santa Fe enlarges plant to include connection extending to new passenger station layout

As a part of the project including the construction of the new Los Angeles Union Passenger Terminal, Mission Junction interlocking, which includes new connecting tracks extending to the new terminal, was enlarged by the Atchison, Topeka & Santa Fe, 104 levers being added to the previous 144-lever, General Railway Signal Company unit-lever electric interlocking plant, thus making a total of 248 levers.

Former Track Layout

The double-track main line of the A. T. & S. F. runs north and south on the west bank of the Los Angeles river, while the double-track line of the Union Pacific lies on the east bank, the two roads being about 400 ft. apart. At Mission Junction, the double-track east-and-west line of the Southern Pacific between Los Angeles, Cal., and Yuma, Ariz., crosses at right angles over the A. T. & S. F. tracks, the river and the U. P. tracks.

The Dayton Avenue freight yards of the S. P. are located to the west of the river about 2½ miles north of Mission Tower. In order to eliminate interference with street traffic, arrangements were made several years ago to route freight trains from this yard over a bridge across the river, to connect with the U. P. tracks on the east side of the river extending to a wye connection with the S. P. line to the east at Mission. Excluding reference to crossovers and single switches leading to various industries, the previous track layout at Mission included protection for the two railroad crossings and the wye connection between the U. P. and the S. P. tracks.

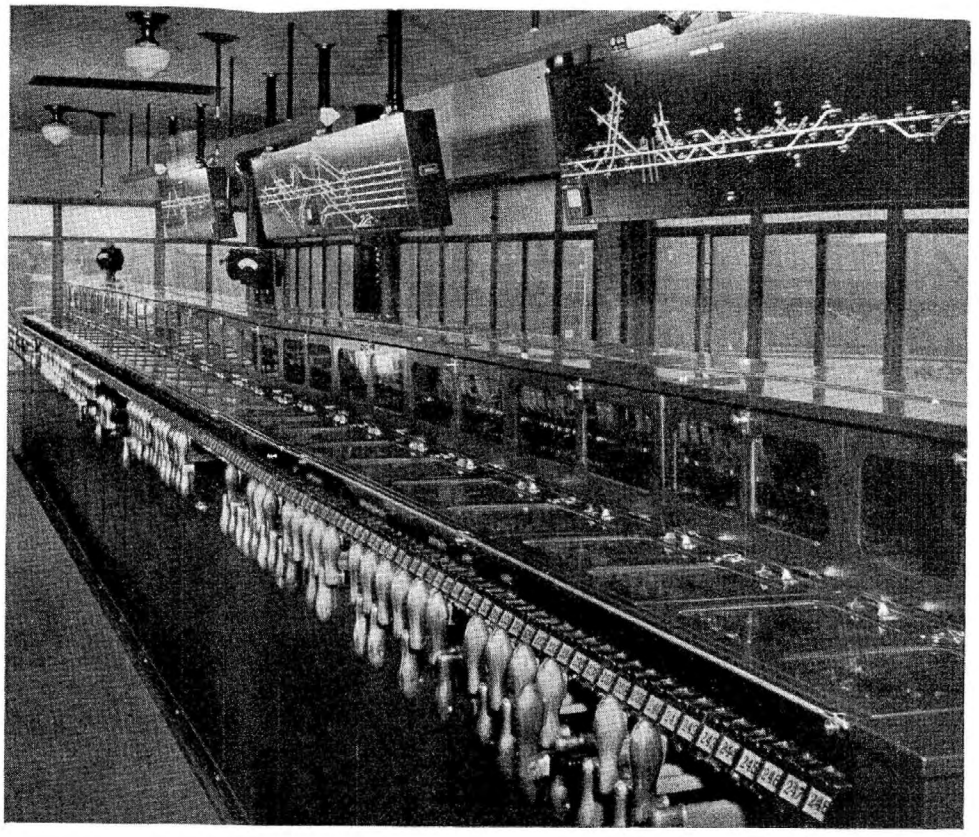
The A. T. & S. F. passenger station, used prior to the construction of the new terminal, was located 1½ miles south of Mission, and the majority of the trains of this road passed through Mission in going to or from the old station. The former S. P. station was located about 1¾ miles south of Mission, and trains to and from this station were operated on a double-track line in Alameda street, which is west of the new station layout. The U. P. trains used the S. P. station and entered this station from the south.

Additions to Mission Track Layout

The new union passenger terminal is located about ¾ mile southwest of Mission tower, and all trains entering or leaving the terminal pass through Mission interlocking, as now enlarged to include the operation of several new track connections which were provided. New double-track wye connections were installed to route trains between the terminal and the

Left—View looking east showing the eastward home-signal bridge in foreground and the tower near the left center

Right—the 248-lever interlocking machine in Mission tower—Note the three separate illuminated diagrams



Below—View of track layout just west of the tower—The telephone plug connection is shown in the near side of the junction box at switch

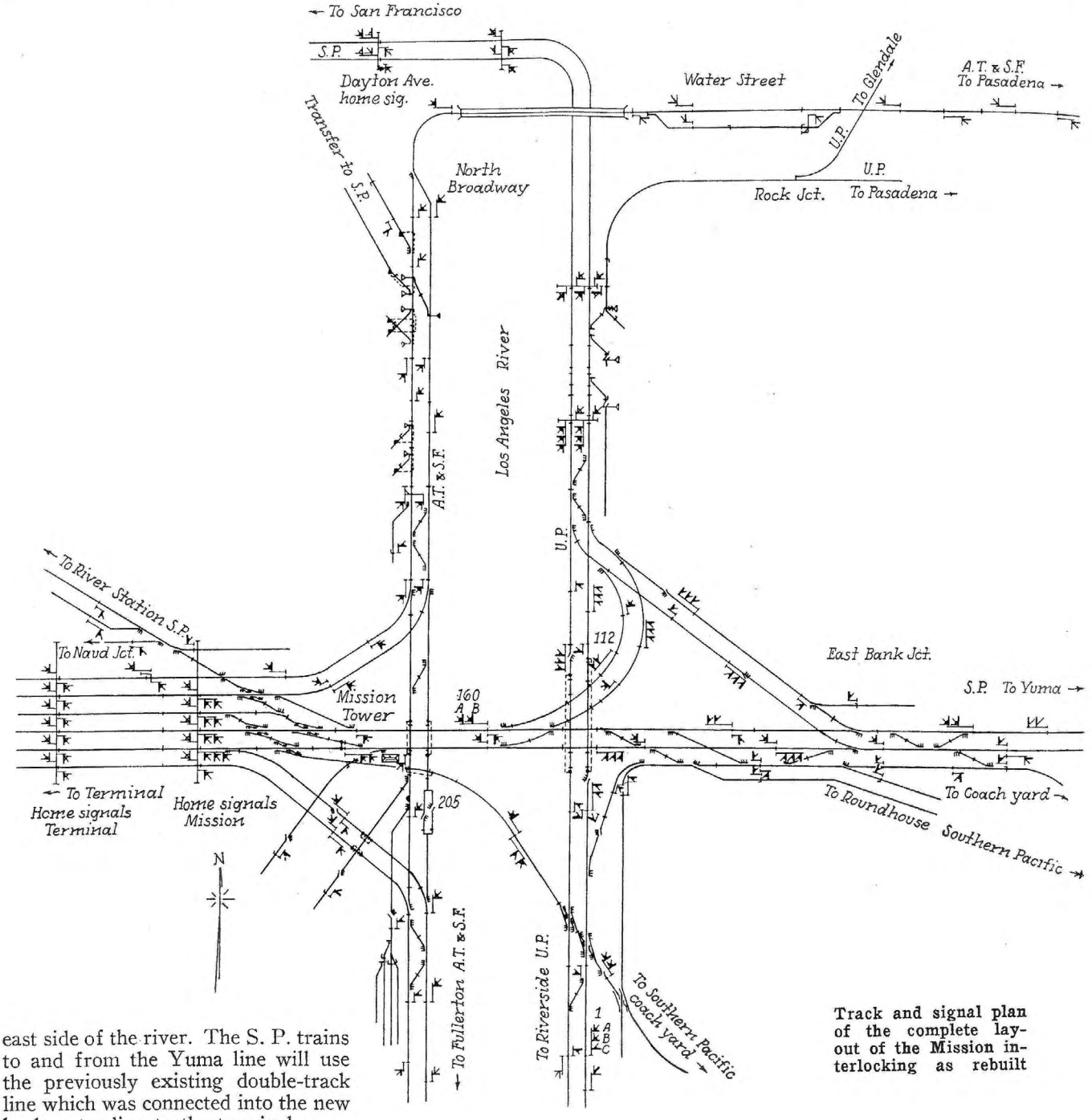
A. T. & S. F. tracks extending to the north, as well as those extending to the south. A single-track connection, on a new bridge over the river, connects the U. P. track through Mission to the leads to the terminal. By means of new crossovers and switches, this connection extends from the U. P. tracks to a new coach yard constructed by the S. P. on the east side of the river. The S. P. trains to and from the Yuma line will use the previously existing double-track line which was connected into the new leads extending to the terminal.

The S. P. trains to and from the north are routed between Dayton avenue and Mission via the line formerly used by freight trains. In order to complete the connections through Mission to the terminal leads, a double-track reverse loop was constructed extending from the previous wye connection, crossing the U. P. tracks and connecting to the Yuma line tracks at a point on the bridge; thus requiring changes and additions to the bridge. At the ends of all these various connections, crossovers were provided to permit routing trains as required.

To the west of Mission tower, various crossovers and switches were added to connect with the new six-track lead which extends west and around a long curve to the south and into the new interlocking at the throat of the new terminal, as explained in detail in a separate article. The six tracks between Mission tower and the interlocking at the terminal, as well as the several new wye connections are signaled for train movements in either direction, in order to increase track capacity in one direction or the other as needed during peaks.

Operating Problems Involved

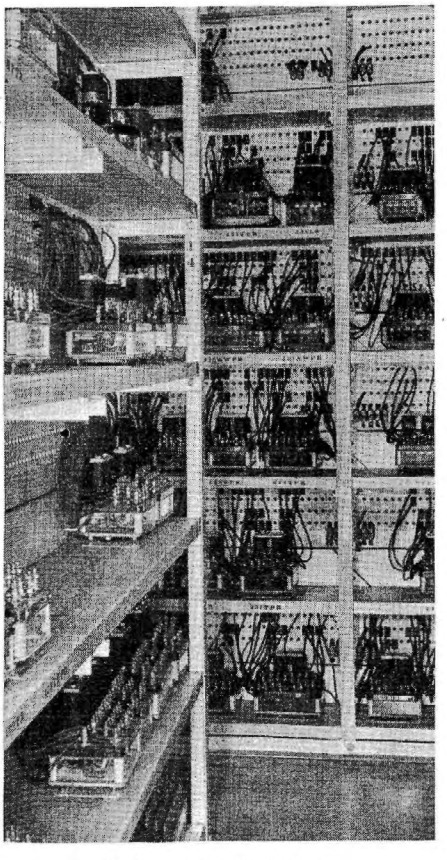
The passenger terminal layout is dead end at the south; therefore, all moves into or out of this terminal have to pass through the Mission interlocking. A total of 36 through passenger trains are scheduled to arrive at Los Angeles, and an equal number to depart, on certain days. Some of these trains such as the Santa Fe Super Chief, and the U. P. streamliner "City of Los Angeles," operate every second or third day. For each arriving train, the equip-



Track and signal plan of the complete layout of the Mission interlocking as rebuilt

ment must be pulled out through Mission Junction to a coach yard, and the road locomotive moved to an engine-house. Likewise, the corresponding reverse moves must be made preparatory to the departure of each train. Various other switching moves in and out of the terminal must go through Mission Junction. Freight trains, as well as many switching moves to serve industries and to transfer cars between connecting lines, are operated through this plant. About 486 train or engine movements are made each 24 hours through Mission Junction.

The difficulties of operation are further complicated by the fact that the arrival and departure of trains comes in certain peak periods in the morning and evening. Between 8 a.m. and 9 a.m., about 60 moves are handled while between 7:30 p.m. and 8:30 p.m. about 54 moves are handled. On account of the extended area included in the plant limits, practically all of the routes are long, and many of the routes conflict with several other routes, so that the operation of a train through the plant ties up various routes for an extended period of time. This circumstance is further aggravated by the fact that the speed limit is low, 15 m.p.h., over certain turnouts and does not exceed 30 m.p.h. for any part of the plant. Sectional-release route locking is used throughout to facilitate changing line ups as fast as the rear of a train clears the switches or crossovers included in the previous route. Nevertheless, the operation of this Mission Junction interlocking requires fast work on the part of the leverman, as well as a high standard of maintenance.

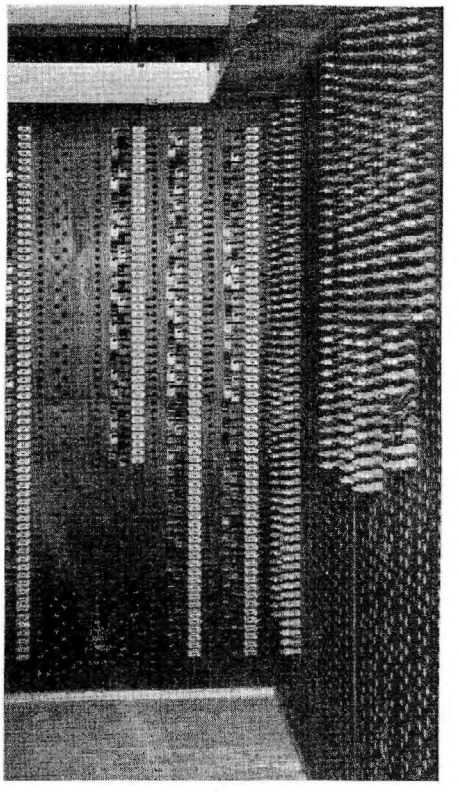


Relay racks in tower

Changes in the Tower

The previous interlocking tower building of concrete construction, was 15 ft. wide and 30 ft. long, including a basement and three floors. A new section of the same construction was added at the west end, thus making the finished building 15 ft. wide and 55 ft. long. In the operating room on the top floor, a 104-lever section was added to the existing 144-lever interlocking, thus making a 248-lever machine of the General Railway Signal Company unit-lever type electric interlocking. New mechanical locking was provided for the entire machine. The wooden case on the old machine was discarded, and a new sheet-steel case installed. Three new illuminated track and signal diagrams are supported from the ceiling over the interlocking machine, the supports being arranged so that the panels slope 12½ deg. from the vertical, thus reducing the amount of light reflection. The left-hand end of the interlocking machine controls the Union Pacific, the middle part controls the Southern Pacific, and all of the track layout extending towards the terminal, while the right-hand end controls the Santa Fe. The three diagrams each reproduce the track layout of the portion of the plant controlled by the levers below them. The purpose of the three separate panels was to provide a diagram of the particular layout, which a leverman was operating, immediately in front of him when handling the levers.

Tile duct through tower basement



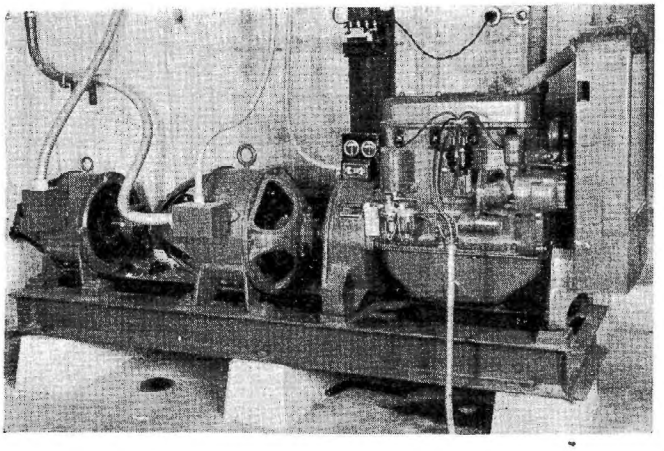
Terminal room in tower

In brief, the new outside construction included the installation of G.R.S. Model-5A, 110-volt switch machines for operating the additional switches, crossovers and derails, and the installation of new searchlight type signals on routes used by passenger trains, the semaphores used previously being used on other than passenger tracks.

Special Control Arrangements

In many ways this new Mission installation represents something quite different from an ordinary electric interlocking. When planning the installation, extensive studies were made to adopt many of the modern ideas of control and locking circuit arrangements, not only as a means of improving safety but also of reducing construction and maintenance, and also primarily to facilitate operation of the plant.

The 110-volt d-c. switch machines are controlled by the regular G.R.S. standard system, using dynamic indication. In addition, each switch controls a WP switch-position repeater relay located in the tower. The signal control circuits are selected through these WP relays to effect regular SS control. Complete approach and sectional-releasing route locking circuits are provided. In addition the complete arrangement of circuit interconnections is in many respects the equivalent of the mechanical locking between levers. The circuits for the plant as a whole are too



The stand-by power unit including gasoline engine, and a-c. alternator and a d-c. generator connected

extensive for reproduction, but an explanation can be given here as to the purpose and operation of several of the more important special features.

Special Relay Checking

All control relays and searchlight signal mechanisms are circuit checked in the energized and in the de-energized positions. Lock stick and time-element relays are checked in the released position. A shunt is maintained on the searchlight signal mechanisms, when released, this being accomplished by contacts in the HR relay which in turn is connected in the combination circuit. The route stick release relay has a slow pick-up characteristic to insure that a light engine will maintain its route in passing over a 19-ft. stagger where 39-ft. rails are used.

All of the interlocking signals are normally on stick control, i.e., the leverman must operate the lever again to clear the signal for a following train. The "inner" signals, i.e., other than plant entering signals, although normally stick signals, can be cleared for following movements over the same route by push button manipulation without further lever operation. For following movements the automatic control is from signal to signal without overlap. This feature decidedly reduces train delays. A closely following movement would hold the approach locking in effect on the signal lever, making it impossible to restore the lever to normal unless the preceding train was in the first track circuit beyond the signal, or unless the time release was operated. The clearing of the signal by push button manipulation makes it unnecessary to operate the lever but does not destroy the approach locking feature.

One normal repeater, NP, relay serves for several signals in a group of opposing signals or converging signals. This one relay controls the normal lock on all these corresponding levers. The control of the NP relay for a group is extended in series through contacts on each of the signal levers, closed from the normal to the normal-indication positions. In effect, locking between the signals in a group is accomplished by interconnection of these circuits. If a signal lever is reversed and the signal does not clear, a repeating relay, controlled by the outside portion only by the NP relay circuit, causes the red signal indication lamp in the symbol for the signal in the model board to remain lighted.

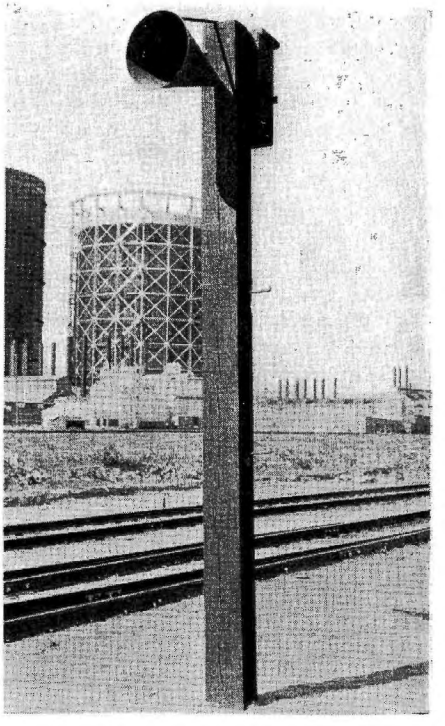
The signal lever lamp is in parallel with the coils of the electric lever lock. If the lever is away from the normal position, and the lock is energized, this lamp is lighted as an indication that the lever is free to be moved.

Automatic Release

No manual release is used for the signals, this being accomplished automatically. When one signal of a group, as explained above, is cleared, the approach locking becomes effective when the approach section is occupied. In normal operation, for a train movement, the signal lever lock is released, and the lever may be placed normal, through the control of the detector section occupied, and also the lock circuit checks the route stick relay de-energized. If a proceed signal is to be taken away from a train which is occupying an approach section, the leverman moves the lever to the indication position, which sets the signal at stop and causes the signal repeater relay NP to be picked up and then the time-element relay starts. At the end of two minutes, the lock relay is energized and the lever lock is picked up. When the proper time limit has expired, the leverman is so informed by the illumination of the lever lamp. In order to prevent accidental momentary shorting of a track circuit beyond a signal from releasing the approach locking, when a train is approaching, the lock release control is extended in series through back contacts of two track relays so that two adjacent track circuits must both be shorted in order to release the approach locking.

Time Releases on Switches

In case a detector track circuit fails, the switches can be operated by means of a sealed clockwork release. In so far as switches are concerned, the plant is sectionalized, using one common for all switches in a group. This main common goes to a bus on the distribution panel in the tower with individual commons from this bus to the switch machines. This method prevents the possibility of multiple indication. For each group there is a clockwork time release, used in connection with a jack box to select one of the several switches in a group. When the release is wound, a stick relay is picked up if all signals controlling routes over the said switch are at stop. With the stick up and the release passing through the 20-sec. "hot spot," the circuit to pick up the lever lock is closed through the jack box. This arrangement provides a safe method of operating switches in emergency when track circuits fail.



Microphone for repeating whistle

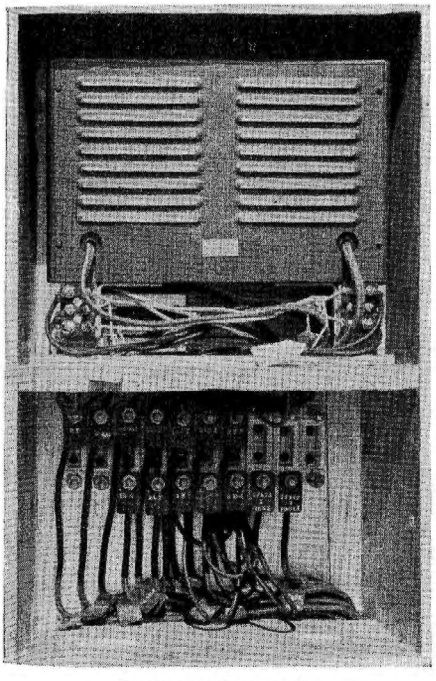
Trap Circuits Over Crossings

Trap circuits were installed in three places where dead sections were of excessive length. In one type of trap circuit, a line stick, dropped by the center section adjacent to the cross-

ing, is picked up by rail contactors. The contactors are used because of lack of space for anything else. In a second type of trap circuit, a line stick is dropped by the center section adjacent to the crossing, and is picked up by track occupancy of the adjacent track circuits on either end. In the third type, a track stick, dropped by the center section adjacent to the crossing, is picked up through occupancy of a pick-up rail.

Special Protection in Lieu of Derails

Although the authorities in the majority of the states do not require derails, such protection was required in this plant by the California Commission. In many instances, turnouts, lined normally for the diverging move, afford derail protection in so far as the crossings are concerned. Derail No. 205, on the northward A. T. & S. F. track just south of the crossing, is of special construction, having a split-point derail for each direction, both operated by one switch machine. The new U.P. connection across the



Loud-speaker unit

river is on a 10-deg. curve as it approaches the crossing with the A. T. & S. F. main line. The use of a derail on this curve was not practicable. Likewise, no derail was used on the S.P. westward track on the bridge between signal 160 and the Santa Fe main line, or between signal 112 and the U.P. double-track line. In lieu of derails at such locations, certain special controls are provided. Unless conditions are such that signal 160 can be cleared, signal 112 cannot be cleared until an approaching train enters a "spotting section" immediately in the approach to signal 112. This spotting section is only 200 ft. long, and, therefore, a train must be going at a very low speed or stop in this section in order to clear the signal under these circumstances. The same type of control, with a "spotting section" 400 ft. long, applies for signal 1 for a diverging route over the U.P.

Whistle Annunciators

Trains approaching Mission Junction on certain tracks may be destined for any one of several routes through the plant. In order that the towerman may know what route to line up, a special arrangement of "whistle repeaters" was provided. In brief, such a system includes a loud speaker in the tower connected to wires extending to equipment at four different points along the tracks approaching the plant. At each field location, a Western Electric Type-232 transmitter, together with battery, etc., is located in a box near the track. When a train occupies the track circuit at that general location, the transmitter is connected through back contacts of the track relay. When the locomotive is in the vicinity of this case, the engineman sounds the locomotive whistle giving a code of long and short blasts. This sound acts on the receiver and is reproduced by the loud speaker in the tower.

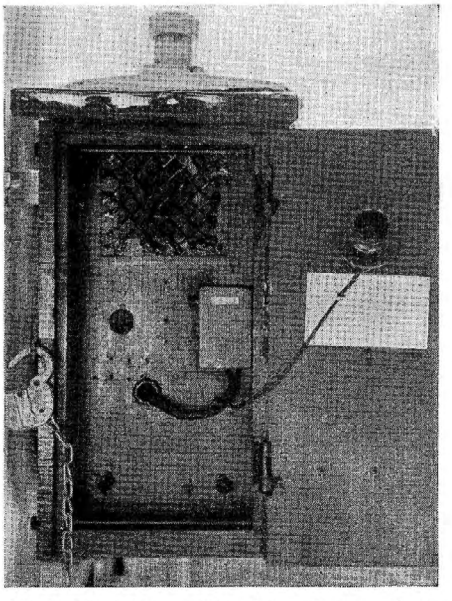
If a train is stopped in the vicinity, a trainman can use the field station equipment as a telephone to communicate with the towerman. Calling in this instance is effected by the trainman pushing a button to cut in a Western Electric Type-349 transmitter. The loud speaker in the tower is a Western Electric No. 579, used with No. 100E amplifiers.

Power Supply for Plant

Power for operating the 93 switch machines is furnished from a set of 60 cells of Exide Type DMGO-9, 80-a.h. storage battery, which is on floating charge from a dry plate type rectifier rated at 120 volts, 2.25 amp. A duplicate rectifier is cut in automatically to add its charging rate every time certain switch machines operate, this being done through the back contacts of a relay which is controlled in series through front contacts of certain of the switch repeater relays. The duplicate rectifier cuts out when the battery voltage reaches 138. Storage batteries feed the track circuits for the trap circuits over the crossings because a momentary loss of power on such circuits would drop the stick relays with no means for restoring them without considerable construction expense. Except for the items above, all control, operating, and lock circuits are direct current, which is supplied from rectifiers fed by alternating current.

The mechanisms of the signals in each group of conflicting or converging signals are all fed from one rectifier, thus isolating a failure to one set of routes. The track circuits, except as mentioned above, are fed from transformers, and wires from the opposite end are extended to the tower to feed an RQ-5 type rectifier which in turn energizes a neutral DN-11, 4-ohm d-c. relay. Mission Junction interlocking is entirely surrounded by d-c. electric propulsion lines, and the possibility of foreign current interference led to the decision to use a-c. rectified track circuits. For track circuits more than 1,200 ft. from the tower, the track relay is at the field location with a repeater in the tower. Separate rectifiers of the RQ-5 and BQ½ type are provided to feed various groups of control and lock circuits. One rectifier feeds all of the control and lock circuits which are confined in the tower.

Outside the tower, the 110-220-volt power distribution is on a three-wire circuit in order to reduce the cost of copper and to improve voltage regulation. In order to localize failures, separate feed circuits extend to each of certain areas, such as the west bank of the river and the east bank. Each circuit is a continuous loop from the tower to all feed points and back to the tower, so that, if a failure occurs in any one section of the cable, it can be cut out and all functions can continue to be fed from the other end. One set of fuses is located in the two "outside" wires at the center



Field telephone and loud-speaker receiver

of each such loop, and at each tower end. There are no fuses or switches in the center or neutral wire. These wires are No. 9 for the west bank feed and No. 6 for the east bank.

A-C. Power Supply

The principal disadvantage of using alternating current so extensively for the supply to such a large interlocking is that failure of the incoming a-c. power would prevent operation of the plant. To prevent such a circumstance, special arrangements were provided. In the first place, a-c. power is brought to the plant on two separate circuits from two independent sources. If either of the outside sources fail, an automatic cut-over circuit breaker switches the load to the connections from the other source. This breaker operates in 3/5 of a cycle; which is such a short period that the filament in a lamp does not have time to cool, nor does a relay have time to drop.

If an extreme emergency should occur, in which both incoming sources of power fail, an alarm is sounded in the tower and the towerman can push a button which starts a gasoline-engine-driven generator set, which will supply the necessary a-c. power for operation of the plant until the normal sources are available. The maintainer can start the engine by a push button in the relay room or by a push button on the engine set. The four-cylinder engine will start, get up to normal speed of 1,800 r.p.m., and take the load in a period of about 7 to 9 sec. The 9-k.v.a., 230-volt, single-phase, three wire alternator will deliver 39 amp. at about 80 per cent power factor. The complete unit was furnished by the Westinghouse Electric & Manufacturing Company, and is powered by an engine from the LeRoi Company, of Milwaukee, Wis. The voltage delivered by the set can be regulated by a rheostat on the switchboard. When the normal incoming sources of a-c. power are again available, the leverman or the maintainer can cut out the feed from the engine set and cut in the feed from the outside sources.

Checking Sequence of Relay Operation After Power Interruptions

A minimum of 8 to 10 sec. elapses from the time outside a-c. is lost until the feed from the engine set takes the load. When power is thrown on the circuits, the line relays controlling the signals might pick up more quickly than the track relays, and, therefore, approach locking then in effect would be lost. In order to obviate such a circumstance, a time delay of 45 sec. is introduced. A power-off thermal time-element relay, POTER, is normally de-energized, but when a-c. power is thrown on the circuits as a whole, this relay starts to heat, and in 10 sec. the front contact is closed to pick up a stick relay POTUSR. Then after the cooling period of 35 sec., the back contact of POTER closes to complete the feed through this relay down and POTUSR up. During this 45 sec., contacts are closed around the stick up circuits to insure that stick relays, which are controlled by track circuits, or levers reversed, pick up as they should in conformance with sequence. The POTUSR is a quick-release relay, which will open its contacts in about 3 cycles.

Either-Direction Train Operation

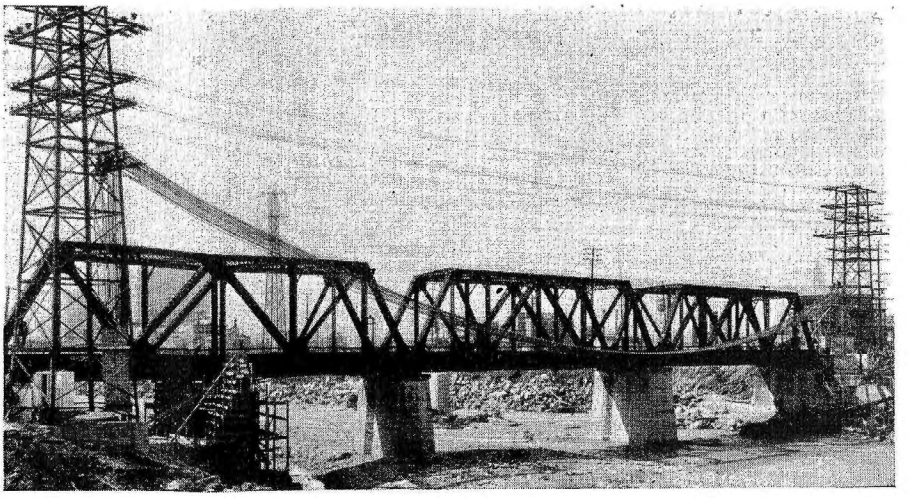
The six track leads between Mission tower and the Los Angeles terminal are each signaled for either-direction train operation. The signals for directing trains to enter this section from either end are controlled by traffic locking which is controlled by co-operative action of the towermen in the two towers. The man at the entering end has final control. In addition to lever lamps, a special loud speaker telephone system is provided for communication between the two towers. The signals on the tracks between the two towers operate non-stick; and, therefore, once traffic direction is established, the signals operate as automatics and clear for following trains without further attention on the part of the levermen.

Either-direction train operation by signal indication is also in service on the two Union Pacific tracks between Mission tower and the Southern Pacific Dayton Avenue tower, and these signals likewise operate non-stick.

Details of Construction

The relay racks on the second floor of the Mission tower are made up of 1¾-in. pine boards using 2-in. by

The field forces which handled the construction of the new Mission interlocking included J. W. Stoliker, construction engineer, W. J. Disney, foreman, and leading signalmen F. A. Olson, W. A. Lee, B. P. Manier, H. T. Phillips. The accompanying photograph includes numbers identifying the men as follows: 1. Whitworth, 2. Overson, 3. Millhouse, 4. Weston, 5. Olson, 6. Stocker, 7. Disney, 8. Stephens, 9. Jones, 10. Fretwell, 11. Burke, 12. Horan, 13. Elliott, 14. Baird, 15. Keate, 16. W. A. Lee, 17. Brown, 18. Hoeft, 19. F. Lee, 20. Walck, 21. Maxwell, 22. Ferguson, 23. Stoliker, 24. Winans, 25. Price, 26. Phillips, 27. Kaufman, 28. Richardson, 29. Carter, 30. Lawrence, 31. Crinklaw, 32. Hyde, 33. Woods, 34. Goodell, 35. Biglelow, 36. Manier, 37. Whitcraft, 38. Miller, 39. McKitchens



Nineteen cables including 500 wires span the 342-ft. distance across the river

2-in. by ¼-in. angle iron supporting frames. Each shelf is 10½ in. deep and 17 in. high, and the racks are six shelves high. The back boards are ¾ in. by 7¼ in. The three wires destined to relay posts of a contact in a relay come through three holes, one above another, in this board; the wire from the top hole goes to the heel, the next to the back, and the bottom to the front. Terminals, mounted on the back board, are used only in case there is a branch off the circuit at that point. The relays are the shelf type except for the L-10 d-c. relays which, because of limitation of space, are mounted in groups on panels which are hinged like doors. All the wiring of control circuits in the tower is No. 14 with 19 strands, using 3/64-in. insulation and double braid. The wire runs in the tower are in ducts or chases made up of No. 10 galvanized sheet iron. The runs in the attic, extending to the model boards, are in Square-D duct.

Outside the tower, the wiring is in cable which is underground except for the span over the river. The underground cables enter the basement of the tower through sections of 12-in. vitrified clay pipe, this type of pipe being used to enclose the cables throughout the cable entrance room, thus reducing the chances for fire damage to a minimum.

Span Across River

The span across the river includes 19 cables totaling approximately 500 wires. These cables are each supported from a ⅜-in. seven-strand Crapo extra high strength, 15,400-lb. test, galvanized iron messenger, using National cable hangers. At each end, these messengers are anchored to existing structural steel towers belonging to the Los Angeles City Bureau of Power and Light. The messengers are attached at a point 25 ft. above rail level, and at the center of the 342-ft. span, the cables sag about 30 ft., which was allowed to reduce the horizontal stress on the towers. These cables are of the aerial construction type, and are terminated on terminals in sheet-metal cases at each end, underground cables being extended from these terminals to the interlocking tower at the west end and to various functions on the east bank end.

The insulated wire and cable on this installation was furnished, one-half by the Kerite Insulated Wire & Cable Company, and one-half by the Okonite Company. The Okonite cable has outer protective covering of Okosheath, while the protection on the Kerite cable is of the "mummy" type. No metal is used in the outer protection of this cable except for the runs across the U. P. bridge, where the same type cables were placed in metal conduit on the bridge deck below the wooden flooring. In general, No. 14 wires were used for control circuits, and No. 6 or No. 9 as required for 110-volt a-c. or d-c. distribution or switch control and operating circuits. No. 9 single-conductor cable was used for the track connections, extending to Raco bootleg outlets with stranded plug type connectors to the rails.

At each switch machine, the cable wires terminate in a cast-iron junction box, from which flexible conductors extend through flexible metal conduit to the machine, thus reducing chances for vibration to break wires. A special feature is that a telephone circuit is available in each of these junction boxes which is equipped with a jack so arranged that a maintainer, by raising a small lid, can plug in his portable phone and talk to the towerman or to another maintainer in the operating room or relay room. A similar telephone jack on the same circuit is located in each instrument case over the entire plant.

Facilities for Locating Grounds

The interlocking machine is sectionalized in six groups, each group with a separate circuit breaker on the operating board. For each section there is a switch "A" which opens the negative side of that section and another switch "B" which opens main common from that section to the outside. If a negative ground develops, the opening of the various switches "A" determines which section is grounded. Closing switch "A" and opening switch "B" of the grounded section, and grounding the positive bus, puts positive battery in the reverse direction through the polar relay of the grounded function. Thus, a ready means is provided for localizing the ground to the affected function. If the ground is of such high resistance that sufficient current will not flow to open the polar relay, then the grounded circuit can be identified by use of an ammeter in the cross-protection circuit of each function in the group.

The installation at Mission Junction interlocking was planned and constructed by signal department forces of the Coast Lines of the Atchison, Topeka & Santa Fe, under the direction of E. Winans, a signal engineer, and under the general jurisdiction of G. K. Thomas, signal engineer system. The engineering was handled under the direction of W. F. Price, assistant signal engineer, Coast Lines, and Russell Foster and J. N. Friedman had charge of the office and field detail engineering. J. W. Stoliker, signal construction supervisor, had general charge of the field forces, with W. J. Disney as foreman. A force of approximately 24 Santa Fe construction men, together with 16 Union Pacific men, were employed for about 12 months, the installation being completed on February 15, 1939, although portions of the plant covering new connections to the terminal were not put in active operation until the terminal was put in service on May 7. The interlocking equipment, including the interlocking machine, switch machines and certain rectifiers, was furnished by the General Railway Signal Company, while many of the new relays and some of the rectifiers were furnished by the Union Switch & Signal Company.