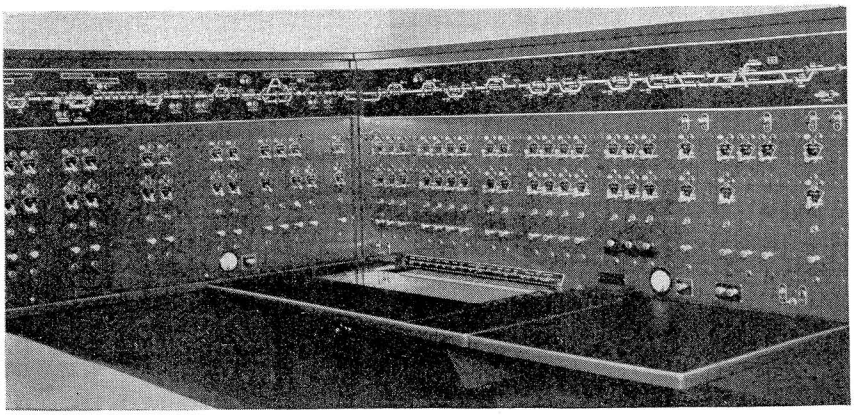
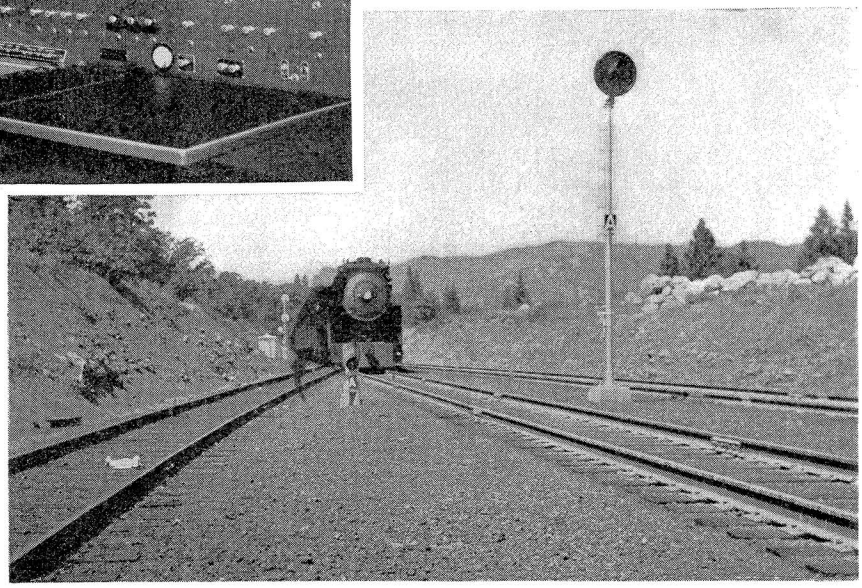
Centralized Traffic Control Speeds War





Above—The C.T.C. control machine includes an automatic train graph and a complete arrangement of lamp indication units. Right—Typical location showing signals at the right of track controlled

THE installation of centralized traffic control on 80.5 miles of single track on the Southern Pacific has relieved congestion in this bottleneck so that the capacity of an entire through route has been increased to meet the demands for handling a large volume of war traffic on expedited schedules. The new centralized traffic control system replaces semaphore type automatic block signaling which had been in service since 1909.

Between a terminal and West which is one end of the C.T.C. project, the line is in open flat country with light grades and curvature, and in the major portion of this section, double track or alternate single track lines are available. Between West and East, 80.5 miles, only the one single track line is available and it is, for the most part, located in the canyon of a river such that train speeds are restricted by heavy curvature, and, on some portions, by heavy grades. Between East and the other terminal of the through route, alternate lines are available on a considerable portion of the line. Thus the section between East and West constituted a bottleneck which limited the capacity of the entire through route.

For purposes of discussion with reference to differences in local grade and curvature conditions, the total 80.5 miles of C.T.C. territory is divided into three sections, section A extending 30.1 miles between West and Adam, section B 26.4 miles between Adam and Bob, and section C, 24 miles between Bob and East.

The First Section

Between West and Adam, 30.1 miles, the ruling grade eastbound, which is the direction of lightest traffic, is 0.9 per cent, while the ruling grade westbound, in the direction of the preponderance of load car movements, is approximately 0.5 per cent. In this section the line includes 49 curves of a 4 deg. maximum, with a total curvature of 2,028 deg., 17.7 miles of the total 30.1 miles being on curves. In this section and except where curves necessitate restrictions in speed, the maximum permissible speed is 60 m.p.h. for passenger trains and 40 m.p.h. for freight trains.

Between Adam and Bob, 26.4 miles, the line follows up the river canyon, with but few sections of tangent and numerous curves, the majority of which range from 8 to 10 deg. The grade ascends gradually northward at an average of about 0.7 per cent although there are short sections ranging up to 1.7 per cent. Northbound tonnage freight trains require one helper which is cut in either at Adam or at Abel which is 4.1 miles west of Adam. On account of the physical conditions, the speeds are limited to 25 m.p.h. for passenger trains and 20 m.p.h. for freight trains.

Third Section Involves Grades

Grades requiring helper locomotives for eastbound trains extend eastward from Bob to East. On a 3.8-mile portion of this section, the line rises from the river canyon, this being accomplished on two long horseshoe curves including numerous long 10 deg. curves and one 14 deg. curve, 1,700 ft. long. The grades vary, with many sections of 1.7 per cent and a few up to 2.7 per cent. The grade on the very long 14-deg. curve is 0.93 per cent.

Thus on account of curvature, the speeds are limited to 25 m.p.h. for passenger trains and 20 m.p.h. for freights in the 24 miles between Bob

Traffic on 80.5-Mile Section of the Southern Pacific

Average time of freight trains reduced due to fewer delays – Track circuits on passing tracks and extra aspects save train time – Carrier current on code line expedites the controls and indications

and East, with the exception that on 3.2 miles, where the curvature is a maximum of 4 deg., the speed limit is 50 m.p.h. for passenger trains and 35 m.p.h. for freight trains.

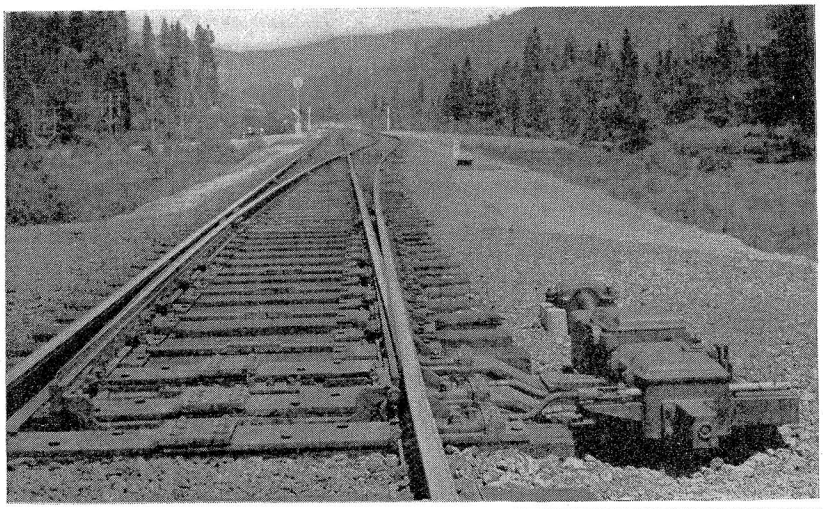
Previous Methods of Train Operation

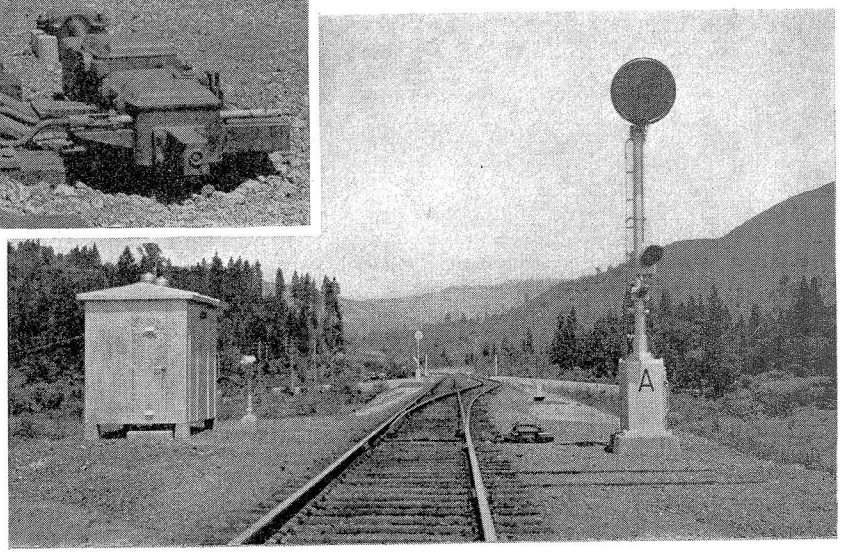
Thus throughout the entire section between West and East, limited train speeds not only increased the time between passing tracks but also increased the time lost when entering or departing from sidings, especially those with hand-thrown switch stands. Furthermore, under the previous operation by time table and train order, arrangements could not always be made for the meets and passes to be made on close time, especially when trains were off schedule and extra trains were required on account of additional war traffic. As a general rule, a freight train which took siding for a meet would lose from 20 to 30 min. When authorizing train movements by time table and train orders, about 60 train orders were issued on each of the three tricks daily.

Four passenger trains are scheduled in each direction daily, seven of these trains each having one scheduled meet and one train two meets on the territory. Under special circumstances, as many as 17 extra passenger trains are handled in a 24-hour period. Three manifest freight trains are scheduled daily, and from four to eight extra freights are operated on certain days of the week. The volume of freight traffic is light eastbound on Monday and light westbound on Tuesday. From Wednesday through Sunday the traffic is heavy. On a normal heavy traffic day there are about eight freight trains eastbound and nine westbound. During the month of December, 1942, 11 passenger trains and 14 freight trains were operated daily in addition to light engine movements, of which there were approximately 6 daily between Bob and Adam and 14 daily between East and Bob. Thus, the average number of movements daily in December ranged from about 31 to 39.

Yards and Passing Tracks

Bob is a subdivision point where all engine crews and freight train crews are changed; therefore, the





Above—Each power switch layout includes three insulated gage plates with adjustable rail braces on three ties. Right—Signaling and power switch at the end of a typical passing track layout

freight trains enter and depart from the yard. Including West and East, there are 23 passing tracks in this territory. On account of physical conditions, the lengths of three passing tracks are limited to 53, 67 and 90 cars respectively, while the remaining 20 passing tracks have capacities ranging from 102 to 120 cars. The

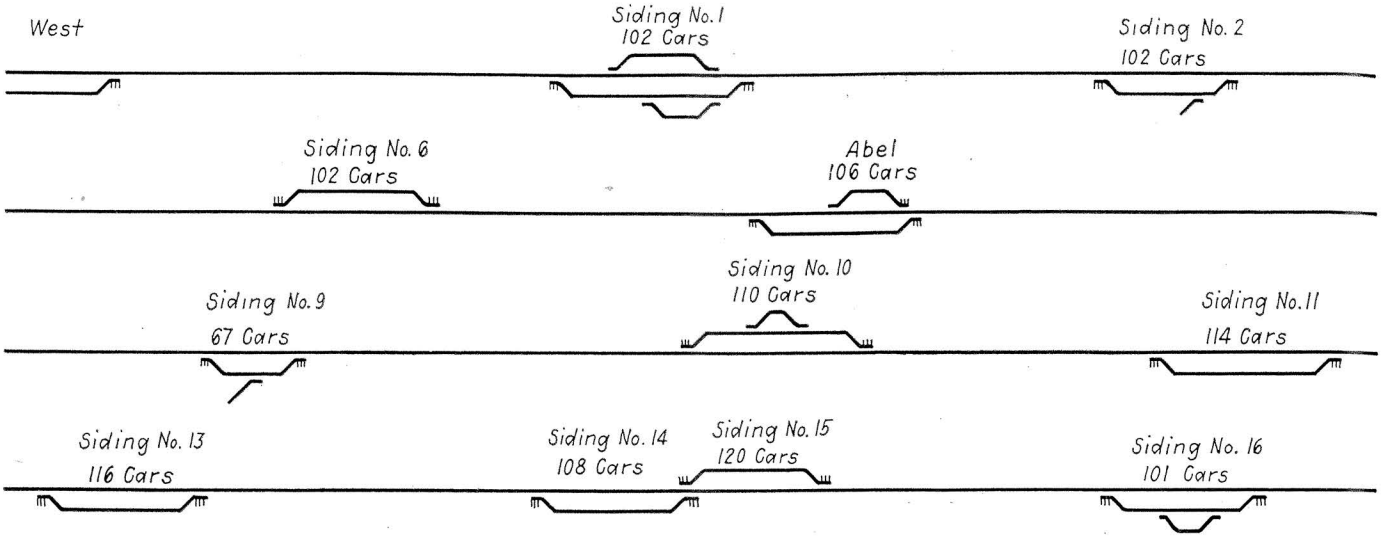


Fig. 1—Layout of passing track on the centralized

manifest freight trains usually handle about 3,700 tons or a maximum of about 86 cars. Other trains with a certain type of locomotive handle up to 5,000 tons or a maximum of about 100 cars. All trains require helpers eastbound between Bob and East, and two or three helpers are required for tonnage freight trains.

Problem Solved by C.T.C.

From a practical standpoint, nothing could be done to change the grades and curvature of the line as a means of increasing the speed of trains when in motion. Furthermore, the enormous expense involved in the addition of second main track was beyond consideration. The only logical solution for increasing track capacity and reducing train time, therefore, was to install centralized traffic control including power-operated switches at the passing tracks and signals for authorizing train movements, thereby superseding time tables and train orders.

The power switches and the semi-automatic signals for directing train movements on the entire 80.5 miles are controlled from the dispatcher's office. By means of track indication lamps and automatic train graph equipment, the location and progress being made by each train are shown so that meets and passes can be arranged on close timing, thereby keeping trains moving whenever an idle section of main line is available, rather than trains losing time unnecessarily on passing tracks. Another consideration is that the power switch machines, as compared with hand-throw stands, permit freight trains to save about five minutes when entering a passing track and from six to eight minutes when departing. These savings are effective in reducing the over-all train time between stations, so that, in numerous instances, trains can be advanced one or more stations for a meet when otherwise they would be held back. Some time saving is effected by being able to accept trains promptly at the ends of the C.T.C. territory, as well as to arrange for trains to depart from the yard at Bob when they are ready to go, whereas, with previous methods, a train might have to wait some time for orders.

In brief, the results accomplished with the centralized traffic control have been highly satisfactory. When off schedule, the passenger trains can make up 10 to 15 min. The time saving for the passenger trains is, in part, due to the fact that the handling of train orders is obviated by the centralized traffic control, and the trains need not reduce speed when approaching stations, as was previously the case when it was necessary that the enginemen observe the train order signal before passing a station.

Prior to 1941, when the volume of freight traffic was normal, the scheduled manifest freight trains were handled on schedule without much difficulty. As traffic increased rapidly during 1941 and 1942, the increased number of extra passenger and freight trains made it more and more difficult to hold the manifest freight trains on schedule. Furthermore, practically all of the freight shipments were of a nature which required expedient handling, so that the so-called dead freight was such a small proportion of the total that all trains had to be handled without delay. Whereas, previously, extra freights had been allowed to work their way along with perhaps three or four hours more time than a scheduled train, on this territory, the problem was to get all trains over the territory in approximately the scheduled time for manifest trains.

On the 31-mile section between West and Adam, the new section of railroad equipped with centralized traffic control, the average time of eastbound freight trains was reduced from 3 hours 13 minutes to 2 hours and 3 minutes, and the average time of westbound freight trains reduced from 3 hours 4 minutes to 1 hour 51 minutes. These figures are based on an average of 8 through freight trains daily in each direction and do not include the freight trains which were involved in 16-hour tie-ups. On the 101.4-mile subdivision between Cain and Bob, the major advantage is that the over-all time in both directions of the extra trains, which formerly accumulated serious delays, has now been reduced as much as three hours.

The major objective of providing the centralized traffic control has been accomplished, i.e., the time of all freight trains over the territory has been reduced to approximately that formerly applying to the scheduled manifest trains. The result is that this territory can now accept all the traffic at each end, and handle it promptly to the other end without accumulating delays out of proportion to the mileage involved as a part of the through route as a whole. Furthermore, this line now has the capacity to handle, with efficiency, any further increases in the volume of traffic that might

reasonably be expected during the present emergency.

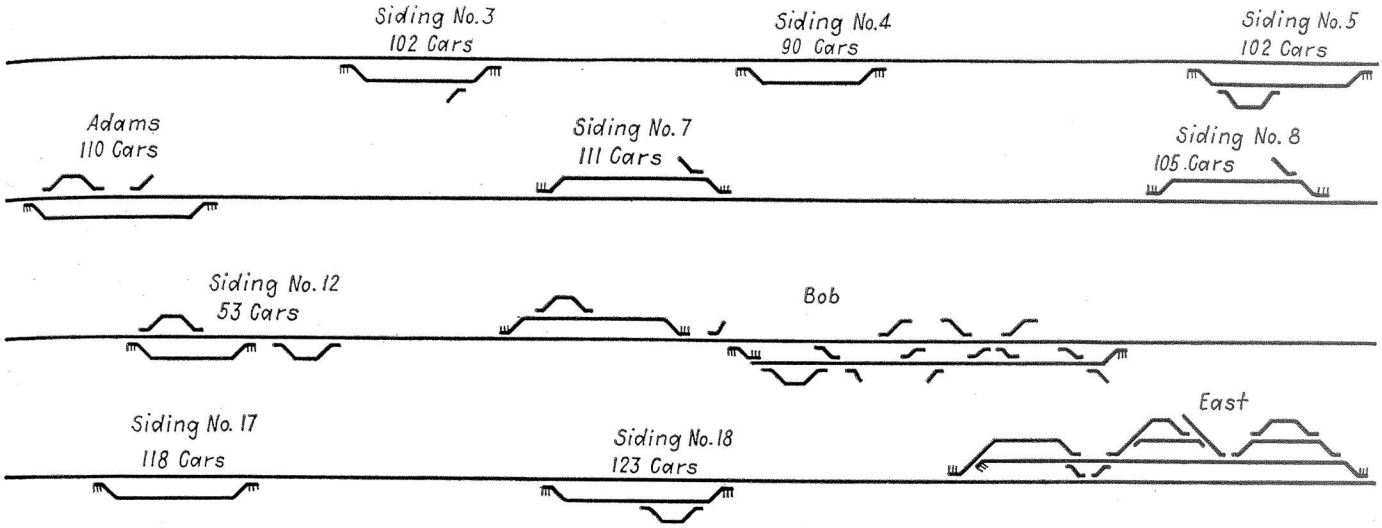
Changes in Flagging Rule 99

Field observations showed that much valuable train time and track occupancy were consumed in providing flag protection when trains stopped, because in most instances the flagman was required to go back around curves, and the time consumed in returning long distances was excessive. Numerous such stops occurred at stations when taking water or when cutting in or cutting out helper locomotives. In view of the fact that the centralized traffic control includes complete automatic block signal protection, a decision was made to modify compliance with the flagging Rule-99, in that flagging protection is not required when a train makes a stop between head blocks at a controlled passing track, except for trains carrying passengers. Flagging is required, however, if a train makes an unusual stop at points between stations. On the average, this change in the application of Rule 99 saves from 5 to 10 minutes for each stop eliminated for a freight train, and may save a total of 20 minutes or more on the average for each freight train operated.

Special Signaling at Passing Tracks Saves Train Time

The turnouts at the ends of passing tracks, which are equipped with power machines are equipped with 24-ft. points so that diverging moves to or from the main line can be made at speeds up to 25 m.p.h. which in general is near the maximum train speed on the main line in much of this territory. On account of the numerous curves and mountains, the engineman of an approaching train which is to take siding cannot see whether the siding is occupied. When the switch is reversed for a train to take siding, it is necessary to provide a signal to govern movements over the switch in the reverse position. In addition to indicating that the power-operated switch is locked in the reverse position and the track section over the switch is not occupied, this signal also indicates whether the siding is unoccupied or occupied by a preceding train. Referring to Fig. 2, if the switch is reversed for a train to enter the passing track, and that track is unoccupied, the lower unit of station-entering signal 5 displays a green aspect under a red in the top unit, which authorizes the train to head in and stop in the clear on the siding. Advance information is given by the display of a yellow aspect on the distant signal 7. If any part of the siding is occupied by a preceding train, and a second train is to be headed in, the lower arm of signal 5 displays yellow under a red in the top unit. This aspect warns that a train is to head in at slow speed, prepared to stop short of the train already on the siding. If the siding is occupied by an opposing train, or the signal at the other end of the siding has been cleared for a movement into the siding, signal 5 cannot be cleared but displays its most restrictive aspect, red over red.

If the sighting distance in approach to the station-entering signal 5 is adequate, advance information for either of the two circumstances explained above is given by a yellow aspect on the distant signal 7. If local conditions are such that the sighting distance to signal 5 is short, when signal 5 displays an aspect of green under red for a diverging move into an unoccupied passing track, then distant signal 7 displays a yellow over green aspect, but if signal 5 displays an aspect of yellow under red for a diverging move into an occupied passing track, then distant signal 7 displays an aspect of yellow only. Thus if the passing track is not occupied, a freight train can proceed prepared to head in on the passing track rather than reducing speed prepared to stop short of signal 5. The extra lower units on the distant signals are of the HC-33 type with yellow glass and equipped with Phankill units. The lamp in the HC-33 unit is normally extinguished, being lighted only under the circumstances explained above.



traffic control between stations East and West

The previous semaphore automatic block signals were removed, and the new installation includes searchlight-type signals for the semi-automatic signals at the passing tracks as well as the intermediate signals. All of the relays as well as line control circuits were installed new as a part of the C.T.C. project.

Three Aspect Leave-Siding Signals and Special Overlaps

Referring to Fig. 2, the leave-siding signals such as No. 3 and No. 4 are capable of displaying three aspects. For a following train movement, if a train has passed signal 8 and is occupying that block, and if a control is sent out to cause a Proceed aspect to be displayed on leave-siding signal 4, with a preceding train occupying the block of automatic signal No. 8, then signal 4 will display an Approach aspect, yellow. On the other hand, if the preceding train is beyond automatic signal 10, then signal 4 would display the Clear aspect, green. The use of the three aspects, red, yellow and green, as compared with the prac-

tice of only red or yellow, affords the advantage that when a green aspect is displayed, the engineman knows that two or more blocks ahead are unoccupied and that he can pull out and accelerate to normal speed assured that he will not need to approach signal No. 8 prepared to stop.

On account of the curves and mountains the sighting distance to some of the intermediate automatic signals is comparatively short. In case a second train is following a first train going in the same direction and the second train is proceeding on the authority of an Approach aspect, the engineman might not be able to stop his train short of the next signal if it were displaying red, even though he may be proceeding at comparatively low speed. For this reason, where local conditions are adverse, the home control of signals is overlapped 2,000 ft. beyond the opposing automatic signal. With this arrangement a train could overrun a signal at least 2,000 ft. before striking the rear of the train ahead.

No Red With a Green

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

Call-On Signal Aspects

At some of the stations where a helper locomotive must pass an absolute signal displaying a Stop aspect in order to be coupled to a standing train, a special C.T.C. controlled call-on signal is provided for authorizing the helper to move into the occupied block. This aspect is given by a third lamp unit mounted on the mast below the other two units. Normally the lamp is extinguished, but, when a couple-up move is to be made, control is sent out from the office and the helper locomotive is moved onto a short track circuit about 100 ft. long in approach to the signal, at which time the signal displays red in each of the two upper units and a flashing yellow in the special bottom unit. The reason for making the track circuit short is to force the helper locomotive to come to a stop or reduce to very low speed before the flashing yellow call-on aspect will appear.

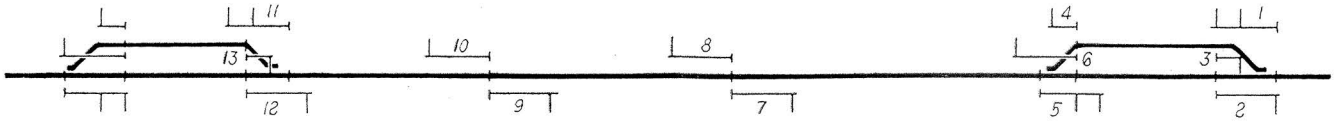


Fig. 2—Typical signaling arrangement

Signal Protection at Hand-Throw Turnouts

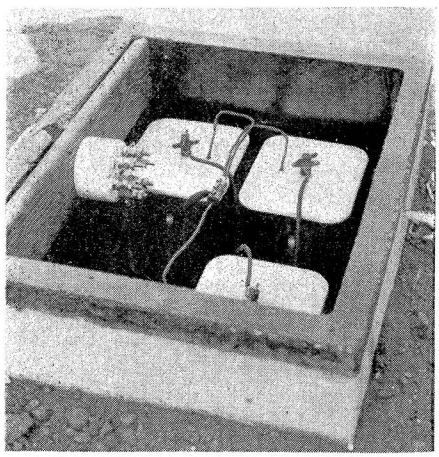
At the main-line turnouts which are not equipped with power switch machines, but which are operated by hand-throw stands, a high-dwarf signal is located opposite the clearance point to govern moves to the main line. A telephone is provided at each of these locations so that the conductor of a train on the siding can secure information from the dispatcher to know that movement of the train to the main line will not interfere with other trains.

Providing the dispatcher has not sent out controls to clear either of the semi-automatic signals admitting trains to the section including the hand-throw switch, the two two-wire line control circuits between passing tracks are energized as explained later. Under these circumstances, when the trainman operates the stand to remove the derail from the track on the turnout, and operates the hand-throw stand to reverse the main-line switch, the signal will display a Proceed aspect to authorize the train to occupy the main track.

Referring now to Fig. 3, when the derail is removed from the track, the circuit controller connected thereto operates contacts which cause relay 25NWPR to be released. The front contacts in this relay operate in the line control circuits so that no signal leading to the location of the said switch from either direction can be cleared. Furthermore, the back points in relay 25NWPR connect the line circuit feeding from the left to relay 4LPR, and other back contacts connect the line circuit feeding from the right to relay 2RPR. If neither station-leaving semi-automatic signal has been cleared and no approaching train is occupying any of the track circuits in the station-to-station block as a whole, then relays 4LPR and 2RPR will be energized, which will control the signal 25 on the turnout to display a green or yellow aspect.

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

Normally the signal operating coil as well as the lamp are de-energized. When the derail is thrown off the track, the lamp is lighted to display a red aspect, and when the switch is thrown, and if the other controls are complete, the signal coil is energized to position the spectacle in the searchlight unit to display either the yellow or the green aspect, as previously explained. If the hand-throw switch is at the end of a siding where regular train movements may be made, there is an approach track circuit provided, which, when occupiel, causes the lamp in the signal to be illuminated.



Typical track battery location

Thus a fact which may well be emphasized is that by using a sepa-

rate two-wire signal line control circuit for each direction, these same line wires serve also for approach lock circuits as well as for controls of signals governing moves from hand-throw turnouts to the main line.

Special Detector Protection

On seven bridges, which have open deck construction, fire detectors are provided which include a circuit with fused connections. At one location where rocks from a mountain side might roll on to the track, a slide-detector fence was provided, a total of 5,500 ft. of such fence being in service on this territory. A set of dragging equipment detectors, as shown in one of the illustrations, is provided at one location.

In brief, if any of the special protection mentioned above is operated, the signals are set to display their most restrictive aspect. Each such signal is designated by a special plate in the form of a triangle which displays the letter "P" in addition to the signal number. The instructions in the divisional time-table explain the form of protection included in the controls of each of the signals with the "P" markers, so that if a train is stopped at such a signal, the crew knows what to look for. An additional feature is that when a detector device is operated, an indication is sent over the C.T.C. system to the control office so that the dispatcher can at once call out the track forces and signal maintainer to clear the track or extinguish the fire, and, when proper to do so, restore the controls to the normal condition.

Track Circuits and Signal Line Controls

The track circuits are the d-c. type using neutral relays rated at 4 ohms except that 2-ohm relays are used in tunnels as a means for securing better shunting characteristics with adverse damp ballast conditions. Each track circuit is fed by three cells of Edison 500-a.h. primary battery connected in multiple. The length of each section of main track opposite a passing track is cut into two track circuits.

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

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

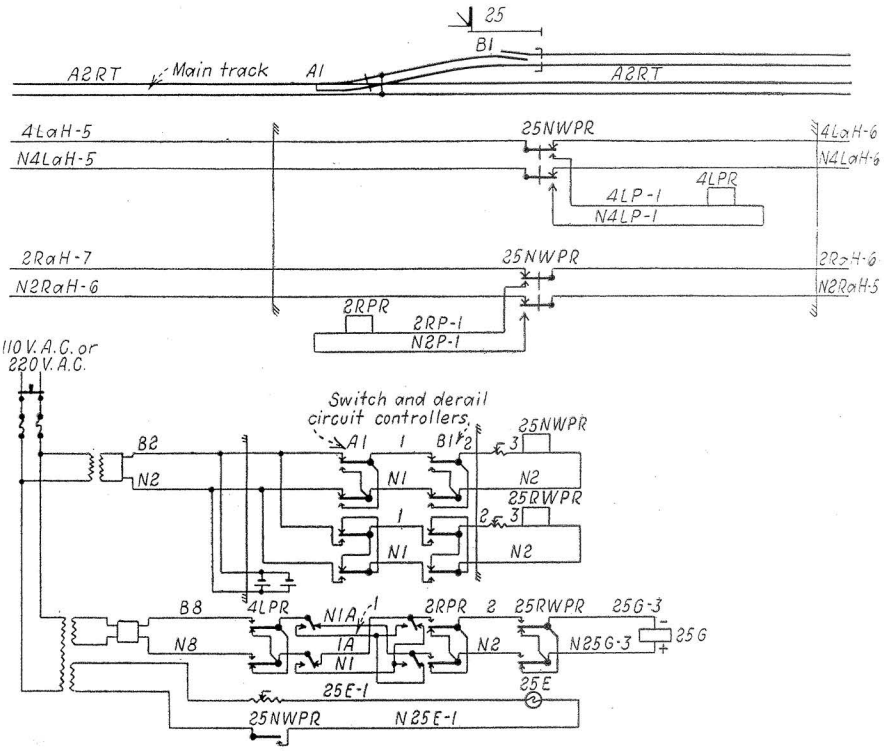


Fig. 3—Circuit for control of leaving signal on turnout with hand-throw switch

The local signal control relays are the Type DP-14 polar rated at 250 ohms. A separate two-wire normally-energized line circuit is used for the controls of signals for each direction. Each line circuit checks through contacts of the track circuits in its respective automatic block. The conventional arrangement of absolute permissive block stick relays provide for the clearing of intermediate signals for a following train. These A.P.B. circuits also include the absolute control of opposing station-leaving signals for a station-to-station block between passing tracks. If a station-leaving signal is cleared, energy is cut off from the line circuits for all opposing intermediate signals as well as the opposing station-leaving semi-automatic signal. Thus if one station-leaving semi-automatic signal has been cleared, the opposing station-leaving semi-automatic signal cannot be cleared, regardless of whether a control code is sent out from the office. Thus the established route and traffic direction is automatically retained. Furthermore, the line controls of opposing station-leaving signals are taken through relays controlled by the approach locking so that if a Proceed aspect of a station-leaving signal is "taken away," the line control circuit of the opposing station-leaving signal is not closed until the expiration of the time release period. Thus, with the two two-wire signal line control circuits, the route and direction are retained and, furthermore, compliance with Item 412 of the I.C.C. Rules, Standards and Instructions is accomplished automatically, without interconnections and extra relays in the control machine.

Signal Line Circuits Used in the Approach Locking Controls

Automatic approach locking is provided, the control of which extends through contacts of the H relay of the signal for the reverse direction, and the control of this relay, for an opposing train movement extends from one passing track to the next. Thus the signal line control serves also in the approach locking without extra line circuits for the locking. If a signal at the next siding has been cleared, or if that signal has been accepted and passed by a train, the signal or switch, if the signal has been

cleared at the given passing track, cannot be changed or operated until a delay period has expired, this period being determined by the operation of a DT-10 time relay.

Code Line Control

The C.T.C. controls are sent out to the field stations and the indications are returned by the multiple time code system, using two line wires. The 504-B scheme of circuits and apparatus is used, the control office equipment having capacity to handle 35 field stations over the two code line wires. The outgoing code chain provides for seven controls at each field station, including switch normal, switch reversed, signal right, signal left, maintainers' call, and two special controls such as for a call-on signal and stick-non-stick signals. The incoming indications include switch normal, switch reversed, signal right, signal left, OS track occupancy, power-off and an extra indication for a special track circuit. This provides for power-off at each end of every passing track and the extra indication step is available for fire protection or approach indication, etc.

Carrier for C.T.C. Line

This project includes the first installation of carrier current apparatus for handling line code C.T.C., controls and indications. On a first section from the control office at Bob to Adam 26.4 miles, the two C.T.C. line wires carry conventional d-c. line code impulse cycles for the control of switches and semi-automatic signals, and the indications are returned to the office by the same means. In this territory these same two line wires handled carrier current between the office and Adam, at which point the carrier current is converted into conventional d-c. impulse code cycles for the control of switches and semi-automatic signals on the section from Adam to West. The carrier current for controls is at 10,000 cycles per second which is above voice frequencies, so that there is no interference with telephone communication. The advantage of using the carrier equipment is that controls to or indications from, the section between Bob and Adam, can be handled simultaneously with controls to or indications from the Adam-West section. The apparatus required for the carrier system is mounted in a sheet metal cabinet with a glass front cover, the equipment at Adam being shown in one of the illustrations. A similar set is located in the dispatcher's office. The equipment is in duplicate at both the dispatcher's office and at Adam so that in case of trouble the spare equipment can be cut in service quickly at either location.

All signal controls are stick; i.e., to clear a signal for a second train, a new control code must be sent. After a train accepts and passes a signal, no code need be sent to set the control apparatus normal at the field station. In addition to the conventional arrangement of levers for the control of switches and semi-automatic signals, the machine includes toggle levers for the control of maintainers' call lamps at the field stations which are mounted below the signal levers. The call-on signals are controlled by special buttons mounted above the switch levers. The locations of trains are shown on the automatic train-graph sheet, and, in addition, the lamps in the track diagram repeat train occupancy of the OS section at the switch locations.

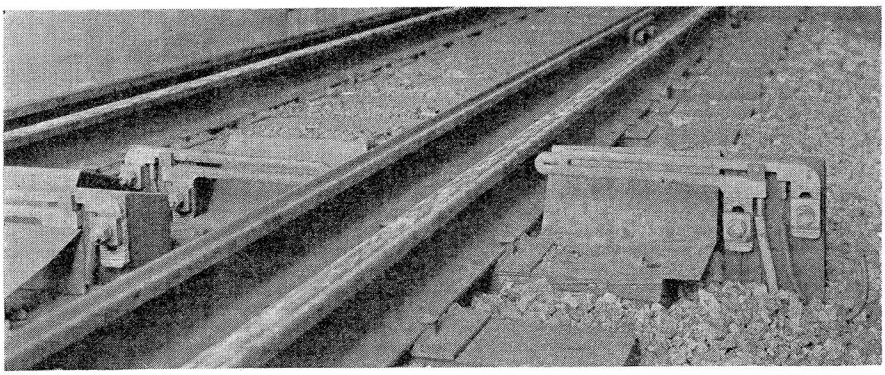
As long as each fire-protection dragging equipment detector and slide-detector installation is normal, a corresponding lamp on the track diagram displays a green indication, but, when the protective device operates in the field, a code is sent automatically to the office to extinguish the green lamp and illuminate a red lamp corresponding to the field location. The dispatcher can then hold trains and call the track forces as well as the maintainer. Details of the construction and operation of fire-protection and slide-detector fences, as used on the Southern Pacific, are explained in an article in the March, 1939, issue of *Railway Signaling*.

Indicators for Users of Motor Cars

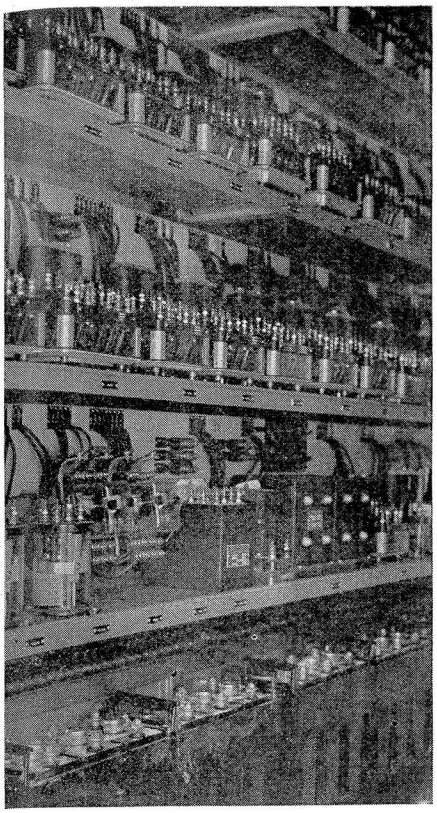
On account of the numerous train movements and the short sighting distances, indicators, which show whether a train is approaching, were installed at numerous points on this territory so that track forces, maintainers and others using motor cars can know when they can proceed with safety. These indicators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

On a portion of the project which was installed first, the indicators are controlled through contacts of the H signal control relays, so that when the dispatcher clears a signal, the indicators display a warning. This scheme of control was not entirely satisfactory, because in numerous instances the dispatchers lined up the signals long before the trains arrived. In the meantime, the maintainers and track crews were waiting. For this reason, on the remainder of the project, the indicators are controlled by circuits which are independent of the signal controls.

In view of the fact that new wire with weatherproof covering was installed for all signal control circuits as a part of the new C.T.C. project, the old bare iron wire, previously used for the line controls of the old semaphore signaling, was available for the control of the track car indicators. The line controls for the indicators are extended through front contacts of the relays of track circuits. One line wire is used as common, and the number of control line wires, at a given place on the pole line, depends on the distance over which the controls of various indicators must extend. Except for special conditions, a total of not more than four line wires are required. An important point is that this indicator system is separate



Dragging equipment detector location



Interior of a sheet-metal house

and distinct from the automatic block or C.T.C. systems, separate batteries being used to feed the indicator line circuits so that line crosses or grounds cannot affect signaling circuits.

Power Switches Well Constructed

Previously the main track switches in this territory were operated by hand-throw stands. As a part of the C.T.C. project, Type-M22A dual-control low-voltage d-c. electric switch machines were installed.

At each power switch, three 1-in. by 9-in. insulated gage plates were installed with Racor adjustable rail braces. Two of these plates extend out under the switch machine, which fits snugly between toe plates; thus lost motion between the rails and the machine is prevented. The toe plates and the riser plates at the rails are welded in place.

The turnouts are No. 12 or No. 14 with 24-ft. points. In order to facilitate operation by minimizing friction, each set of switch points is equipped with a set of roller bearings which normally support the points free of the slide plates.

Pole Line Construction

On the 30.1 miles between West and Adam, a new pole line was constructed to carry communication as well as signaling line circuits, the latter being on the bottom arms which have a capacity of 10 pins each. The poles are butt treated cedar ranging from 30 to 35 ft. in length and are spaced from 40 to 50 to the mile. Between Adam and East, the previously existing signaling pole line was rehabilitated, approximately 40 per cent of the poles and 80 per cent of the anchors and guys being replaced, the new poles being fir, treated full length with creosote.

The two line wires for the C.T.C. line coding are No. 8 copper with weatherproof covering, and the same type of wire is used for the signal line controls in sections where heavy ice loads are encountered, but on the other sections, No. 9 iron wire with weatherproof covering is used for signal line circuits.

The a-c. power distribution circuit is on No. 6 bare copper wires. Commercial power is available at various locations to feed about four miles in each direction, thus including all signal locations but leaving a gap from the end of one feed to the nearest end of the next, thereby saving line wire. Ordinarily, the feeds are not more than three miles for a 220 or a 110-volt circuit, but a 220-volt circuit can be used to feed up to six miles if the load at the far end is not too heavy.

At the various switch and signal locations, the 110 or 220-volt a-c. power distribution circuit is extended to a W-10 transformer and an ANL-30 power-off relay unit in the instrument housing. Rectifiers are provided to charge the storage batteries for operating the switch machines, control circuits and line coding apparatus. On certain sections of the project, the storage batteries are the Exide lead type, while on other sections, Edison nickel-iron type batteries are used. Each track circuit is fed by three cells of Edison 500-a.h. primary battery, connected in multiple.

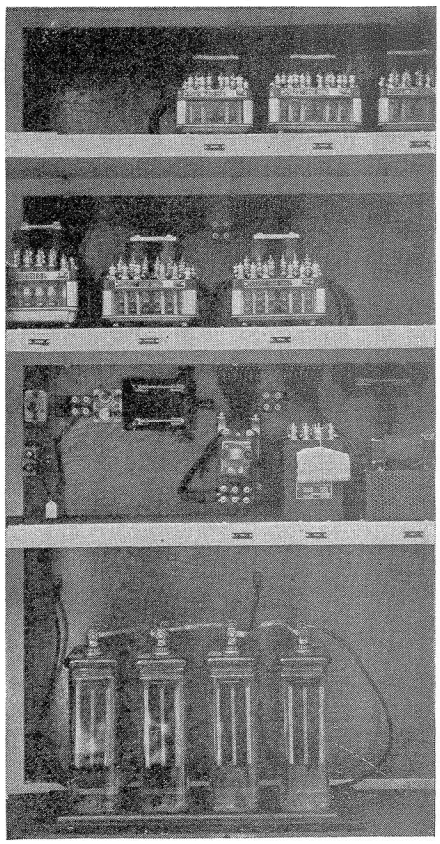
Insulated Wires and Cables

The drops from the line poles to the instrument housings are in multiple-conductor No. 14 aerial cable ranging up to 37-conductor. The insulated wiring in the instrument housings is either No. 14 or No. 16. The underground cable is No. 14 for controls, No. 9 for signal lamp circuits, No. 6 for switch feeds and No. 10 for track circuit connections to the track. The switch control relays are located in the sheet metal houses so that a six-conductor No. 6 cable as well as a 10 conductor No. 14 cable extends to each switch machine. The underground cables have non-metallic mummy-type protective coverings and were furnished by the Kerite Insulated Wire & Cable Company.

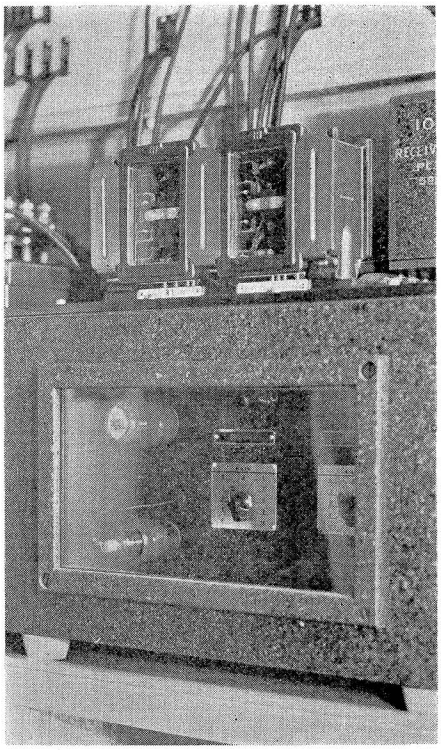
Thyrite type arresters made by the General Electric Company are used on the code line and on the signal line circuits, one set of these arresters being located in the instrument housing and another set in a box on the pole under the cross-arm. The special purpose of the arresters on the pole is to drain off static and provide protection to the drop cables from lightning surges. Experience on the Southern Pacific has proved that this arrangement is effective. General Electric Company pellet-type arresters are used on the 220-volt a-c. power distribution circuit.

Ground connection for the arresters in the instrument houses is obtained by connecting to one of the track leads. Normally there are four-track leads, entering the instrument house; three of these leads are also connected to Thyrite lightning arresters, and the fourth lead is connected to the ground post of all lightning arresters, including the three for track leads. With this arrangement, lightning coming in on the rails from either direction is influenced to pass through the location and be dissipated on the rail beyond, rather than affecting the track relays.

By providing lightning arresters at all track cuts and always using the track lead that connects to a certain rail and extending in the same direction, the rail actually becomes a condenser of large capacity, since a charge



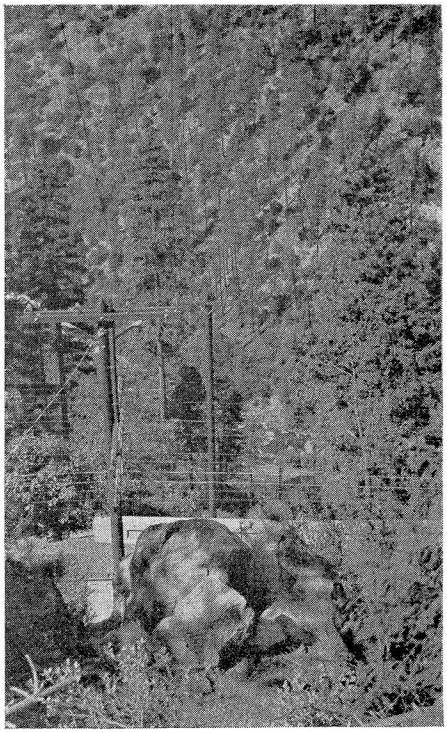
Case at an intermediate signal location



Oscillator-amplifier unit in the carrier system

will continue to dissipate through several track circuits by discharging through a lightning arrester at each consecutive track cut.

Two Copperweld ground rods, 5/8 in by 6 ft., are driven at the line pole and one such rod is driven at the instrument housing at each C.T.C.



Pole line down mountainside

code location. A 9/32-in. hole is drilled through the rod, 1 in. from the top, the ground wire being connected to the rod by driving a channel pin in this hole.

On account of the scarcity of aluminum due to the war program, the practice of using aluminum paint on signaling equipment has been abandoned on the Southern Pacific. For this reason, a new type of enamel made by the National Lead Company, and known as "S.P. Co. Silver Gray Exterior Eggshell Synthetic Enamel No. 8x59," was used for painting the signals, instruments cases, etc., on this project. This enamel is gray, being slightly darker than aluminum. It is easily applied with a brush or a spray. Enamel of this type, which has been in service now for a year or more, seems to maintain a good appearance and render satisfactory service.

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

Lap Order Results In An Accident

On December 11, 1942, a head-on collision occurred between two freight trains near Tebbetts, Mo., on the Missouri-Kansas-Texas. The following information concerning this accident was abstracted from a report by the Interstate Commerce Commission.

In the vicinity of the accident this line is single-track, over which trains are operated by time table and train orders, no block system being in service. During the 30-day period preceding the day of the accident, the average daily movement in the vicinity of the accident was 21.46 trains.

At Hartsburg, 22 miles south of Tebbetts, the northbound freight train, Second 72, received train order No. 57 reading as follows: "Second 72 Eng. 737 wait Tebbetts 12:10 p.m. for Extra 853 South."

This northbound train Second 72 departed from Hartsburg at 11:29 a.m., and, while traveling at an estimated speed of 35 to 40 m.p.h., it collided head-on with Extra 853 South 3.8 miles south of Tebbetts.

At Mokane, 6.1 miles north of Tebbetts, the southbound freight train Extra 853 South, received a copy of train order No. 57, previously quoted, directing that train to wait at Tebbetts until 12:10 p.m. On arrival at Tebbetts, this southbound train received train order No. 61 reading in part as follows: "Extra 853 South has right over Third 72 Eng. 892 Tebbetts to Boughner and has right over Fourth 72 Eng. 898 Tebbetts to Easley Second 72 wait Hartsburg 12:45 p.m. for extra 853 South."

The northward train Second 72 did not receive a copy of train order No. 61, in the meantime was proceeding northward between Boughner and Tebbetts on the authority of train order 57 which gave up to 12:10 p.m. for this train to arrive at Tebbetts.

On the authority of train order No. 61, the southbound train Extra 853 South left Tebbetts at 11:55 p.m. The first that the members of the crew knew that anything was wrong was when the engineman saw Second 72 approaching at a distance of about 800 ft., and he immediately moved the brake valve to the emergency position. He stated that the speed had been reduced to about 3 to 5 m.p.h. when he jumped off just before the collision occurred. The point at which the members of the engine crew of Second 72 first saw the other train cannot be determined because both the engineman and fireman were killed in the accident.

According to the statement of the train dispatcher, he erroneously worded that part of order No. 61 which contained the provision for Second 72 to wait at Hartsburg. It should have read Third 72 instead of Second 72. The order was repeated as sent and he failed to detect the error. He said there was no condition in the dispatcher's office that caused him to become confused.

In the territory involved, trains are operated by time-table and train orders only. The Commission investigated a head-end collision between two passenger trains which occurred in this territory on December 17, 1941, and resulted in the death of 3 persons and the injury of 14 persons. The report of the Commission covering the investigation stated that if an adequate block system had been in use on this line the accident would not have occurred, and recommended the establishment of an adequate block system on the line involved. In the present case, if an adequate block system had been in use, the accident would not have occurred. This carrier has an automatic block-signal system in operation between Easley and Sedalia, Mo., a distance of 64.7 miles. The northern end of this system is 31.2 miles south of Tebbetts.