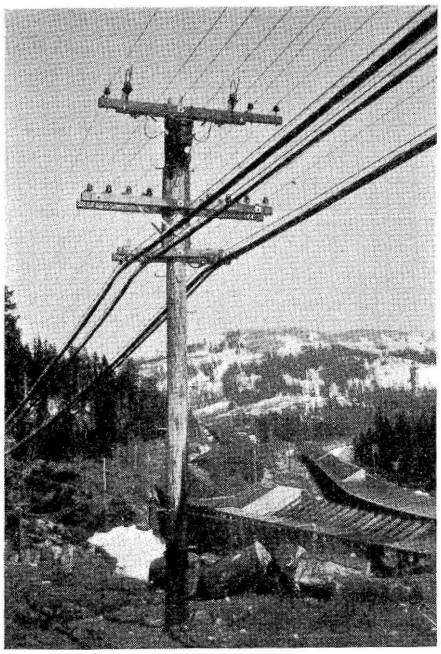
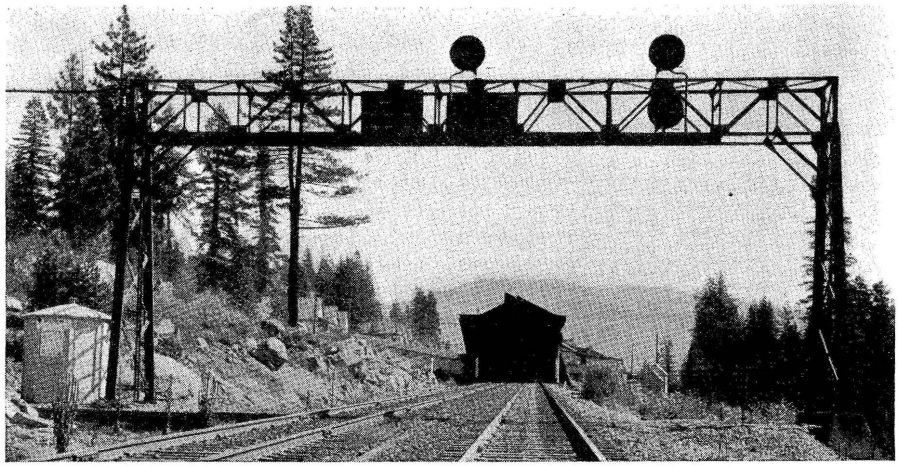
Electric Interlocking in Snow

Train-stop used in conjunction with home signals—Watchman and fire-alarm system—Either-direction operation on double track



View showing cable construction with snow-sheds over tracks in background



Home-signal bridge at west end of Norden

A 56-LEVER electric interlocking, involving switches and signals in a track layout more than a mile long, is located entirely under snow sheds at Norden, Cal., near the summit of the Sierra Nevada mountains on the main line of the Southern Pacific between San Francisco, Cal., and Ogden Utah. The elevation is 6,880 ft. at Norden, which is located just west of the tunnels through the crest of the divide.

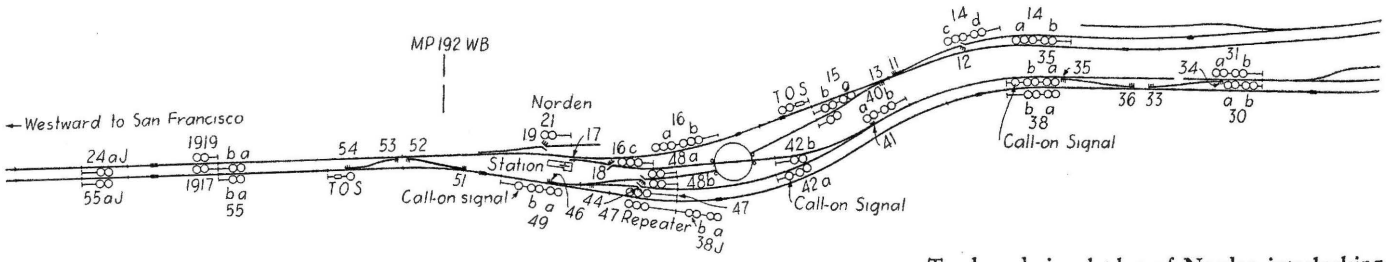
The ascending grade from the west starts at Roseville, Cal., and extends to Norden, the difference in elevation being 6,718 ft. in a distance of 85 miles, the line ascending at a uniform grade of about 2 per cent all of the way. Likewise, from the east the grade starts at Sparks, Nev., just east of Reno, and ascends 2,453 ft. in the 54 miles to Norden, the grade ranging from 1 to 2½ per cent.

Ordinarily, each freight train consists of about 100 cars, using one helper locomotive near the rear and another about midway of the train. The track layout at Norden, the crest of the grades, is laid out to facilitate movements necessary to cut out these helper locomotives and remake the train ready for its descent down the grade.

The main line throughout this division is double track, and approaching Norden from the west, the two tracks are parallel and on the same grade. However, at Norden the two lines separate, the eastward track being on a new alinement running through a new tunnel at a lower elevation than the westward track, which uses the original line and tunnel.

A separate passing track is located along each of the two main lines, starting in the station layout at Norden, and extending eastward. The two main lines in this area were so constructed on different grades that a train on the eastward siding is on level track while a train on the westward siding is on a slight descending grade so that it is easy for a single locomotive to start the train when ready to depart.

When an eastbound freight train approaches Norden, it enters the passing track through switch *46* reversed, and the head end is stopped short of the east switch *27,* and the rear end east of derail *44.* The helper in the center of the train is then east of signal *31.* The train is cut ahead of the helper. This helper backs the train so that it is west of signal *39,* after which crossover *35* is reversed. The helper then cuts off and moves on to the main track after which the crossover is again placed normal. The second helper leaves the cars behind it west of signal *42,* pushes the train



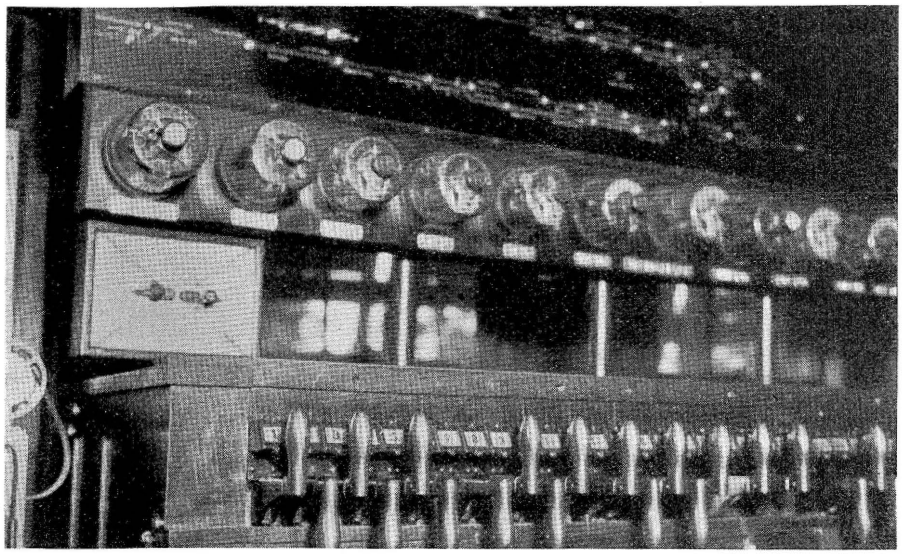
Track and signal plan of Norden interlocking

Sheds on the Southern Pacific

together, backs up through switch *41* reversed, is turned on the table and is routed through switch *17* to the westward track. The first helper that was cut out moves west on the main track, stops west of signal *49* and is moved on to the siding to couple the remaining cars. It is then moved to the turntable and is also routed through switch *17* to the westward track and both helpers then return light to Roseville.

In the meantime, the train is recoupled, the retainers turned up and the train is ready to depart. The same general procedure is followed in the handling of westward trains. Approximately 8 freight trains are operated in each direction daily, while during the peak of 1929 as many as 18 freight trains were operated in each direction daily.

The present schedule includes three passenger trains in each direction daily. No helper locomotives are used on the passenger trains, the same type of power being used for both passenger and freight trains in this territory. An interesting feature of the motive power is that the locomotive is operated with the cab end to the front, the tender being pulled at the other end of the locomotive, this arrangement being practicable because oil is used as fuel. The advantage of having the cab at the front is that the enginemen have a clear view of the track and signals without interference of locomotive smoke, this feature being of special benefit on account of the numerous snow sheds and tunnels on this division.



A special interlocked controller for the turn-table signals is mounted at the left of the machine

The Interlocking Plant

The train movements in this area are directed by a 56-lever General Railway Signal Company all-electric interlocking, the machine being located in a one-story concrete building located between the main tracks under the snow shed. The interlocking machine has 53 working levers to control 8 switches, 5 crossovers, 4 derails and 62 interlocked signals. A separate lever is used for each end of every crossover. A separate lever is used for each electric lock on the hand-thrown switches and another lever is used for traffic locking.

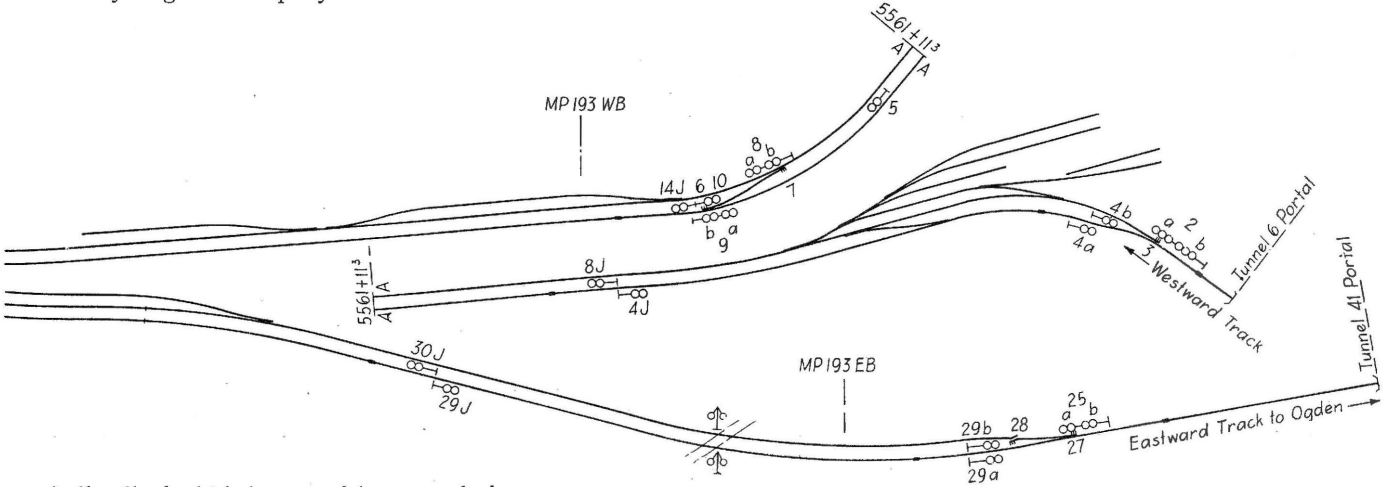
The number plate for each signal lever has a lamp which is normally extinguished but is lighted when the lever is reversed and the signal clears. The regular system of G.R.S. dynamic indication is used for the switch control circuits.

On account of the fact that the leverman has a very limited view of the tracks, a large illuminated track and signal diagram, which shows track occupancy of each track circuit, was constructed and mounted over the interlocking machines.

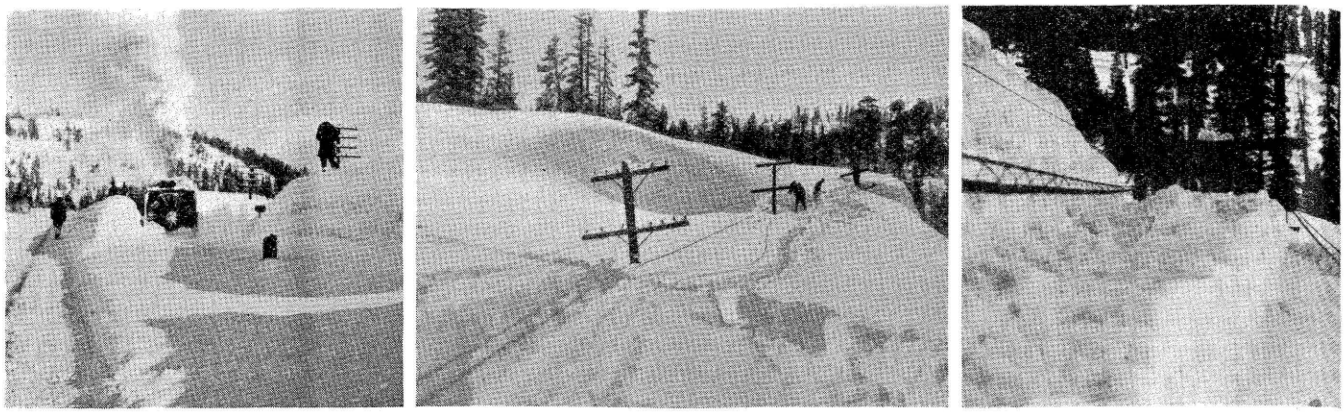
The signals for directing the movements of locomotives off of the turntable are controlled by two special circuit controllers, the handles of which are arranged on a special panel as shown at the left and just above the cabinet of the interlocking machine. These two levers are interlocked so that signals cannot be displayed for conflicting movements.

Outside Equipment

On account of the limited side clearance in the snow sheds, it was necessary to use light signals and even with this type there was no space available for backgrounds. However, backgrounds or hoods are not necessary because very little sun-



practically all of which is covered by snow sheds



Winter scenes illustrating the difficulties encountered in fighting snowdrifts

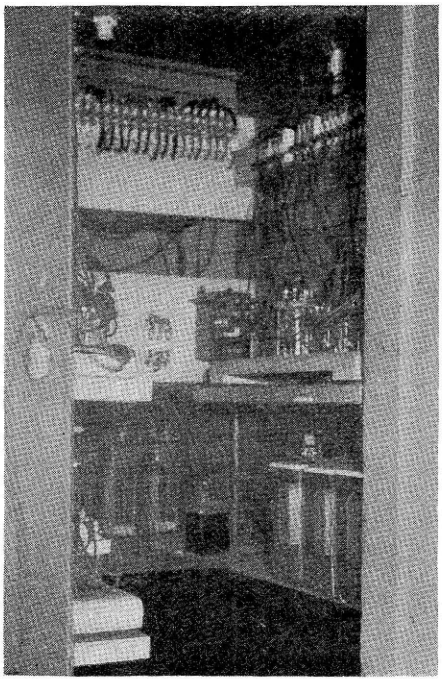
light enters the snow shed or tunnels, especially in winter when all of the windows and openings are closed. The signals are of the color-light type using 8-volt lamps with two filaments, the main one being rated at 13.0 watts and the secondary rated at 3.5 watts. On account of the difficulty of seeing certain signals, it was necessary to install a duplicate repeater signal on the opposite side of the track, such repeaters being used for signal *47* and signal *48*. The signals located outside of the snow shed, such as No. *55*, are of the searchlight type. Three signals, No. *49*, No. *38* and No. *42* are equipped to display special call-on aspects, used only to close in a helper locomotive when the block is occupied. Such a call-on aspect is controlled by reversing the signal lever and pushing a button, the signal being displayed provided the switches are in proper position and locked, and the track circuit between opposing signals is unoccupied. The call-on signal consists of a Style-H crossing signal unit equipped with a yellow lens and the aspect is a flashing yellow.

Special Train-Order Signal

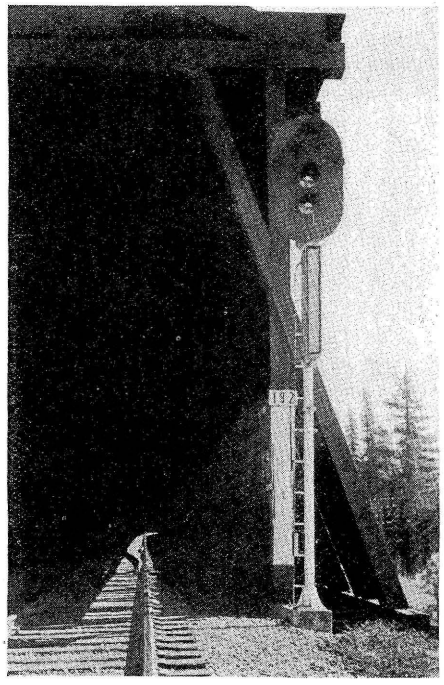
Another special feature of the signaling is the use of color-light train-order signals, one for eastbound and the other for westbound trains, located as shown on the plan. These signals are of the color-light type and are normally dark, and the signal indicates red when the train enters the approach lighting circuit. The signal will indicate green when the train enters a short track circuit in the approach of the signal, provided the train order signal lever is reversed, but when a train is being directed to stop for orders a red aspect continues to be displayed. An illuminated sign reading "Train-Order Signal," mounted on the mast below the signal unit, is lighted when the signal aspect is displayed. Each of these signals is located some distance in the approach to the office, and the rules direct the engineman of a train encountering a red signal aspect to reduce speed and stop at the office for orders. Each train-order signal is controlled by a separate lever in the interlocking machine.

Train-Stop Through Plant

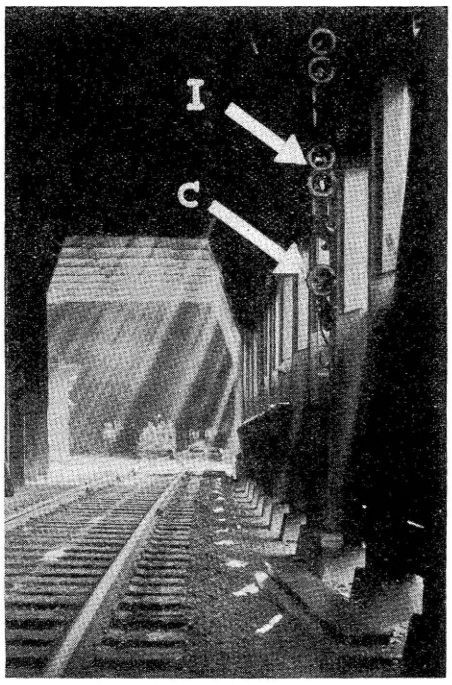
Several years ago, the Southern Pacific made a voluntary installation of intermittent inductive train-stop, operated in conjunction with its automatic signals, between Andover and Emigrant Gap. This installation continues through the Norden interlock-



Instruments and battery located in insulated houses



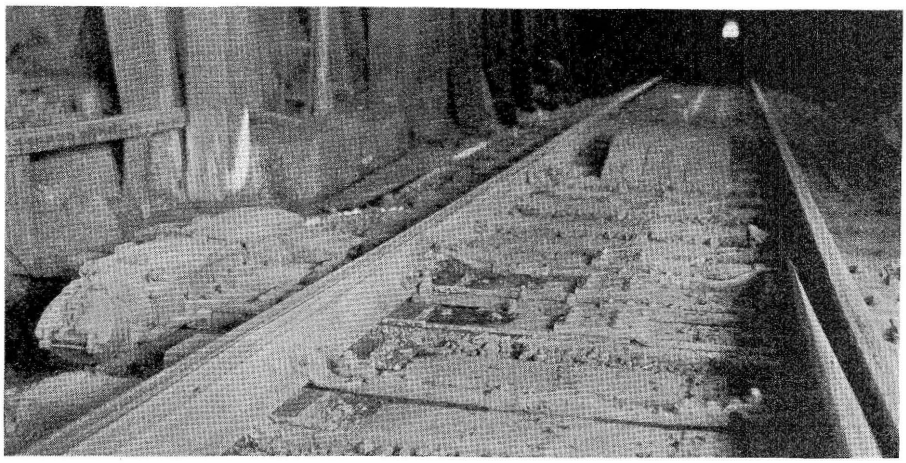
Illuminated train-order sign mounted on the signal



Call-on signal marked by arrow "C" and interlocking signal by "I"

ing plant. The National Safety Appliances Company system of intermittent train-stop is used, a track magnet being located in the approach to each main-line home and distant signal of the interlocking, as well as at each automatic signal. A total of 96 locomotives, operating over this territory, are equipped with train-stop apparatus.

The switch machines are of two types, the G.R.S. Model 5 and the G.R.S. Model 4, both types being equipped with 110-volt d-c. motors. The usual lock rod and point detectors are used on these switch machines. The switch layouts are well constructed, using 1-in. by 8-in. gage plates and rail braces on three ties, including the one ahead of the points.



Switch layout and train-stop magnet in snow shed

Power Supply

The main battery, located in a room adjacent to the operating room, consists of 60 Exide DMGO-9 lead cells which are on floating charge of about 1 amp. from a motor-generator set. A separate low-voltage battery, for control and lock circuits, consists of five DMGO-9 cells, charged by a dry-plate rectifier. At each signal location there is a set of four cells of the DMGO-5 type of battery, used for local circuits and as a stand-by supply for the signal lamps. In order to protect the instruments and battery from severe temperatures, a frame house 4 ft. by 6 ft., with double insulated walls and door, is provided at each signal location.

Each track circuit is fed by a set of three cells of 500-a.h. Edison primary battery located in the same housing. A limited number are housed in concrete boxes set in the ground.

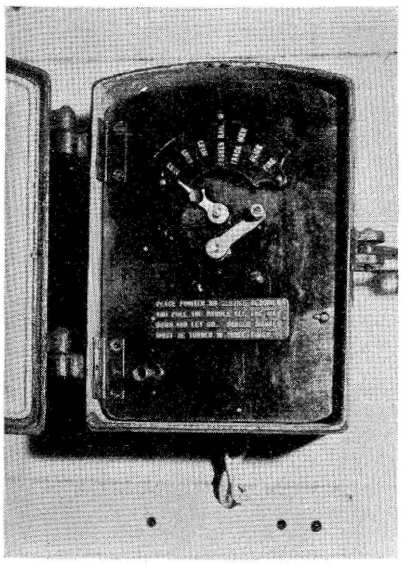
The wiring distribution over the plant is in Kerite aerial cable on stranded messenger, using Raco cable straps run on the pole line outside of the sheds. The underground runs are Kerite No. 10 wire with 5/64-in. insulation. The connections to the train-stop magnets are No. 10. The track connections are also No. 10 wire except where the loads are of considerable length and No. 6 wire is used.

Watchman and Fire Alarm System

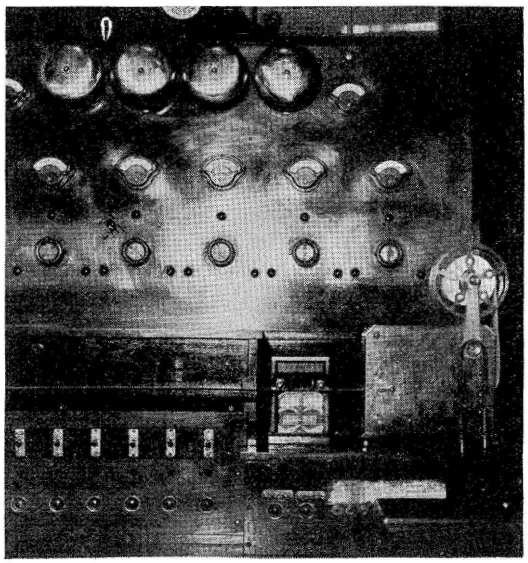
In addition to the extensive snow sheds over the Norden track layout, there are numerous other short snow sheds over sections of the track for several miles in each direction from Norden, a total of about 14 miles of the line being so protected. As this area is covered by spruce, cedar, pine and other inflammable timber, the fire hazards are serious. Therefore, the Southern Pacific maintains lookout and fire-alarm systems, as well as fire protection.

Located at a central point, which overlooks about 25 miles of the main line west of Norden, there is a lookout station with a man on duty at all times. Other watchmen patrol all sections of the line daily. Located at various points along the line there are a total of 37 alarm stations, which are connected by circuits extending to a central panel in the tower at Norden. The equipment operates like a city fire alarm system. A certain number of the boxes are connected in series on a circuit using one line wire with the far end grounded, a total of six such circuits being used on the Norden system. Each of these six circuits is fed separately and regulated by a separate rheostat. A battery of 30 DMGO-5 Exide storage cells is provided to feed this alarm system, each of the six line circuits requiring about 60 m.a. normal discharge.

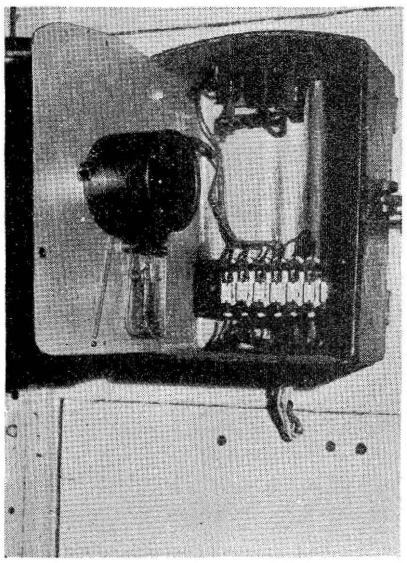
A view of one of the alarm boxes is shown in an illustration. Normally the box is out of the circuit, being cut in by a button operated when the outer door is opened. When a watchman is ready to report, he sets



Alarm station with outer door open



Central station of alarm system



Alarm station with inner door open

the point to the word indicating what he wants to report and then pulls the handle down. By means of a selector sending arrangement inside the case, this sends in a code which causes the central station equipment to ring a bell and operate a perforating tape to indicate the box number, the time, and a code explaining the condition or circumstance being reported, such as broken rail, slide or fire, or to call track men. When no danger is to be reported, the watchman sets the point to either West or East, depending on the direction in which he is going, and sends in the report as a matter of record. In case a dangerous condition is being reported, an alarm is sounded and the operator at Norden checks the tape. For example, if a fire is reported, he takes steps to stop the trains on the line and calls out the fire train, which is maintained at Norden under steam and fully manned, ready for immediate dispatch.

Either-Direction Signaling on Double Track

On the line descending the west slope of the mountains, between Norden and Emigrant Gap, 20 miles, there are several tunnels and numerous snow sheds. On account of the frequent occasions when fire, slides, or other trouble interfere with clearances on one track or the other, it is highly important that arrangements be provided so that trains can be operated in either direction on each of the two main tracks in this territory between Norden and Emigrant Gap. Normally trains are operated right-hand running, but if one track or the other is blocked between two stations, the other track can be used to run trains in either direction the same as on a single-track road.

At Norden, as well as at Emigrant Gap, crossovers and sidings are available for routing trains to either main track. Likewise, at two intermediate stations, Troy and Crystal Lake, there is a center passing track with connections to both of the main lines at each end so that trains can be crossed over from one track to the other through hand-throw switches.

When it is necessary to run trains against the normal direction of traffic, such movements are directed by train-orders and signal indications, the signals being controlled by check locking arrangements, using desk levers at the intermediate stations. Automatic block signal protection is provided for trains moving in either direction on each track. However, the automatic blocks for reverse running are somewhat longer than those for normal direction operation. Color-light automatic signals are used throughout this territory. At the locations where signal bridges were not available, the signals for reverse running were located on ground masts between the two tracks which are spaced on 17-ft. centers, thus allowing clearance for a signal mast, but the usual background had to be eliminated.

The interlocking and signaling described in this article were designed and installed by the signal forces of the Southern Pacific.

Accident at Drawbridge

ON FEBRUARY 12, 1935, there was a derailment of a passenger train on the Florida East Coast near Jupiter, Fla., which resulted in the injury of 73 persons as well as the wrecking of a drawbridge. The following information was abstracted from the report of the investigation made by the Bureau of Safety of the Interstate Commerce Commission.

The accident occurred on the double-track line that extends from Fort Pierce to Miami, Fla., over which trains are operated by train-order and time-table authority, with automatic block signals. The point of the accident was at the end of the draw span of a steel-girder drawbridge over the Jupiter river.

The signals involved are of the color-light type, there being a home signal near the bridge, an approach signal 2628 ft. away, with approach-locking circuits extending 9,695 ft., in the approach to the home signal. In addition, a smash-board signal is located 9 ft. beyond the home signal.

Special time-table instructions restrict the speed for passenger trains to 65 miles per hour on tangent track, 55 m.p.h. on curves, and 45 m.p.h. over Jupiter drawbridge.

The passenger train was a second section of the Florida Special, consisting of 11 cars and the locomotive, and was running approximately 12 minutes behind schedule. This train passed the approach signal displaying an approach indication, passed the home signal displaying a stop indication, struck and broke the smash-board and then struck the lifted draw span while traveling at a speed between 10 and 25 m.p.h.

This accident was caused by the failure of the engineman to operate the train in accordance with signal indications. During the investigation, the engineman narrated various details of his observance of the signals and his subsequent action. However, the facts in the case do not support his statements. His principal explanation was that the distance from the approach signal to the home signal was not as great as he had thought. According to his statements, he reduced the speed of the train from 60 to 45 m.p.h. after passing the approach signal and later to 30 or 35 m.p.h. After seeing the home signal at stop, he applied the brakes in emergency, too late to avert the accident. It was also evident that he had a faulty understanding of the meaning of an approach indication, and that he thought he was closing up on the first section of the train which he was following.

The signals involved were installed in 1926, when the speed limit for passenger trains was 50 m.p.h.; but in 1930 this limit was increased to 65 m.p.h., with no change in the spacing of these signals or in the signal indications. The engineman was examined on the rules when he was employed, but he did not then thoroughly understand the speed limit clauses in the rule requiring proper observance of caution signals. At the distant signal he should have been running not over 27½ m.p.h., but he made no definite attempt to observe this limit.

The conclusion drawn from the investigation is that the engineman was not well enough acquainted with the road and the operating rules. To insure adequate protection at this point, some alternative other than a rule interpretation should be adopted, such as respacing of signals, providing an "approach-restrictive" indication when the drawbridge home signal is at stop, or a restriction of the maximum speed for a sufficient distance approaching this drawbridge, to insure adequate stopping distance between the approach signal and the home signal, which is located near the drawbridge.

It is a matter of common knowledge that on many railroads maximum authorized speeds have been increased and faster train schedules adopted. Before such changes are made, however, in order to insure an adequate margin of safety, the spacing and location of signals should be thoroughly checked and necessary revisions made to provide adequate stopping distances under all circumstances.