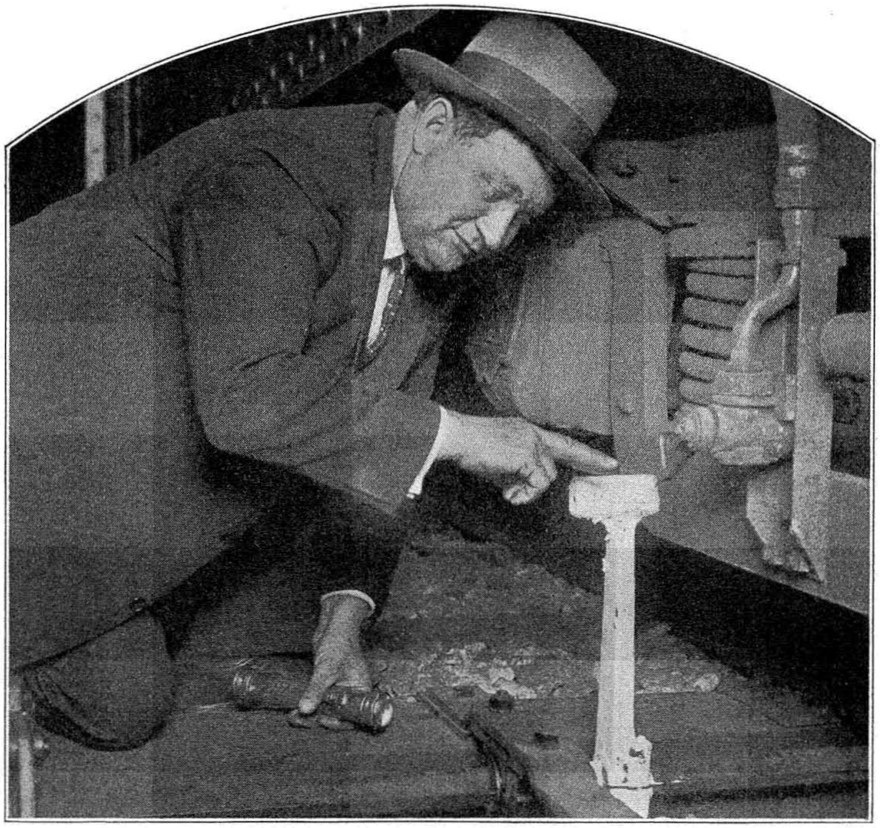
Railway Signaling

Vol. 21 December, 1928 Number 12

Pacific Electric Protects Subway Traffic With Signals and Train Stops



Solenoid-operated train stops are worked direct from copper oxide rectifiers—Speed restrictions enforced with the aid of train stops

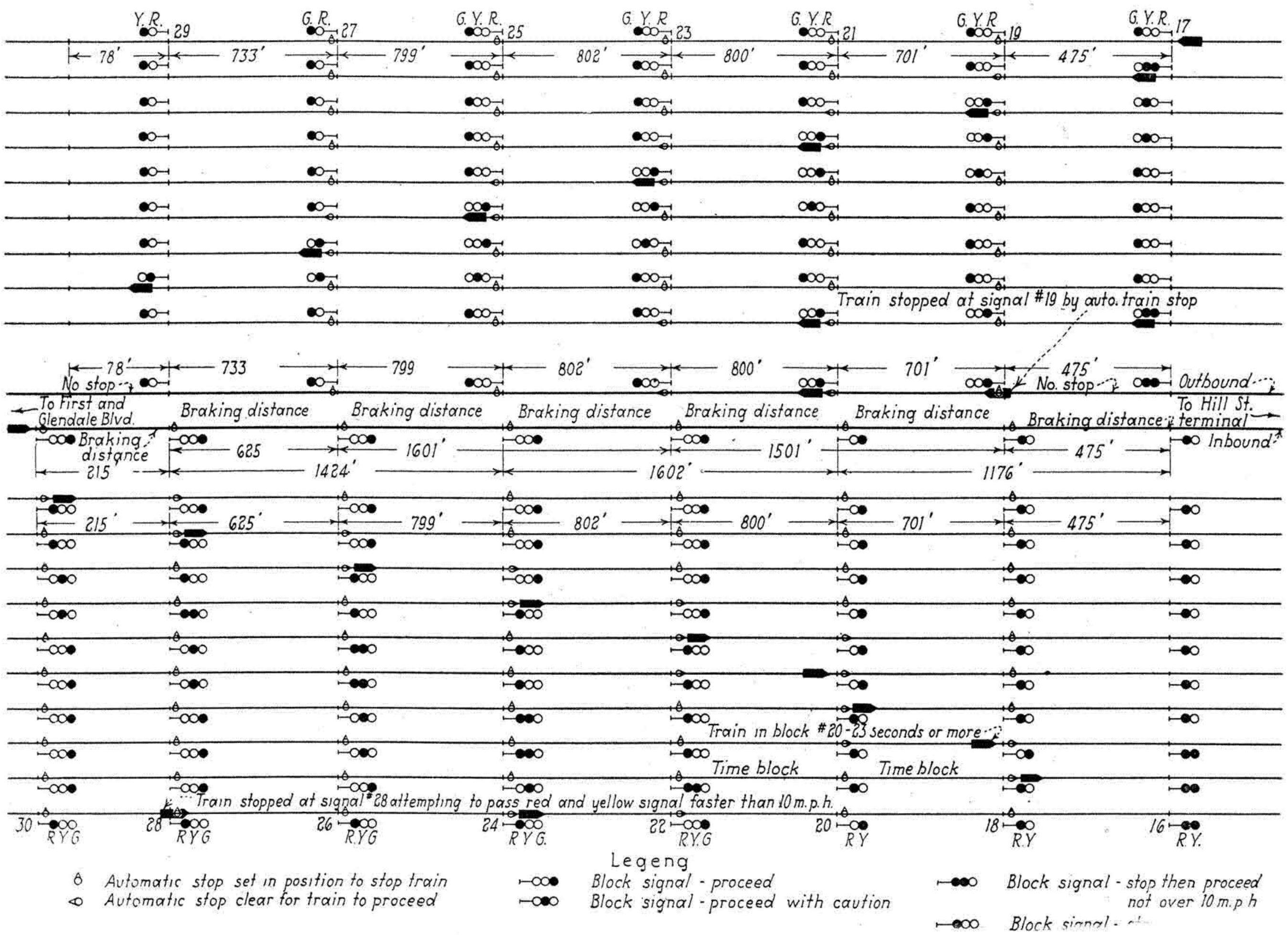
Sam Florence, signal engineer, pointing out the trip cock lever which has just been deflected by the roadside stop arm

A UNIQUE installation of automatic signaling and train stops has been installed in the Pacific Electric, Hollywood-Glendale subway, which adjoins the new Hill street terminal in Los Angeles, Cal. Two noteworthy features of this installation are, the enforced speed restrictions maintained by the automatic train stop installations at a number of the signals, and variations in signal overlaps to obtain safe braking distances. This double-track subway, which is a little more than a mile long handles, a very dense traffic during the morning and evening rush hours, a recent survey showing a total of 47 trains inbound and outbound in a period of one hour.

In order to make the description of these facilities as clear as possible, the automatic block signaling will first be described. When the Hollywood-Glendale subway was completed on December 1, 1925, the Pacific Electric installed color-light automatic block signals to protect trains on the double-track line. Fourteen signals were installed, seven for each direction of traffic, and spaced a maximum distance of 800 ft. The signal controls were originally arranged in such a way that a red light was displayed as long as a train was in the first block; a yellow light displayed with the first block unoccupied, and a train in either the second or third block; and a green light, with three blocks unoccupied. It will be noted that the blocks at either end of the subway are considerably shorter than those further in the tunnel. Train speeds are much slower in these end blocks.

Because of the 600-volt d-c. propulsion current, all of the signaling, including the track circuits, is alternating current type. The track circuits are double-rail return with impedance bonds to allow the return propulsion current to pass through the rails of the adjoining track sections. These impedance bonds prevent the alternating current, employed for signal controls, from passing from one track section to the next track section and improperly energizing the track relays. The latter are of the double-element, two-position vane type. The line control relays, necessary for the green and yellow signal lights, are of the single-element vane type. A three-phase 2,200-volt, 50-cycle power line is carried in lead-covered cable through a duct line in the subway wall. The same power line furnishes energy for all electrical equipment in the Hill street station and subway. Another lead-covered cable is employed for the 110-volt line relay control circuits, and this cable is also carried in a duct line in the wall. At three different points in the subway, 5-kw. G.E. transformers are installed to step down the 2,200-volt current to 110 volts for signal lights, line relays and the line elements of the a-c. track relays. These same transformers also supply the subway lights located in niches in the subway. Additional transformers are introduced at each signal location to step down the 110-volts to 2.8 volts or more for energizing the track circuit. An individual transformer is employed on each track circuit, with an adjustable reactance coil connected in one of the track leads to regulate the track circuit voltage.

Approximately $18,000 was expended for block signaling materials, which, added to the installation labor cost of $8,400, made the total cost of the block signal installation $26,400.



Detail chart of signals, train stops and train movements to make clear the operation of the stop arms ahead of an approaching train and to illustrate the scheme of enforcing speed restrictions

Automatic Train Stop Installed Two Years Later

On March 1, 1928, the Pacific Electric completed the installation of electro-mechanical train stops, the trip mechanisms being located as shown on the track plan. These automatic train stops were necessary for safe operation owing to the high density of traffic and fairly high operating speeds in the subway.

The roadside train stop apparatus comprises an electric solenoid mounted in a cast-iron case and mechanically connected to a rocker shaft on which are mounted two trip arms. The apparatus is mounted on two long switch timbers with the solenoid control apparatus at the end of the ties, where it is well in the clear of the trains. The rocker shaft is carried between the switch timbers, slightly below the top of the ties and has a trip arm fastened to it at each end. These trip arms are located 17½ in. outside of the gage side of the rail and, when in the tripping position, the top of each arm is 7 in. above the top rail in the vertical position. The two trip arms always assume this position when the solenoid is de-energized. Whenever the solenoid is energized, the trip arms are operated mechanically to an oblique position, the top of the arms being about one inch above the rail, where they will not strike the trip cocks mounted on the car.

A noteworthy feature of the operation of these solenoids is the fact that they are operated from the 110-volt, 50-cycle a-c. circuit through copper-oxide rectifiers without a storage battery reserve. The control circuits are so arranged that the solenoid is connected directly across the d-c. output terminals of the copper-oxide rectifier. The a-c. solenoid control circuits are checked through the track relays in such a way that the approaching train energizes the solenoid of the automatic train-stop next ahead, causing it to drop to the clear position, providing the signal indicates proceed.

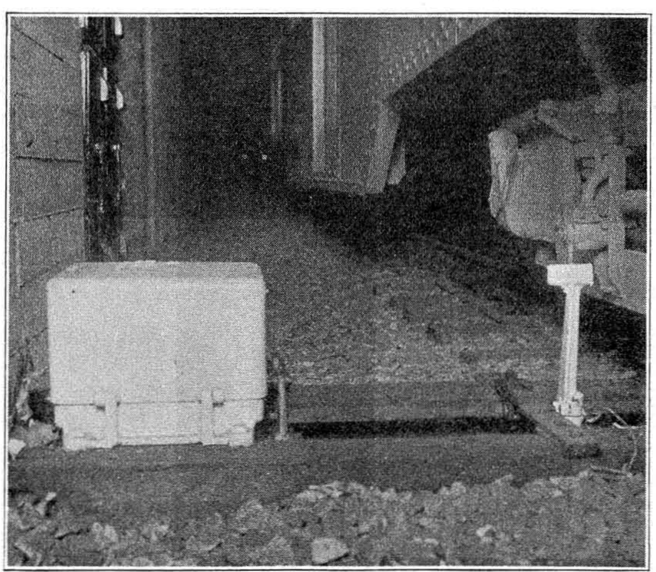
Equipment on Cars

Each car operated through the subway has a trip cock mounted on each end of the car at opposite sides and connected to the train line controlling the air brakes. When this cock is closed, it assumes a downward or vertical position, being the same distance from the gage side of the rail as the stop arm of the roadside apparatus. The bottom of the trip cock on the car is 5½ in. above the top of rail when in the vertical position. It must be remembered that when the solenoid of the roadside apparatus is de-energized, the trip arm is seven inches above the top of rail, or about 1½ in. above the bottom of the trip cock on the car. Thus, if a train passes a red signal, the stop arm will engage the trip cock of a car passing over it. As there are two arms on the roadside stop apparatus and two trip cocks on each car, double assurance of an automatic stop is obtained, because, if the cock at the front end of the car fails to operate, the one at the rear in all probability will stop the car. Two hundred and ten cars are equipped with trip cocks, the simplicity of the equipment on the car being one of the deciding factors in choosing this type of automatic train stop for the subway.

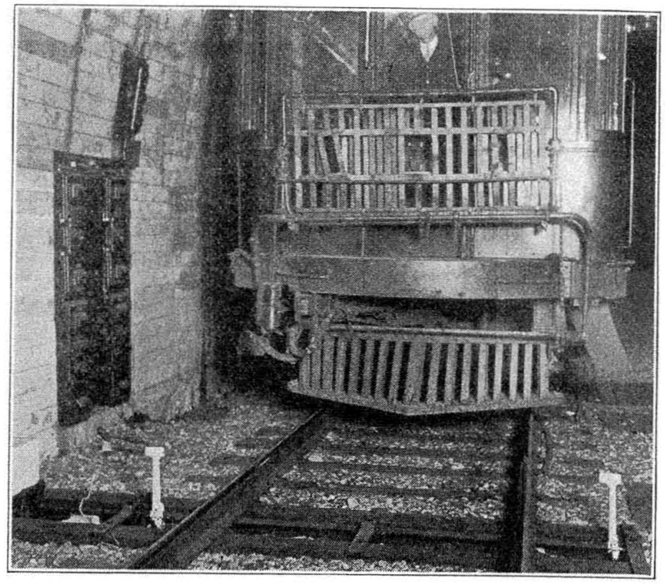
As shown on the track plan, automatic stops are provided at 12 signal locations. An additional 5-kw. G.E. distribution type transformer was added to the 3-phase 2,200-volt signal power line and 2 No. 6 rubber-covered copper wires were run the length of the subway as 110-volt secondary mains for supplying power for the operation of the automatic train stop apparatus. A careful study of the operating diagram of the signals and automatic train stops in the subway, shown in this article, will make clear the control of the signals both inbound and outbound as well as the approach control of the roadside stop apparatus.

Operation of Signals and Train Stop

A detailed study of an outbound train from Hill street terminal throughout the extent of the subway signal installation, and a similar study of the inbound signaling with the aid of the diagram of signals and train stops shown in this article, will make clear the overlap scheme of signal control and the enforced speed restrictions at certain signal locations. Assume that an outbound train has left the terminal and has passed signal *17*. This signal will give a red and yellow aspect as long as the train is in the first block. The yellow over red signal aspect is a permissive one and a following train is not required to stop at signal *17* under these conditions but may pass at a speed not to exceed 10 m.p.h. It should also be noted that no automatic train stop is located at this signal. If a train is stopped at signal *17*, considerable delays to following trains as well as to inbound trains and trains using the interlocking plant are incurred. It was believed that a train could not attain sufficient speed at this point to require



Close-up of electrically-operated solenoid mechanism which actuates the stop arms



Signal on tunnel wall, relay cases in niche of wall and roadside stop arms

the installation of an automatic stop. Signal *17*, shows a yellow indication with one block clear for similar reasons, but will not show green until three blocks are clear; the green control being the same as for the remaining outbound signals.

Signals *19*, *21*, *23* and *25* each show a red indication with a train in the first or second block, yellow with two clear blocks and the third block occupied, and green with three blocks clear. Holding a red signal for two blocks is necessary with this type of automatic stop because the brakes are applied when a train passes a red signal, and with this arrangement, a train holds two red signals and will apply the brakes on a train at the next signal in the rear, having a whole block to stop a train before it can reach the train ahead. The spacing of trains moving under green signals is the same as before the stops were installed.

Signal *27* has two lights only, red and green. The red light holds for two blocks as with the signals mentioned above, and the automatic stop operates in the same manner as described above. This signal will show green with but two blocks clear, as this insures that no train is in the subway. Signal *29* operates red and yellow only and the block for this signal is only 78 ft. long, and no automatic stop is used in connection with this signal. This signal is out of the subway and is used only to obtain an overlap for the control of signal *27*. Signal *29* was located and the length of block arranged so a train standing at the First street station would not hold a train in the subway.

Inbound Train Movements

All inbound automatic signals are equipped with automatic stops. It was necessary to move inbound signals *30* and *28* closer to the subway portal than they were previously, so as to allow inbound trains to clear First street when stopped at signal *30*. As now arranged, signal *30* has a block 215 ft. long and signal *28* has a block 625 ft. long, which is ample for the speed a train can attain at this point. Signal *30* will show red with a train in the first or second block, yellow with the first and second blocks unoccupied and a train in third or fourth block, and green with four blocks unoccupied. The action of the automatic stop is the same as described for outbound signals.

Signals *28, 26* and *24* show red with a train in first or second block, red and yellow with first and second blocks unoccupied and a train in third block, yellow with three blocks clear and a train in the fourth block, and green with four clear blocks. This arrangement was desired because there is a 2.10 per cent down grade to the station, and it was believed that the lengths of the blocks were not sufficient to insure that the brakes, on certain classes of cars, would stop the train within the length of one block, with a reasonable margin of safety.

The operation of the stop with a train in the first or second block would be the same as previously described. When a train is in the third block and red and yellow lights displayed, the stop will not clear when a train approaches as it will with a yellow or green signal. The stop, however, is located 16 ft. ahead of the signal and will clear when a train passes a red and yellow signal. The time the stop takes to clear is slightly less than the time it takes a train moving at 10 miles per hour to travel 16 ft., therefore if a train passes a red and yellow signal at 10 m.p.h. or less, the stop will clear, but if it exceeds this speed, the brakes will be applied before the stop has time to clear.

Signal *22* has the same controls as the signals mentioned above except that it shows green instead of yellow with three clear blocks. Signal *20* has only two indications, showing yellow normally and red when the first or second blocks are occupied. Signal *18* is normally red and shows yellow when an approaching train has passed signal *20* and has been in block *20* for 23 sec. or more, insuring that the train is not exceeding 20 m.p.h. The controls of signals *18, 20* and *22,* mentioned above, are to insure that trains come into the Hill street terminal at a reduced speed.

At the far end of the subway, a turnout and crossover are located to handle trains going to and coming from the car yard at this point. These moves are governed by light type switch indicators. The signal circuits at this location are arranged so that two signals and stops in the subway are controlled by the moves on the tracks involved. This insures that another train approaching will be stopped before it reaches the train doing the switching.

Signals *23* and *25* are located on a curve where they cannot be seen by motormen as soon as other signals. Hence small repeater signals were installed between the tracks to repeat the indication of these signals and give advance information to trainmen.

The roadside stop apparatus and labor required to install it represents an expenditure of over $12,000, while the cost of providing trip cocks on the cars totaled nearly $8,000 or a total cost of $20,000 for automatic train stop apparatus. When to this is added the cost of the original automatic block color-light signals, $26,400, and $25,500 for interlocking the entrance to Hill street station, the total cost of the signal and train stop installation in the subway amounts to $71,900. The Union Switch & Signal Company furnished all of the color-light signals, relays, impedance bonds, track transformers, reactors and other signal apparatus of the original signal installation. The roadside train stop apparatus, together with the rectifiers, line relays and time-element relays for enforced speed restrictions in block *20* were also obtained from the Union Switch & Signal Company. The trip cocks on the cars were obtained from the Westinghouse Air Brake Company. The Kerite Insulated Wire & Cable Company, furnished all of the wire used, including the lead-covered cables.

Mexican Road Uses Parkway Cable for Telegraph Service

By B. E. Arias

Superintendent of Electricity and Telegraphy, National Railways of Mexico

THE National Railways of Mexico have an installation of parkway cable for telegraph circuits near Buena Vista station in Mexico City, D. F., which has given three years of satisfactory service. This cable runs from the telegraph office in the station to a signal tower 3,800 ft. distant and from there to the telegraph office in the yards in Nonoalco station, 1,150 ft. away, and to another signal tower, a distance of 1,225 ft. From those places, the telegraph circuits proceed as aerial lines. Altogether, therefore, 6,175 ft. of cable have been installed with the purpose of carrying telegraph lines between those offices, and many advantages have been derived therefrom, inasmuch as the obstruction caused by, and the risk of accidental contact with bare wires, which are numerous in the yards, is totally avoided.

Advantages of Parkway Cable

Causes of interruption are reduced to a minimum as the line is not affected by storms, dead trees, branches and vines overhanging or leaning against the conductors. Troubles resulting from stones thrown to the line or poles and wire throwing, resulting in short circuits, are eliminated. The line does not suffer rusting or corrosion as a result of sulphurous fumes from the smoke of locomotives. Freedom from inductive interference is obtained, and as a consequence of all this, better service is obtained and the cost of maintenance repairs is reduced to a minimum.

Several railways have avoided the use of underground installations on account of the high initial cost. We had, however, in mind, the fact that against the cost of insulation on cables, as compared with bare conductors, there must be set the cost of poles, crossarms, brackets and insulators required by bare conductors. The ease with which the cable can be installed, was also taken into consideration.

On this particular installation, we used 5,166 ft. of Okonite steel-tape armor, lead-covered cable, 37 conductors, No. 12 BWG and 1,009 ft. of Okonite steel-tape armor, lead-covered cable, 12 conductors, No. 12 BWG. We did not find it necessary to lay the cable in ducts for its total length, and used vitrified clay ducts only at the entrance to the office in Buena Vista station and at the manholes along the installation. For the rest of the line, the armored cable is laid in a trench 14 in. wide and 28 in. deep, and thus the installation was easy and inexpensive.

Manholes are located at the offices and at regular spaces along the line, and are of appropriate dimensions to provide ample working space. The manhole roofs are made of concrete. In laying the cable in the trenches, care was taken to avoid sewer pipes and other metallic underground obstructions nearby. The path of the installation is straight for almost all of its length except for a turn (a long radius curve) in front of the signal tower.

The cable is at a distance greater than three feet from the nearest rail, and crossings with our railroad lines are made in accordance with the requirements of the National Electric Code of Mexico.