were so badly damaged that they could not be made fit for further service.

The eight-lever mechanical interlocking machine shown in Fig. 4 was made up entirely of scrap parts which had accumulated in the machine shop. No two levers came from the same place. This machine, for all practical purposes as good as a new one, was put in service on the district and is still in use. It is the practice to send all scrap parts from the entire district to this shop, and when enough of them that are worth saving have accumulated they are put to use.

A signal bridge may be seen at the right of Fig. 6. This bridge was brought into the shop to be repaired on account of the destruction of some of its members by locomotive gases. The bridge was in service on the eastern slope of the Allegheny mountains about one mile west of the Horseshoe Curve. The grade at that point is 99 ft. to the mile. Freight trains going up this slope generally have three, and sometimes four engines, and the gases and sand-blast effect from the locomotive stacks had eaten the top and bottom chords of the bridge about one-half through and totally severed two of the diagonal members. This bridge was built up of 2½ by 3 in. angle bars.

In addition to the economy resulting from conducting relay repairs in the shop the signal department secures, from the possession of the facilities at East Liberty, an independence not otherwise obtainable. It is almost completely separated from the necessity for outside operations. This, of course, increases the responsibility of the department to a considerable extent, i. e., it obviates the possibility of shifting the responsibility for delays to any other department. But the increased effectiveness of the organization, and the independent spirit which is engendered by the knowledge each man in the department has of what his department can do, more than counterbalances the increased responsibility.

THE STAFF SYSTEM ON THE SOUTHERN PACIFIC.

BY S. L. BAXTER.

The longest stretch of track operated under the electric train staff system, in this country, covers 94.2 miles of single track on the Southern Pacific, between Loomis and Truckee, Cal. The road between these two points crosses the Sierra Nevada mountains at an elevation of 7,000 ft. and a maximum grade of 2.7 per cent. For 41 miles in the vicinity of the summit, where the snow last winter reached a depth of 27 ft. on the level, the tracks are covered with immense snowsheds, and night signal indications are displayed 24 hours each day.

The summit is 15 miles west of Truckee, which is the eastern staff terminus, and under normal traffic conditions it is necessary to cut out a number of helper engines here each day and return them light to the foot of the grade. These, with the large number of trans-continental trains passing over this road overtaxed the line under the old system of train orders and telephone block to such an extent that traffic was constantly being delayed.

The staff system was furnished by the Union Switch & Signal Co., was installed in 1905 and 1906, and has relieved the congestion by cutting down the delay at meeting points and enabling the dispatcher to keep the trains moving, as he can change a meeting point in about five seconds, whereas with the old system from three to ten minutes would be required; and to change one meeting point would often necessitate changing several others. The 94.2 miles of single track covered by the installation is divided into 35 blocks, averaging 2.7 miles each. Two instruments, one placed at each end, are required for the control of each block, and these are connected by a metallic circuit, a three-conductor cable being used for this purpose through the snowshed district. This is supported by a No. 9 galvanized iron messenger wire tied to oak brackets on the inside wall of the snowsheds. This is dead-ended at each station, and carried to lightning arresters in the pedestal of each instrument by a No. 14 rubber-covered copper wire along with the cable, so that it, as well as the extra strand in the cable, can be used in case of emergency.

Outside of the snowshed district two No. 6 galvanized iron wires are strung on poles set approximately 64 to the mile. This lead also carries telegraph and other wires.

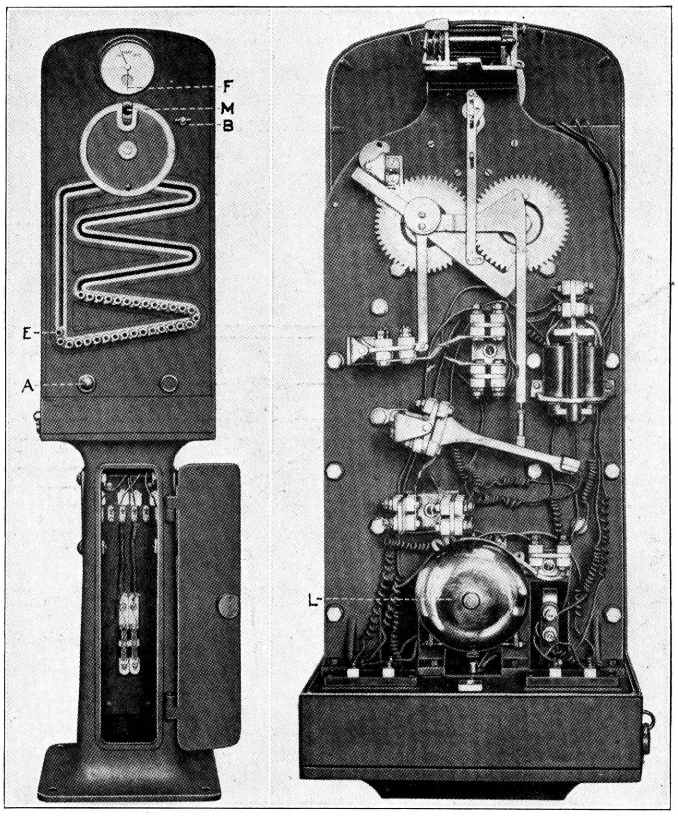


Fig. 1. Fig. 2.

Fig. 1 is a front view of one of the staff machines and Fig. 2 is a rear view of the head with the cover removed showing the mechanism.

To withdraw a staff the operator at "A" presses the button A, Fig. 1, three times, ringing the bell L, Fig. 2, at "B," the

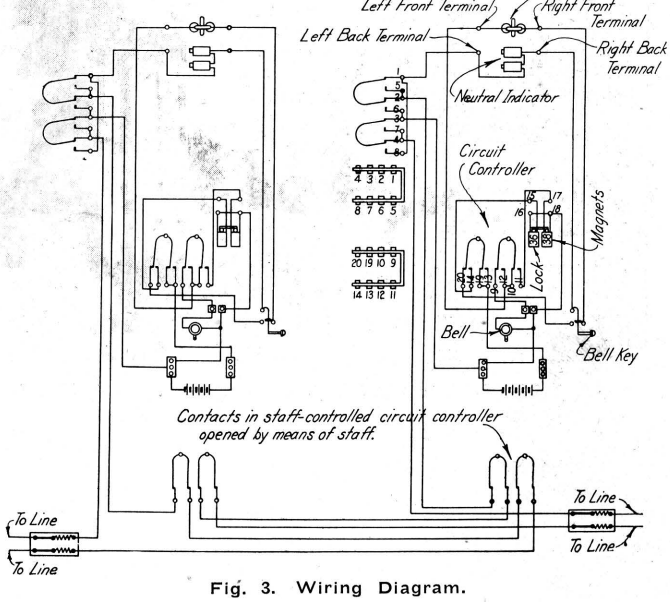


Fig. 3. Wiring Diagram.

opposite end of the block. The operator here, after consulting his block sheet, answers the signal and holds the button in, thus supplying current to the instrument at "A," which is indicated to the operator there by the deflection of pointer F, Fig. 1. "A" now turns the spindle B to the right as far as it will go, and

then allows it to return to its normal position. This has brought the armature up against the cores of the locking coils, where it is held. The red disc in the face of the instrument now disappears, indicating to "A" that the unlocking has been accomplished. The circular shield has previously been brought into position for the slot to receive staff E, which is now brought into place and used to turn the shield to the position shown, and the staff is then withdrawn at M.

The act of removing the staff has operated the pole changer shown in Fig. 2, putting the batteries of the two instruments out of synchronism, and no more staffs can be withdrawn until this

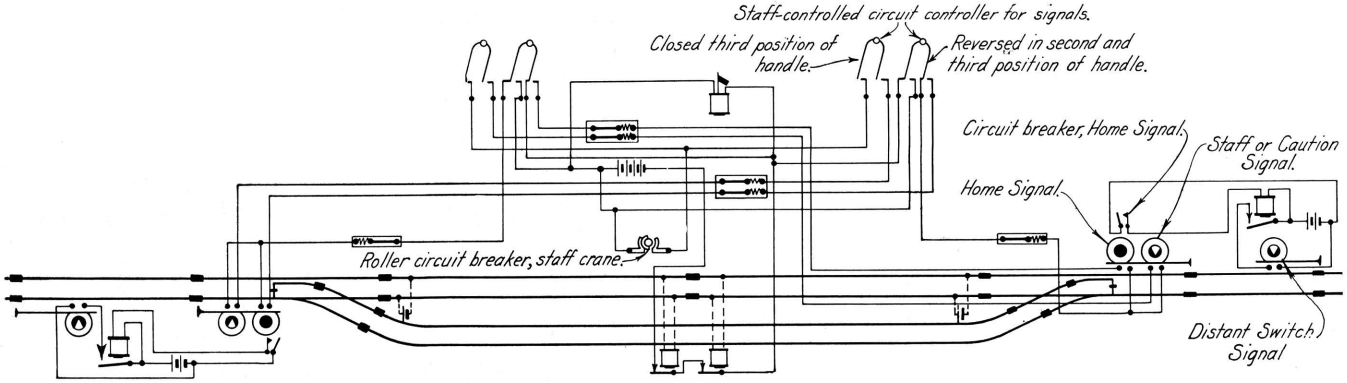


Fig. 4. Wiring Plan for Stations.

one is put back in this instrument or the one at the opposite end of the block.

For delivery the staff is placed in a rubber pouch attached to a steel hoop of about 14 in. diameter and hung in the staff delivery crane. Fig. 6 is a view of the crane. From it enginemen are able to catch the staff at speeds of 40 miles per hour or more. The crane consists principally of a counter-balanced arm, pivoted at the head of a mast, and carrying at one end a spring clasp shaped to receive the staff hoop, and from which it can be withdrawn with a slight pull. This view shows a staff in position to be caught. When the arm is relieved of the weight of the staff the counter-balance brings it to an almost vertical position out of the way. At the approach to each station there are two signals of the enclosed disc type, home and distant, mounted on the same pole and located 60 ft. in the rear of the switch. By these the operator is able to give the following indications: (1) take siding, (2) continue along the main line prepared to stop at the office, and (3) continue along the main line, staff for the next block is in the crane.

A distant signal of the same type is placed approximately 1,500 ft. in advance of the home signals, to regulate the approach thereto. The home signals are operated by from four to six cells of storage battery placed at the station; the same battery operating signals on each side of the station. The distant signals require two cells of the same type which are placed at the signals. The storage batteries are all of the Exide portable type used extensively in the operation of automatic block signals on the Southern Pacific road, and in this service require charging but once every 30 days.

Fig. 4 is a wiring plan for stations, showing how the signals and instruments are inter-connected. The normal indication of the signal is at a station "take the siding," and this cannot be changed if the track between switches is occupied. The indication, "proceed to the office" is obtained by the operator moving the signal controller to the second position which clears the home signal at the switch and the distant signal proper, leaving the caution signal displayed at the switch. For the next indication all signals must be cleared and before this can be done it is necessary for the operator to obtain a staff for the next block, use it to unlock the signal controller, move the controller to the third position, and place the staff in the crane, for delivery. This last act closes the final break in the circuit, which is in a circuit breaker attached to the staff crane arm.

With this indication displayed a train would proceed at normal speed, the engineman dropping the staff he has at the station, and catching the one giving him the right to proceed through the next block.

Fig. 5. The Staff Signal.

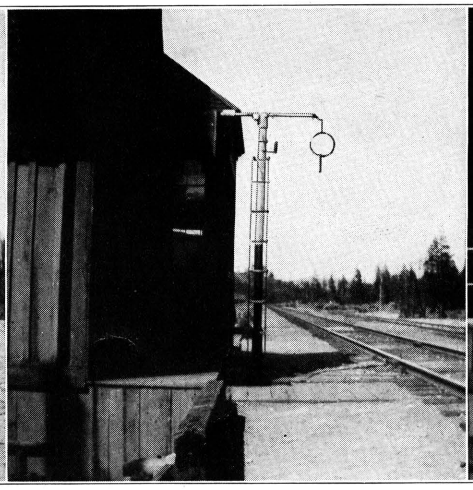


Fig. 6. Staff Crane.

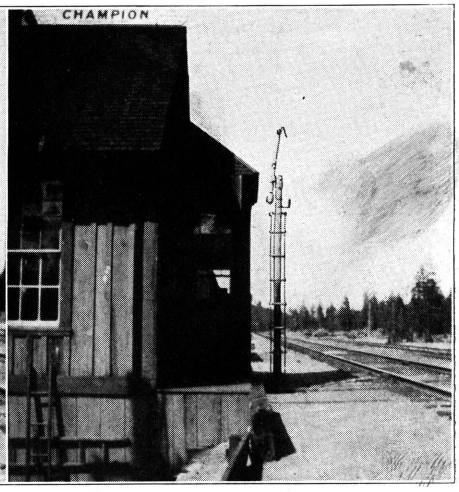


Fig. 7. Staff Out.

To avoid the possibility of the operators placing the staff left by the train, in the instrument controlling the block into which it has just passed, the instruments are made in four styles, known as "one," "two," "three," and "four." The staffs are stamped with these numbers, and a No. 1 staff cannot be placed in anything but a No. 1 machine, etc., so that a staff would have to be carried by three block stations before another machine of the same number would be reached.

At Summit station a special feature is attached to one of the instruments, which was designed to protect helper engines while returning to the station after helping a train part way through the block. This consists of a box containing a staff of special

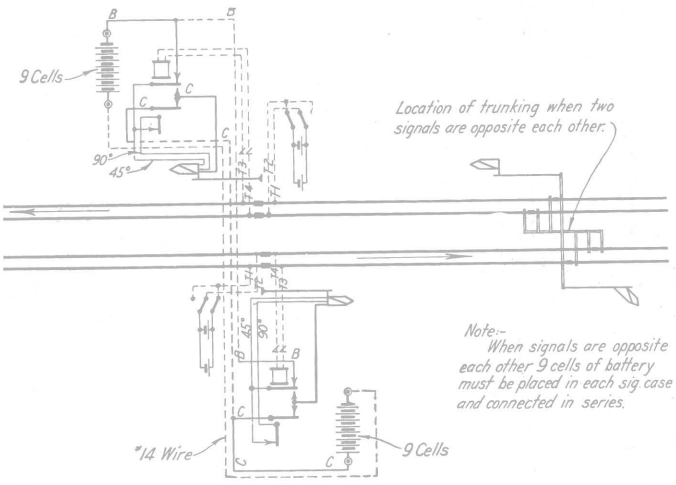
design,—differing very materially from the others,—and plainly stamped "Pusher Staff," so there is no danger of confusing it with those conveying right to proceed through the block. The pusher staff cannot be withdrawn from the box until a staff for the block has been obtained and used as a key to release it. The regular staff may then be delivered to the train, and the pusher staff to the engine which is to cut loose at the top of the hill and return. Both engine and train will now be fully protected in the movements they are to make, by the fact that the withdrawal of the pusher staff opens the staff circuit, leaving the block completely locked up until it is returned to its place in the box, and the regular staff is placed back in one or the other of the instruments.

In the operation of the staff system here, regular trains starting out receive a clearance card, and extra trains receive a 19 order to "staff" Loomis to Truckee, or vice-versa. No other orders are necessary. Operators have instructions to "staff" the superior train first unless otherwise directed by the dispatcher. Twenty stations are telegraph offices, and 16 are only block stations, the signalmen at these receiving their instructions as to the handling of trains through the operator at the adjoining telegraph station by telephone. There is a telegraph office on at least one side of each telephone station.

The question of maintenance is taken care of by seven repairmen, whose districts average about 13 miles in length. Each repairman looks after everything on his district, and in addition, in the snowshed district, maintains a system of fire-alarm and district-telegraph boxes, which are used in the protection of the track and snowsheds in this territory.

BATTERY HOUSING ON THE ATLANTIC COAST LINE.

The Atlantic Coast Line lies in a territory of mild climate. J. C. Kelloway, signal engineer of the road, has taken advantage of this condition in the housing of the primary batteries used in automatic signaling on this line. He has found battery wells and chutes unnecessary, and instead employs special rectangular battery jars so designed that 16 cells of primary battery can be placed in the signal case with space enough left for three cells



Signal Location Plan, Atlantic Coast Line.

of gravity battery. These rectangular jars are of heat-resisting glass, and cost but very little more than the porcelain jars.

Where signals are located opposite each other only 18 cells of primary battery are used. Nine cells are placed in each signal case, and the two batteries are connected in series. With 35 blade movements per day it is estimated that a battery of 18 cells, each cell of 400 amp. hrs. capacity, will last a year and probably longer.

The sketch shows the layout and placing of the trunking when signals are opposite. Although this arrangement can be used only in certain parts of the country the economy of employing it wherever possible is evident.

NEW 400-LEVER INTERLOCKING MACHINE.

H. S. Balliet, engineer of maintenance of way of the Grand Central Terminal, New York City, and signal engineer of the electric division, has just erected a 400-lever electric interlocking machine in one of the two principal cabins of the terminal. A picture of the machine as it was set up for testing in the shop of the General Railway Signal Co. at Rochester, N. Y., is shown herewith. Back of this machine is seen the 360-lever machine for the upper level; the first mentioned being for the lower level. These machines have 'lever lights" or illuminated numbers over each lever. Some of these are faintly discernible in the picture. The irregularity of appearance of the controllers at the back of the machine is due to the fact that on some of the levers these controllers are two tiers in height, on others three, and on others four or five. The construction of these "unit levers" was described in *The Signal Engineer* for October, 1910, page 168, and the design of the "four-story" fireproof signal cabin was shown. In this the rooms used for the machines are in the second and fourth stories (at the north end), that in the second story for the lower level tracks, and that in the fourth for the upper. This building, just north of 49th street, stands close to the line of Park avenue, which is overhead, and which runs parallel to the center tracks through the yard. The signal station for the upper level is designated "A," and that for the lower level "B."

The interlocking machines are the General Railway Signal Co.'s Model 2, but the lever arrangement and numerous details were designed by Mr. Balliet and his assistants.

The 400-lever machine is 67 ft. 7 in. long, 2 ft. 6⅛ in. wide and 4 ft. 3⅝ in. high. It is built in 10 sections, each section comprising 15 locking plates, a total of 150 plates. In order to have perfect alinement of tappets and locking, these plates, which are 16 in. long, have been milled to within 1-1,000th of an inch of the calculated size. The length of the longest locking strip used in this machine is 210 in.

There are five distinct operating sections to this interlocking machine. It is an assemblage of five machines interconnected by mechanical interlocking, instead of electrically, as would be necessary if there were five separate plants. The following tabulation shows the number of units controlled from each section:

Section Nos.—	1	2	3	4	5	Ttl.
Levers for signals	21	43	34	51	60	209
Levers for switches and M. P. frogs	10	33	26	45	39	153
Total working levers	31	76	60	96	99	362
Spare spaces	5	8	7	11	7	38
Total frame	36	84	67	107	106	400

There is a lever for each signal, no signals being worked through selectors. There is also a lever for each point switch, each set of slip points and each set of movable-point frogs, the entire arrangement having been worked out on the basis of the simplest method of maintaining the apparatus and of promptly making repairs if failures occur. The 153 switch levers control switches as follows: 13 turnouts No. 6½; 16 turnouts No. 7; 35, No. 8; 1 No. 10; and 1 No. 12; 6 No. 7 double slips; 23 No. 8 double slips, and 29 movable-point frogs, 6 of them No. 7 and 23 No. 8. The use of sub-stations at 10 points in the yards was described in our former article, referred to above.

The levers in this machine are numbered from 701 to 1,100 inclusive. Throughout the yard each switch, slip, movable-point frog and signal has a different number, so that there are no duplicates anywhere in the whole terminal, including both the upper and lower levels. This plan was adopted to simplify the issuing of orders and the interchange of directors and other employes between the different cabins. Thus any function in either yard can be quickly and accurately designated with the least possible chance of error.

With the two machines in stations A and B this building will house the largest number of interlocking levers ever assembled under one roof. As the cabins, both in the upper and lower levels, are surrounded by numerous columns supporting the structure above, the signal men will have to depend entirely on their electric indicators for their knowledge of the position of trains. This being so, it would have been entirely feasible to put all of the 760