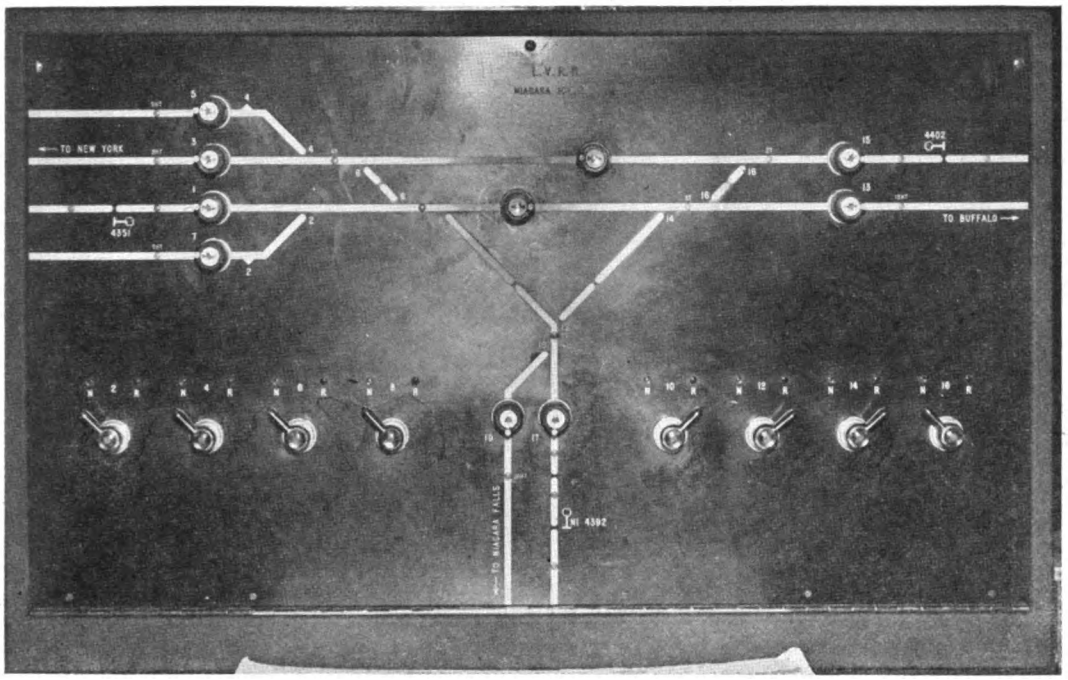


Panel of the new machine has seven levers to control switches and eight knobs control the signals

Relay Interlocking on Lehigh Valley

As compared with previous mechanical plants, the new electric interlocking saves train time and delays, especially during the heavy snow falls

At Niagara Junction, nine miles east of Buffalo, N. Y., the Lehigh Valley has installed a new electric interlocking, with all-relay controls, to replace an old mechanical plant. As shown in the accompanying plan, two main tracks on the route between Buffalo and New York extend east and west through this interlocking. Two junction switches, on the westward main track, connect with legs of wye extending to the line to Niagara Falls. Two crossovers, between the two east-and-west main tracks, permit train movement to be routed between either of these tracks and the Niagara Falls line. A passing track extending east from the interlocking is connected to the eastward main track at Switch No. 4. A stub-end track, used for interchange or storage of cars, as well as to accommodate a helper locomotive, extends eastward from Switch No. 2 on the westward main track.

The mechanical interlocking previously in service at this junction was equipped with 39 levers, and had been in service since 1896. This plant as a whole was worn beyond the stage of being repaired and maintained economically. Even the old frame tower was in need of extensive repair. Since long pipe lines were used to operate the switches, it was necessary to employ up to 75 men at periods when heavy snowfall was encountered, in order to keep the plant in operation. After consideration had been given to all these factors it was decided to completely rebuild the interlocking.

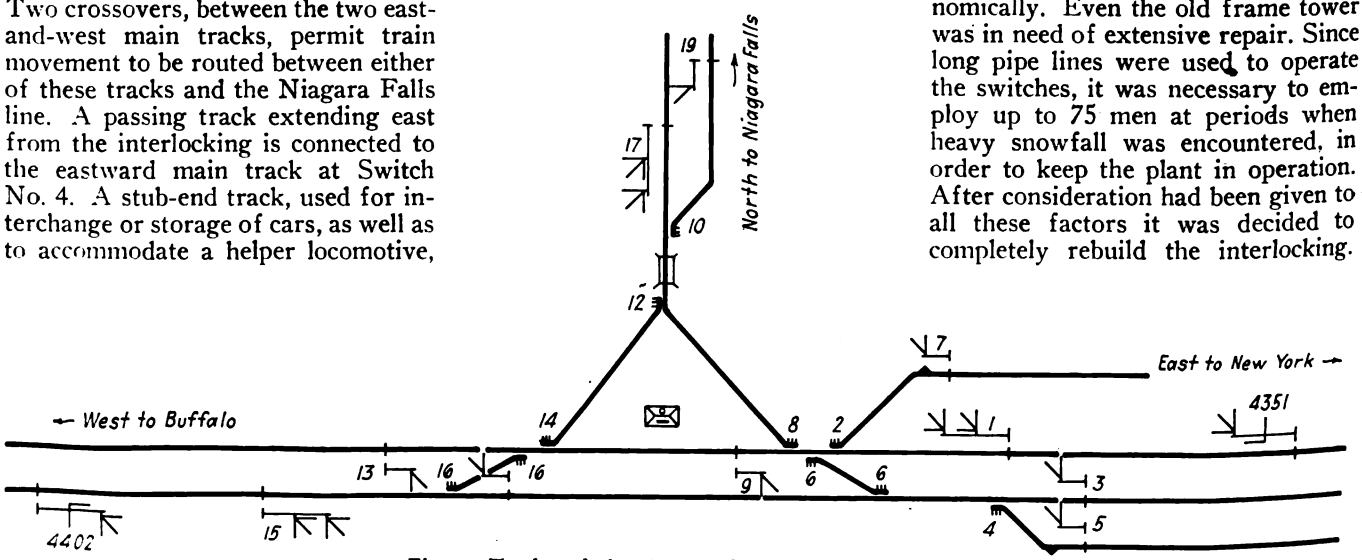
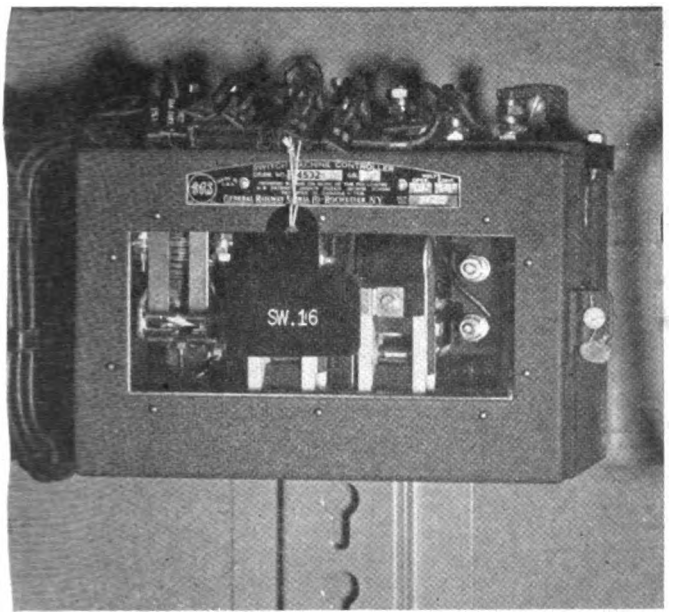


Fig. 1—Track and signal plan of the new interlocking

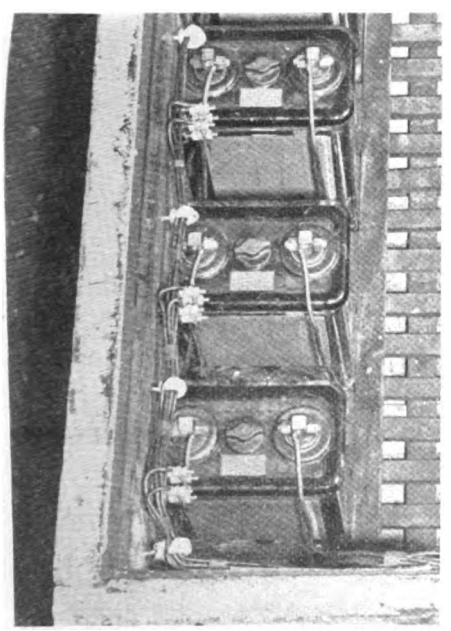


One of the switch machine controllers mounted in sheet-metal housing at central location

Three main-line through passenger trains are operated in each direction daily. Sleeping cars en route from New York to cities in Canada are taken off westbound trains at this junction, and are moved over the line to Niagara Falls for connection with trains of the Canadian National. Likewise, sleeping cars en route from Canada to New York are handled in the reverse direction.

A large percentage of the through eastbound freights are made up and depart from the Tifft Terminal yard, which is located west of Niagara Junction. Further, many of the westbound freight trains terminate at this yard. In addition, the freight traffic from Niagara Falls, and from other rail connections at that point, are made up in through trains, operated to Niagara Junction and thence east. Similarly, some westbound trains are diverted north to the Niagara Falls line at Niagara Junction interlocking.

Eight scheduled fast through freight trains, in addition to extra trains, are operated each way daily.



Battery in box at home signal

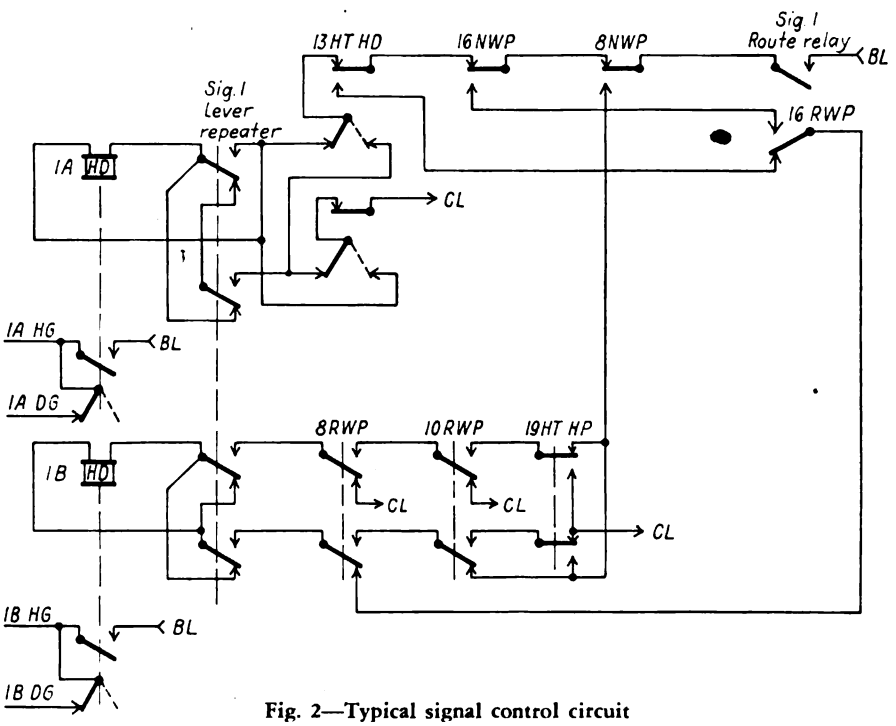


Fig. 2—Typical signal control circuit

Each eastbound tonnage train requires a helper locomotive from Niagara Junction eastward up the grade to Wende, N. Y., 9 miles distant. Also each tonnage train from Niagara Junction northward to Niagara Falls has a helper. Many extra line-ups through the interlocking are required to handle these helper locomotives.

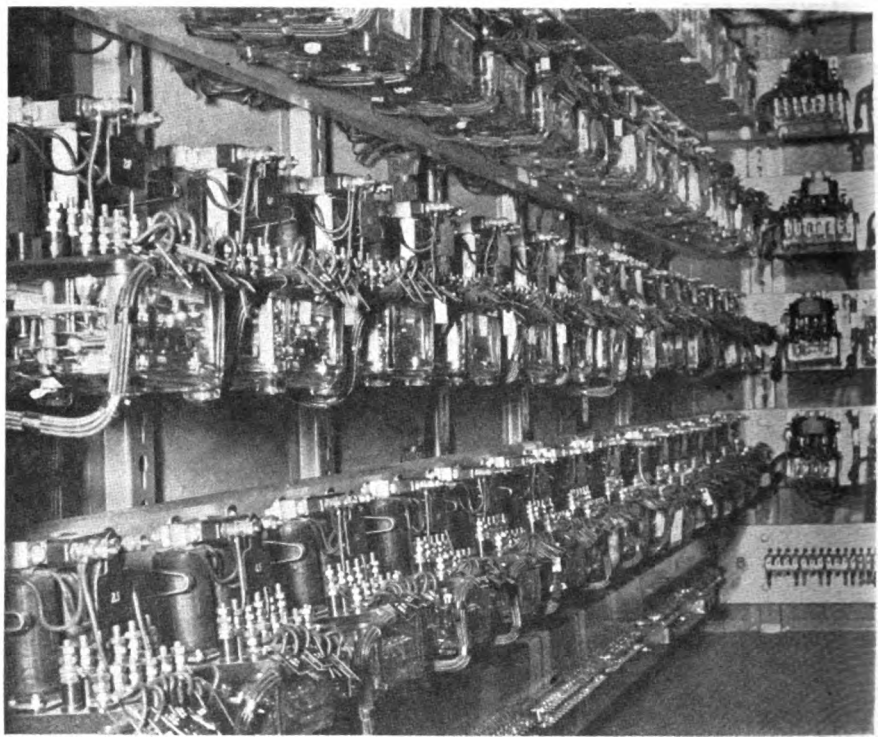
The problems brought about by the grades, the operation of helper locomotives and the movements via the Niagara Falls line, were all taken into consideration when planning the signaling at this interlocking. The crossovers are No. 15, and can be traveled at medium speed, therefore, the high home signals governing movements over these crossovers are arranged to display a medium-clear aspect, and under these circumstances the associated distant signal will display an approach-medium aspect. Thus the enginemen can bring their trains up to and through the plant at the speed for which these crossovers were designed, rather than approaching under control prepared to stop at the home signal.

Referring to the track and signal plan, the eastward back-up dwarf No. 9 on the westward track was provided in addition to eastward back-up dwarf No. 13 on this same track at the west end of the layout. Signal No. 9 allows a helper locomotive to be held at this signal to be routed over crossover No. 6 reverse, behind an eastbound freight train, while, at the same time, moves can be made via wye switch No. 8 reverse. Similarly, the back-up dwarf No. 11 on the eastward main track permits separate line-ups to be made at the west wye switch and crossover, while different moves are under way at the east end of the plant.

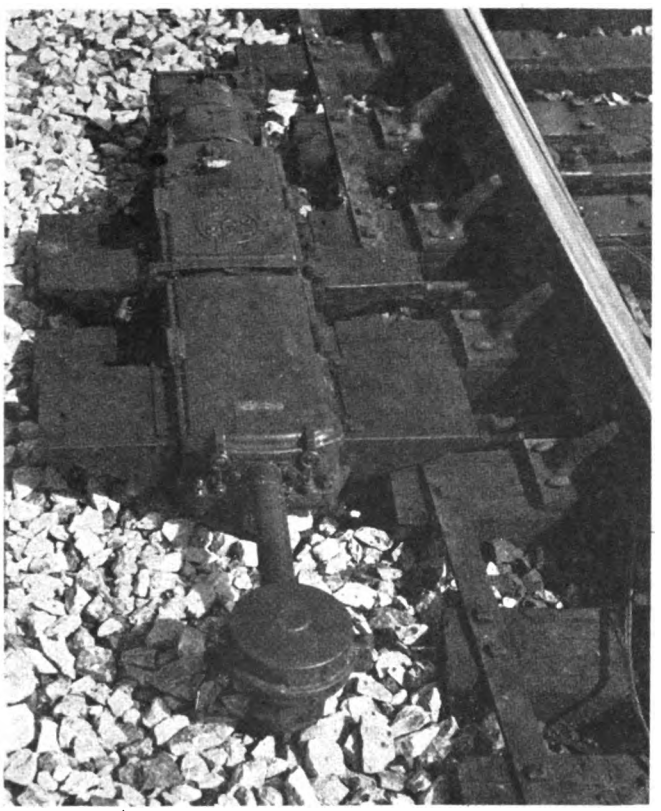
On account of the heavy ascending grade eastward beyond this plant, a following eastbound train often approaches the interlocking before a train ahead has cleared the next automatic block east of the plant. Under these circumstances, with the old interlocking, the towerman could not clear the home signal for a call-on aspect, and as a result there were

numerous train stops which caused congestion with other trains. Similarly, westbound trains may be stopped at an interlocking west of Niagara Junction, which would cause a following train to be held at the westward home signal No. 1. Therefore, when planning the new electric interlocking, arrangements were made to display the Restricting aspect on certain signals so that following trains can be kept moving, providing the train ahead has passed beyond interlocking limits.

The circuits controlling signals No. 1, 15 and 17 are practically the same as far as the method used to select the proper signal indication. As there is only one lever for each signal, the different aspects must necessarily be selected by the route which has been set. The method used is shown roughly in Fig. 2. When Signal No. 1 lever is turned, the lever-repeater relay and the route relay will pick up. Then, depending on how the route is set up, either 1A HD relay or 1B HD relay will pick up. 1A HD relay and 1B HD relay are retained neutral polar relays which control the signal mechanisms.



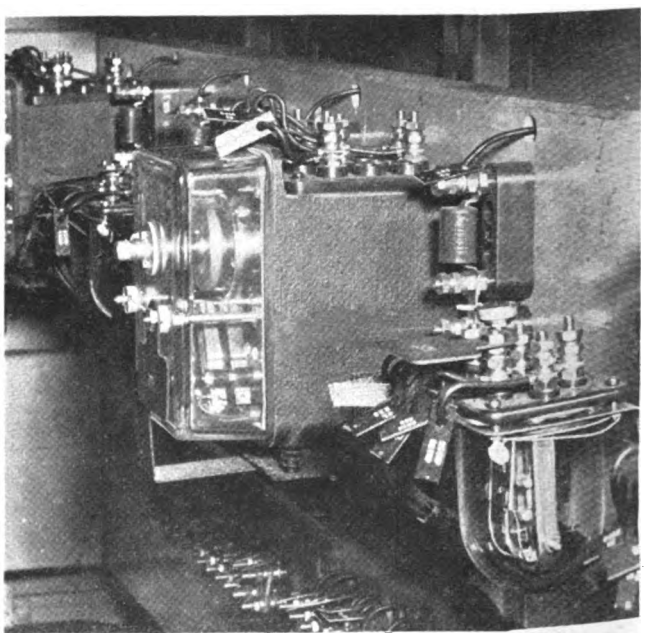
Above—The relays are wall-mounted on racks in the large sheet-metal central location.



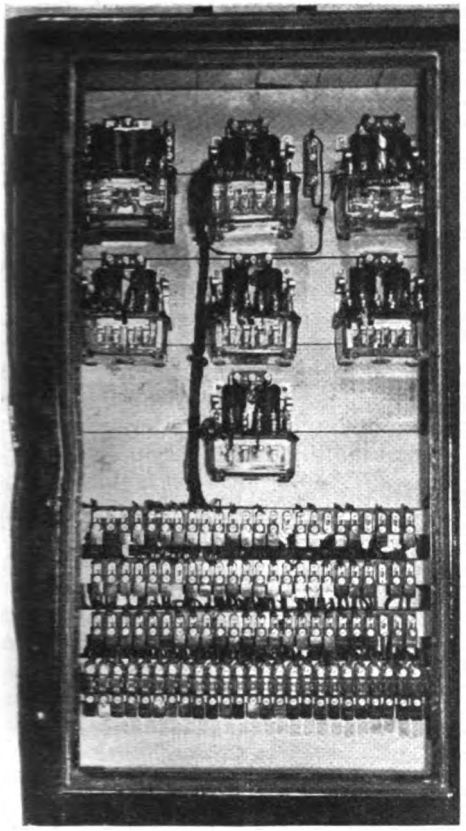
Left—The switch machines were installed before removing pipe lines

The new interlocking machine is of the panel type with rotary switches to control switches and signals. The machine includes no mechanical locking between levers, or lectric lever locks, the interlocking protection being accomplished by interconnections of circuits in an all-relay scheme.

The panel of the machine is 15 in. high and 27 in. long. The illuminated track diagram has white lamps which are lighted when corresponding sections of track are occupied within interlocking limits and on the approach sectitons. On the approach section on the eastward track of the Niagara Falls Branch there is a water column. In order to prevent a condition wherein the towerman would clear the home signal for the eastward train, thus locking up his route until the train has taken water and departs, a short track-occupancy section was installed south of the location where a locomotive stops when taking water. This short track section controls a separate track-occupancy lamp on the illum-



Right—Motor-driven time-element relay and right a thermal relay



Relay case at a signal

inated diagram. When a train is taking water, the towerman will not clear his signal until the train has taken water and occupies the second section. Another feature of this interlocking is that a track circuit 300 ft. long was installed on the siding in approach to signal No. 5 and also on the storage track in approach to signal No. 7. Each of these short track circuits is repeated by a lamp on the track diagram.

Control of Signals

On the lines representing tracks, there is a rotary switch at each location corresponding with a home signal. The outer rim of each switch can be rotated to control the corresponding signal. The signals are stick type, so that the rotary switch must be returned to its normal position in order to clear the signal for a second train.

Inside the face of each switch there is a fixed arrow pointing in the direction which the corresponding signal governs. A white dot on the outer rim is normally at the base of the arrow, the rim being rotated 90 deg. to clear the signal. A lamp behind the arrow is lighted to show green when the corresponding signal clears.

Control of Switches

The switches and crossovers are controlled by levers which are in a row on the lower portion of the panel. There is a green lamp above the normal position and a red lamp above the reverse position of each switch lever. These lights are lighted when the switch and the lever are in correspondence. A red lamp in the face of each switch lever is lighted when the electric locking is in effect to prevent operation of the switch, even if the lever were thrown. This information is helpful to the leverman in that he can throw a switch as soon as the locking is released and his red lock light goes out.

Tower and Instrument House

On account of curves in the tracks and high banks, the new tower was built on the north side of the tracks, at a location shown on the diagram, so that the towerman can have the best possible view of trains. This new tower is one-story 16 ft. by 16 ft., built of brick on a concrete foundation.

Based on shorter lengths for the larger underground cables, the welded steel bungalow containing the relays and batteries was located on the south side of the tracks opposite the tower. This bungalow is 8 ft. wide and 16 ft. long. The relays are the wall type mounted on boards, 2 in. thick, which are bolted to channel iron uprights on the walls of the building. A one-inch space is available behind the boards in which to run wires or cables.

The wires from the terminals of each relay are taped together in a cable that runs through a hole in the board behind the relay. The terminals are mounted in a single row along the bottom of the three sides. Each wire from the terminals runs through a hole in the terminal board directly above the terminal.

For the most part, the relays are the type K. The time-element relays used for time locking on main-line routes are type KB, motor-driven, and those used for locking on switching moves are type TG, thermal. In order to insure a better shunt and hold it, each track circuit within the interlocking limits is equipped with a primary-secondary track circuit. Outside of home signal limits, each track circuit has a 16-ohm relay at the entering end and a 4-ohm relay at the leaving end of the track circuit.

Each electric switch machine is controlled by a General Railway Signal Company switch machine controller mounted on the racks with the relays in the welded steel bungalow, as shown in an accompanying photograph. Each of these controllers is

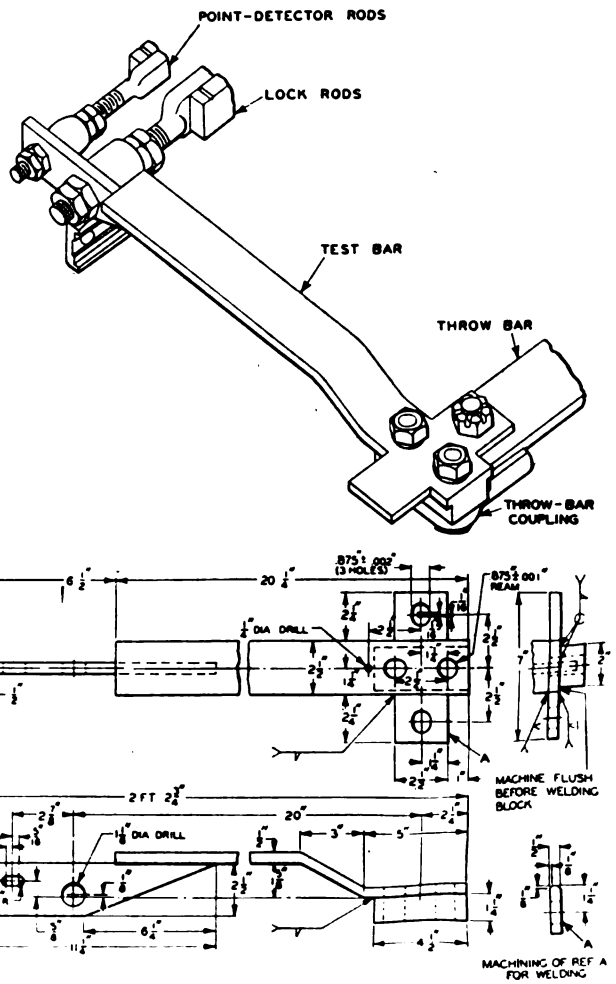


Fig. 3 — Drawing of a switch bar by means of which machines are adjusted previously

controlled by its corresponding switch lever. The 110-volt d.c. energy from the main battery feeds through contactors in each controller to the three-wire circuit for the switch machine. By using these controllers, each switch machine is provided with a separate common, normal and reverse wire, thereby providing each switch with individual overload protection, cut-out and restoring features. The overload relay in each controller is adjusted to open the circuit automatically with an excessive current flow such as would be encountered if the switch was obstructed. If a switch is obstructed, the leverman knows from his indication lamps that it did not go over. Then by restoring the lever to the previous position he causes the contactors in the controller to be restored so that he again his control of the switch and it follows the lever. One advantage of placing the controllers in the instrument house, rather than in the cases of the individual switch machines, is that practically all the instruments are thus concentrated in one place where they can be inspected more readily.

A three-wire, two-phase 110-volt and 220-volt a.c. power circuit extends from a commercial connection to this interlocking. One 110-volt phase feeds east from the tower, one west, and north a 220-volt line was brought in to the bungalow to furnish current for the electric unit heater and air-conditioner. The storage batteries are charged by dry-plate rectifiers. The 110-volt switch battery consists of 55 cells of 160-a.h. storage battery. Twelve cells of 160-a.h. battery feed the switch controllers at 24 volts, and a set of six cells feed the dwarf signals and other circuits. Each track circuit is fed from one cell. These batteries are the Exide EM-9. The 110-volt, the 24-volt, the 12-volt batteries and one track battery are located on racks in the center of the gungalow. In order to support the weight of these batteries a section of 136-lb. rail was placed lengthwise under the center of the building.

The underground cable is of the mummy finish type with no lead or steel in the outside coverings, and was furnished by the Kerite Company. The wires leading to rail connections are No. 9. For all other circuits No. 14 wire was used.

This interlocking was planned and installed by the forces of the Lehigh Valley, under the direction of J. F. Yerger, superintendent of telegraph and signals, the field construction being under the supervision of C. L. Ditchendorf, signal supervisor. The major items of equipment were furnished by the General Railway Signal Company. The circuits were designed by W. J. Varner, signal circuit designer, who also made break-down tests of every circuit after the apparatus was in place and wiring was complete. Before the interlocking was placed in service, operating tests were made under the direction of Carl Nelson, general signal inspector.

The old pipe lines for operating the switches from the old mechanical interlocking machine were continued in service while the new electric switch machines were installed. By using a special device known as a switch test bar, as shown in the accompanying sketch, the operating rod, lock rod, and detector bar of a switch machine were attached to this test bar in such a manner that the operation of the machine, including the lock rods, could be checked and tested the same as if the machine were operating the switch. Thus, during the change-over the only work required was to remove the old operating rod from the adjustment basket, insert the operating rod from the switch machine, then disconnect the old lock rods and connect the ones from the switch machine. This could be done quickly because, in most instances, very little time was required to complete the adjustments.

Length of Block

At Bowden, Fla., on the Florida East Coast on November 5, 1946, a northbound passenger train hauled by a Diesel-electric locomotive struck the twenty-sixth car of a cut of freight cars being pulled by a yard locomotive through two crossovers from the southbound track to the northbound track and to a yard lead track. The second crossover is 246.5 ft. long with the north switch on the main track and the south switch on the yard track. Northward automatic signal 5.4 on the northward main track is 8.4 ft. south of the south switch of this crossover, and the next northward automatic signal 6.4 is 5,154.5 ft. south of signal 5.4. In other words, the automatic signals, 6.4 and 5.4, are respectively 5,270 and 115.5 ft. south of the point of accident. These signals are the three-indication color-light type. As flag protection, two torpedoes had been placed on the northbound track 4,033 ft. south of signal 6.4, in other words, 9,303 ft. south of the point of accident. The two crossovers were lined about 6:37 a.m., and the yard engine with the 68 cars started the movement from the southbound main track through the two crossovers to the yard track about 6:39 a.m.

The passenger train was approaching Bowden at a speed of about 85 m.p.h., as indicated by the speed recorder on the locomotive. This train passed Bowden yard office, the approximate location of the torpedoes, about 6:41 a.m. On account of fog, the view had by the enginemen of the track ahead was restricted. When the locomotive exploded the two torpedoes, 9,303 ft. from the point of accident, the engineman moved the control lever toward the closed position and made a 6-lb. brake-pipe reduction, which was not released. When the locomotive was in the immediate vicinity of signal 6.4, the engineman observed that this signal was displaying the Approach aspect and he immediately made a 15-lb. brake-pipe reduction. Before the brake-pipe exhaust had ceased, he moved the brake valve to full service position. The engineman thought the action taken was sufficient to stop the train short of signal 5.4. However, the speed was 52 m.p.h. when the locomotive passed signal 5.4, which was displaying the red aspect, and 45 m.p.h. when the collision occurred 115.5 ft. north of signal 5.4.

After the accident, tests were made with a train made up of equipment similar to that of the passenger train involved in the accident. At a speed of 85 m.p.h., and following the railroad instructions for making unexpected stops, the distance the train traversed following the initial brake-pipe reduction was 8,515 ft., or 3,360 ft. greater than the distance between signals 6.4 and 5.4.

The report of the Interstate Commerce Commission concludes with the statement: "Section 204 of the Commission's order of April 13, 1939, * * * requires that signals shall be spaced at least stopping distance apart or, where not so spaced, an equivalent stopping distance shall be provided by two or more signals arranged to display restrictive indications for trains approaching signals where such indications are required. The circumstances in this case forcibly direct attention to the necessity for this requirement. A passenger train was being operated at or near maximum authorized speed in a dense fog which greatly reduced the sighting distance of signals, in territory where, as disclosed by subsequent braking tests, the signals were not spaced far enough apart to provide adequate stopping distances. To correct this condition, the carrier will be expected at once to properly respace its signals or to reduce the maximum authorized speed of its trains to rates which will enable them to be stopped in conformity with the restrictive indications of the signal system as it now exists."