timing cylinders exhausts to atmosphere through port c^2, permitting the return of the pistons k and n and the closing of the entire locomotive circuit at contacts *j-j*. From the opening of the circuit at contact b to the final closing of the circuits at contacts *j-j* there is a definite, unvarying period of time—say six seconds. It will therefore readily be seen that should the speed of the train be in conformity to the spacing of the non-magnetic rail sections the locomotive circuit, which was opened at the first section encountered (A), will have automatically closed before the section A' is reached. Should the train be running faster than the predetermined rate between A and A' the proper period of time will not be consumed; and, contacts *j-j*, being open, the locomotive circuit will open at b when it reaches A'; and magnet i controlling valve o attached to the brake pipe, 37, will be de-energized and this will cause the application of the train brakes.

During the timing operation the circuit to magnet i is complete through contact b by means of wires a^1, a^2 and a^3 and back by b^1; although the circuit through wires j^2 and j^1 is open at *j-j*. The breaking of contact at b, under these conditions, de-energizes magnet i, with the result mentioned above.

Under normal conditions magnet i is held closed by the circuits through battery, a^3, b^1, a^1 and a^2; and also through j^2 *and* j^1.

As shown, the brakes are automatically released, as the timing operation is repeated at every non-magnetic section. On reaching A' compressed air is again admitted to the timing cylinders, and *j-j* and *y-y* remain open, until the timing operation has been completed. As the relay disk carried by the piston rod closes the circuit across contacts *y-y* after the air is exhausted, magnet i is energized, closing valve o.

Where the system is to be used without this release feature, contacts *y-y* are omitted and the energizing of magnet i to release the brakes may be accomplished by a push button which can be operated by the engineman after he has broken a seal.

In order to economize on the maintenance cost of the track magnets (3, 4, 5, 6) it is designed to keep the circuit of battery 33 normally open, as is done with "normal danger" semaphore signals; with this arrangement a train approaching a block section automatically closes the circuit, provided the succeeding block is unoccupied. If the block is occupied the track relay would of course prevent the energizing of the circuit from 33.

To illustrate the operation of the apparatus, suppose a train reaches A running 75 miles an hour. At this rate of speed it will consume 3.2 seconds in running the 354 ft. from A to A'. The timing device is so adjusted that the piston, in its stroke down and back, will consume six seconds. It will be seen that, when the train reaches A' the piston has not completed its movement; and contacts *j-j* will be open when the engine reaches A'. Contact b will then be opened by the passage over A'; and with b and *j-j* open at the same time magnet i will be de-energized and the brakes applied.

Now, assume that it is desired to require all trains to come down to 40 miles an hour at A. If the speed is within that limit the train will consume 6 seconds or more between A and A', so that the piston k will have returned to its normal position and that there will be no application of the brakes.

At the intermediate point, where the speed limit is 20 miles an hour, the distance between B and B' is 177 ft. If the train is moving faster than 20 miles an hour it will take less than 6 seconds to run from B to B', and the brakes will be applied as in the case above described

At the home signal the rails C and C' are spaced so that at any speed above five miles an hour the brakes will be set; or, by putting the manganese rails close together, the brakes can be made to apply, however low the speed.

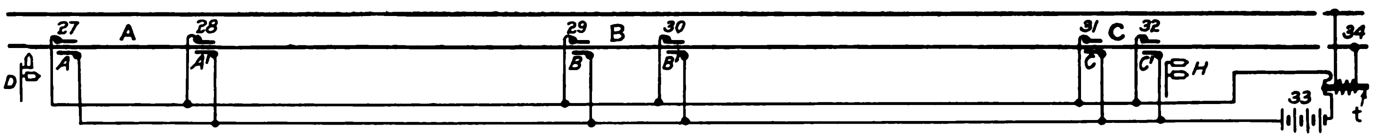

Fig. 2. Showing the Arrangement of the Manganese Sections of Track Rail in the Approach to a Home Signal.

To give a service application of brakes, as on a long freight train, valve o can be connected to the equalizing reservoir instead of the brake pipe.

Where a track has switches and frogs composed of manganese steel, provision is made to counteract their effect by means of auxiliary magnets carried by the locomotive between the running rails. These auxiliary magnets are connected in multiple with the main operating magnet, and the circuit across their contact points is normally open, there being nothing to complete the magnetic circuit.

Opposite each manganese frog a length of old steel rail can be spiked to the ties between the running rails. This will complete the magnetic circuit through the auxiliary magnets before the circuit of the main magnet is broken. These magnets being connected in multiple, only one of them is necessary to maintain the engine apparatus in closed circuit.

To prevent any possibility of ordinary steel rail being laid between the rails at speed control points, a timber can be spiked to the ties in line with the auxiliary magnets so as to prevent any possibility of the magnets being improperly affected.

It will be seen that the entire apparatus is designed on the closed circuit principle. Any ground or failure of batteries will cause an application of the train brakes. As, in the assembly of the apparatus on a locomotive, certain wires are run in cables, an overload circuit breaker, *CB*, is provided; and suitable resistance is inserted in the circuit at each contact point. The crossing of any wires would cut out the resistance and the entire locomotive circuit would be opened at *CB*. The possibility of failure of the system by the breakage of tension spring a is provided against by running the current through the spring to contact b.

The accidental application of the brakes because of snow or ice is guarded against by making the wheel treads serve continually to clear the way for the magnet.

The proprietors expect to be able to make this device at moderate cost. The apparatus to be put on the engine is compact and can be easily applied and inspected. No power is required except that furnished by a small battery and by the air supply, which comes from the air brake system. The stopping apparatus requires no contact of anything on the engine with anything on the track; and on the track there are no moving parts, so that there is no question of clearance.

The address of Messrs. Horne & Crane is 114 Liberty Street, New York City.

BRIDGE-MEGGERS FOR TESTING INSULATION.

The signal department of the Pennsylvania is making extensive use of bridge-meggers for testing the insulation resistance of wires, cables, relays, indicators, motors and other electrical apparatus used in their interlocking and signal installations. The results obtained from the use of this instrument have been very satisfactory.

The bridge-megger is an instrument which combines the functions of an ohmmeter with those of a Wheatstone bridge. As a megger, the instrument will determine by direct reading the insulation resistance of any circuit between 5,000 ohms and 40 megohms, the first division representing 5,000 ohms. By turning a change-over switch to "bridge," the connections of the instrument are altered in such manner as to convert the ohmmeter of the megger into a galvanometer of a Wheatstone bridge. When connected in this manner and used in connection with the resistance box, any resistance from one ohm to one megohm can be determined.

Energy for making tests is supplied by a small hand-operated direct-current generator located in one end of the instrument case. A handle projects through the case for the purpose of rotating the generator armature, and very little exertion is required for operation. When the handle is turned at a rate of 100 R. P. M., an E. M. F. of 500 volts is generated; if the handle is turned at a rate exceeding 100 R. P. M. a clutch slips so that a constant speed of the armature is maintained, thus insuring a constant E. M. F. of 500 volts.

On the Pennsylvania system one megohm has arbitrarily been fixed as the minimum safety value of insulation resistance of any circuit. If any circuit tests less than one megohm, immediate measures are taken to find the location of and correct the fault.

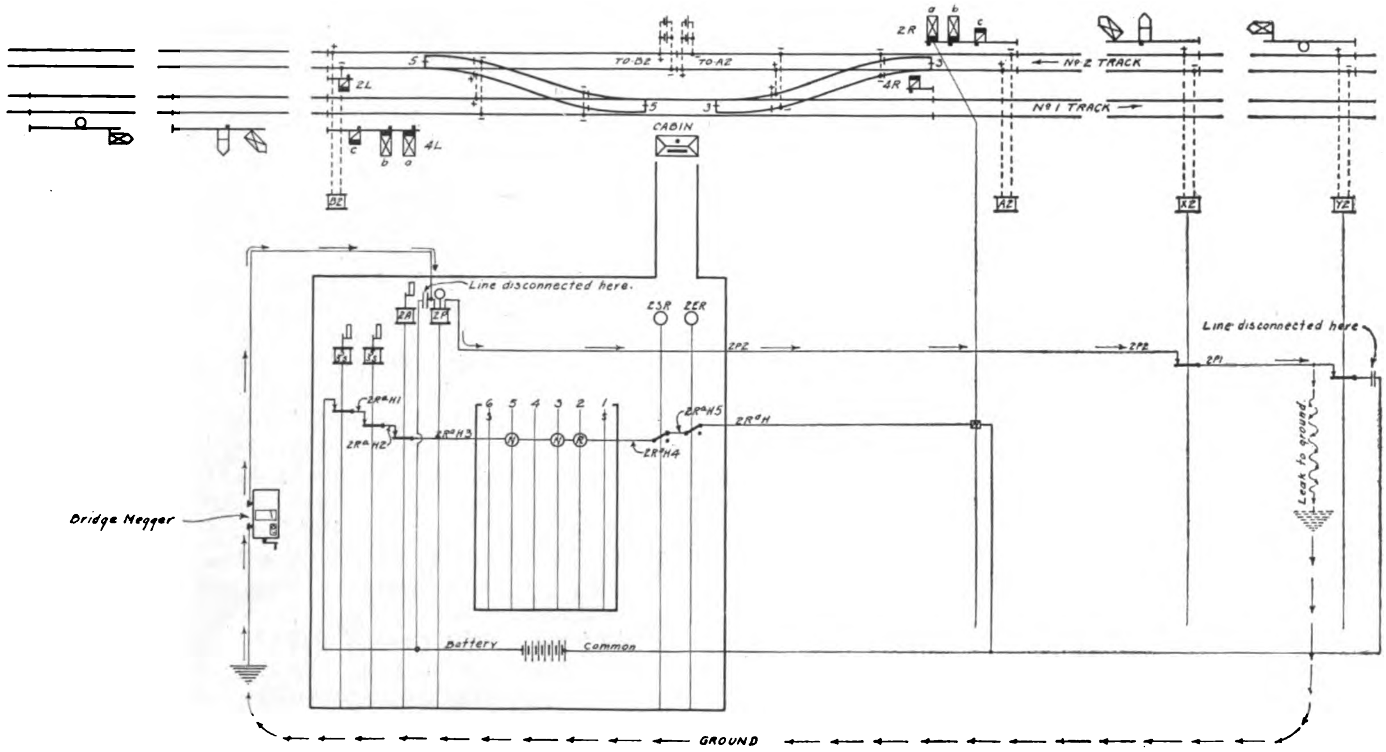

Fig. 1. Showing the Bridge-Megger Used in Locating a Defective Circuit at an Interlocking.

Tests are being made of all circuits at all interlockings and a record kept of the insulation resistance of each circuit, the type of apparatus, the kind of wire and the date the wire was installed. These tests will be made at least twice each year, and records kept of each test. These records will be very valuable in determining the life of wire of various makes.

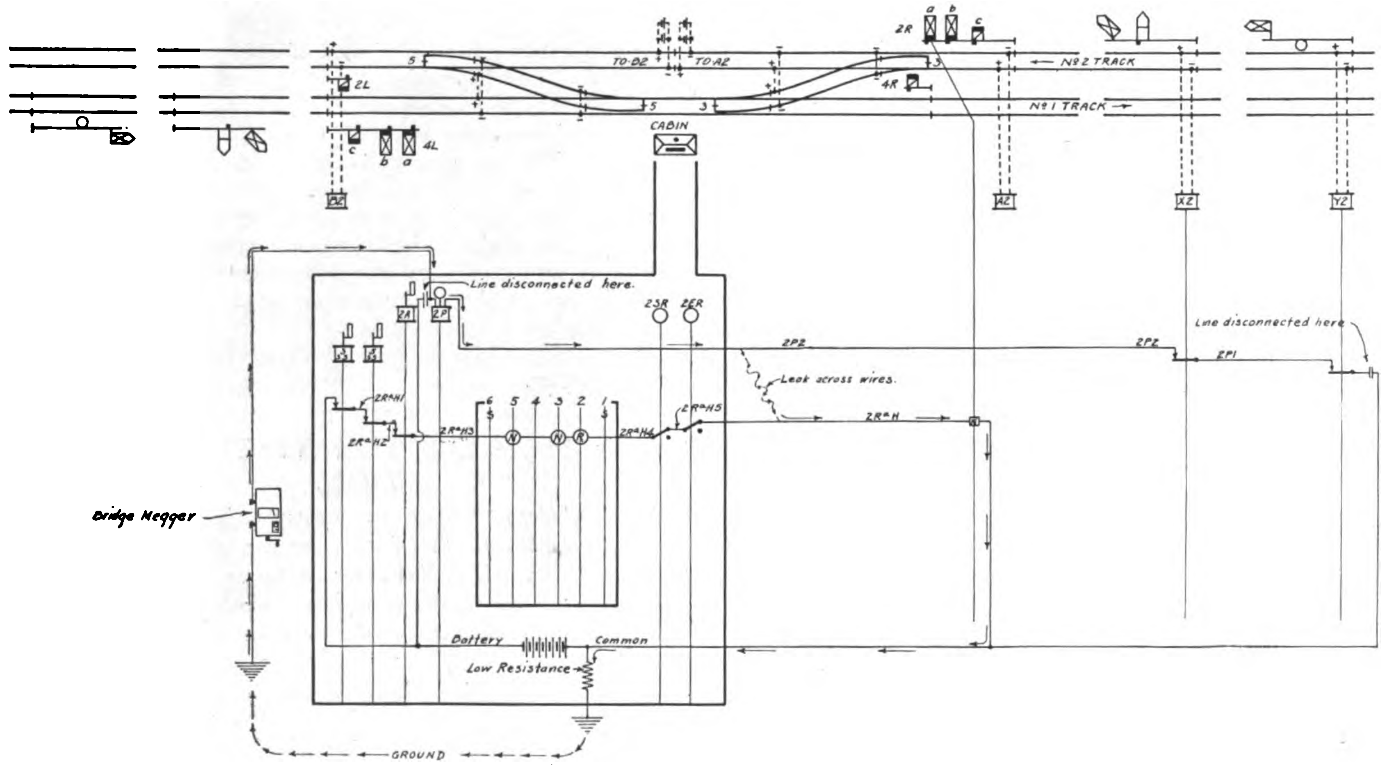

Fig. 2. Illustrating the Second Method of Making the Test for a Defective Circuit on an Interlocking.

On the first test on one of the main line divisions of the Pennsylvania, 40 per cent of the circuits tested above 40 megohms, 50 per cent between one and 40 megohms and 10 per cent less than one megohm. The defects in the 10 per cent that tested less than one megohm were found to be due to poorly made wire joints, cuts and breaks in the insulation of wires, dirt and carbon deposits around binding posts of apparatus, and in many cases small cuts and pin holes in the insulation of the wires, through which corrosion from the copper wire had worked. The locating of these defects has no doubt prevented many failures.

Two methods are used in testing—first, circuits are tested for insulation resistance to ground, as shown in Fig. 1. The circuits for "2P" indicator (approach indicator for No. 2 track) is disconnected at "2P" indicator and at relay "Y2." The line post of the megger is connected to the circuit at "2P" and the ground post connected to the earth. This circuit tested less than one megohm due to a ground on the line near relay "Y2." The line was opened at relay "X2" and test made which showed insulation resistance of infinity. The ground was located between relays "X2" and "Y2." The bridge was then connected with the megger and a Varley loop test made to locate the ground.

The second method is to connect the common wire to ground through a low resistance as shown in Fig. 2. As practically all circuits at an interlocking are connected to common through some apparatus the connection of common to ground really grounds all circuits at the interlocking through comparatively low resistance and as one side of the megger is connected to ground, any weakness in the insulation between wires will be detected. Weather conditions should always be considered when making tests. It will be found that during damp or rainy weather the insulation resistance of circuits will test much lower than in dry weather. Tests of a five-conductor switch cable at an electro-pneumatic interlocking during dry and wet weather were as follows:

First test made during dry weather; all five circuits tested to ground as shown in Fig. 1 and between the respective circuits showed an insulation resistance of infinity. The second test was made when ground was wet and air damp and showed the following:

Normal control to ground	Infinity
Normal indication to ground	2 megohms
Lock to ground	8 megohms
Reverse control to ground	250,000 ohms
Reverse indication to ground	625,000 ohms
Normal control to reverse control	Infinity
Normal control to lock	Infinity
Normal control to normal indication	Infinity
Normal control to reverse indication	3 megohms
Reverse control to lock	30 megohms
Reverse control to normal indication	3 megohms
Lock to normal indication	Infinity
Reverse control to reverse indication	1 megohm
Lock to reverse indication	35 megohms

These results show that during wet weather the reverse control and the reverse indication circuits had insulation resistance below the allowable minimum. Another test of a switch cable during damp weather showed four of the five circuits with less than one megohm resistance. This test was made with one end of the cable exposed to the damp air; the end had absorbed enough moisture to reduce the insulation resistance. The end of the cable was cut off and all circuits then tested above five megohms. From the above it will be seen that defects can be noted and corrected before trouble occurs.

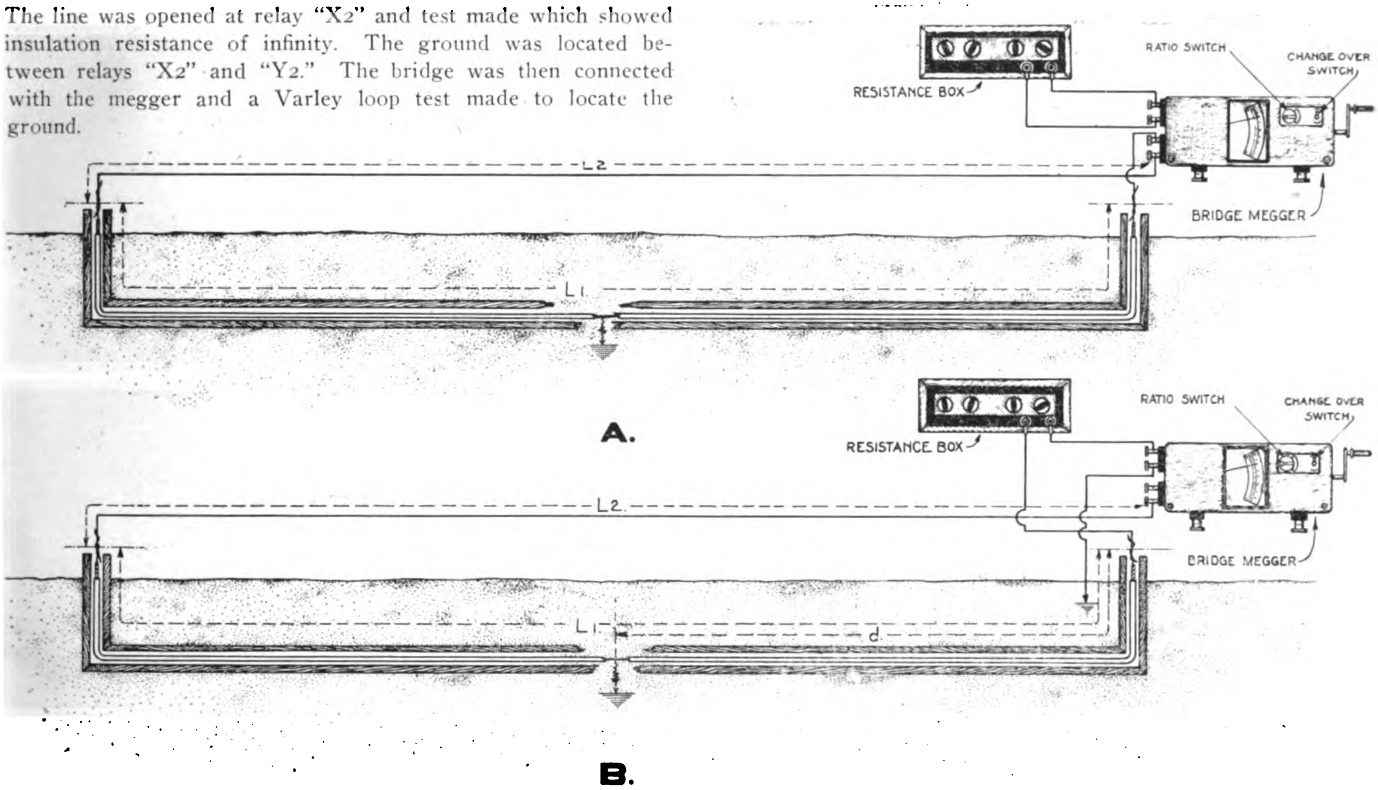

Fig. 3. Showing the Bridge-Megger Used to Locate the Fault by Means of the Varley Loop Test.

Fig. 3 shows the bridge-megger used in locating a fault in an underground wire. From the equation $d = \frac{L1 + L2 - R}{2}$ the distance in ohms from megger to fault is determined. The resistance of the loop (L1 + L2), is calculated or determined by bridge-megger as indicated in Fig. 3A. R = balancing the resistance determined by the bridge-megger operated as indicated in Fig. 3B, and d = resistance in ohms of the wire from the megger to the fault. Hence, d divided by ohms per foot equals the distance in feet from the megger to the fault.

The bridge-megger is a rugged instrument, very simple to operate, and gives accurate information in much less time than can be procured by any other method.

This device is manufactured by James G. Biddle, Philadelphia, Pa.

REPETITION SIGNALS ON FRENCH ROADS.

BY J. H. BLAKEY.

In 1911 the French Minister of Public Works required the installation of "repetition" signals, that is, signals repeating in the cab of the locomotive, on all the railroads of France. Some of these are visible signals, others are acoustic; some are operated mechanically, some electrically. In all cases the purpose of the repetition signal is to warn the engineer