fact a little bit above resonance due to the super capacity which allows a large amount of current to flow.

When the train passes the track elements in the clear position, the armatures of control relay 33 drop, due to the increased choking effect of choke coil 41 which would stop the train were it not for the fact that simultaneously with this action, the pick up voltage drop relay 47 is energized by the current flowing from track battery 59, armature 57, contact 53, connection 51, wheel 46, connection 44, pick up relay 47, connection 44, wheel 46, connection 52, contact 56 and armature 58, back to battery. This causes armature 48 to touch contact 49 which energizes the hold up relay 16 by current flowing from the alternator 10, connection 11, armature 48, contact 49, connection 15, winding of relay 16 and connection 19 back to the alternator. The clear electro-pneumatic valve 17 and visual signal 18 are energized, allowing the train to proceed in clear position under full control of the engineman.

When the choke coil passes over the inert track armature 42, in the caution position, the control relay 33 is opened as explained previously, but the track mechanism has changed the polarity of the current so that the pick up voltage drop relay 47 is energized, causing its armature to move to the right, touching contact 50, by the current flow from track battery 59, armature 57, contact 55, connection 52, wheel 45, connection 44, relay 47, connection 44, wheel 46, connection 51, contact 54, armature 58 back to battery 59. Armature 48 then touches contact 50, causing current to flow from alternator 10, connection 11, armature 48, contact 50, connection 26, winding of relay 23, and connection 19, back to the alternator which holds up relay 23.

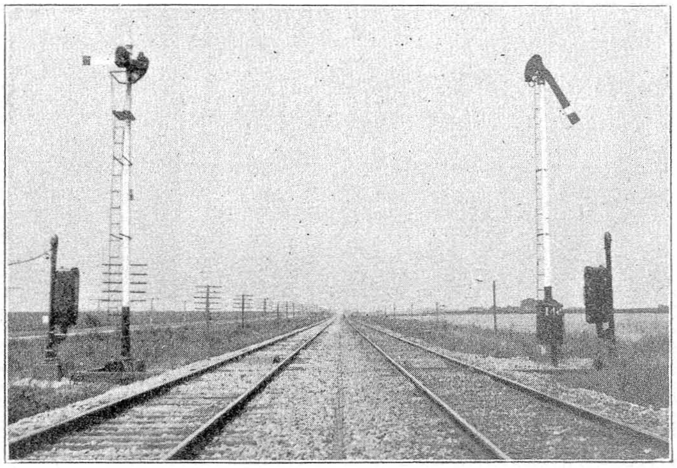
The holding relay 16 has become de-energized and remains de-energized or open. Electro-pneumatic valve 29, and visual signal 30 in parallel are now energized by current flowing through connection 11, armature 20, connection 21, armature 22, connection 26, armature 25 in its lowered position, connection 28 through visual signal 30, and the winding of electro-pneumatic valve 23 in parallel to connection 19, back to generator, causing the train to proceed at restricted speed. The electro-pneumatic valve 23 controls a slide valve which now takes a midway or safety position, and co-operates through a governor, controlled valve by the speed of the train, so that after the locomotive has exceeded a predetermined speed limit, say 30 or 35 m. p. h. the brakes will be applied automatically, and it will have to continue through the caution block at the restricted speed.

As the locomotive passes over the track elements in the stop position, track armature 42 opens control relay 33 which causes the train to stop because the signal track relay 60 has disconnected battery 59 from the connections 51 and 52. As explained, the electro-pneumatic valves 23 and 17 will be de-energized as the air brake mechanism now controls a small piston operated by main reservoir pressure moving a slide valve, causing the train line to be vented and the train to stop. If necessary, for single track operation, a reversing switch may be put in the connections 44 to the pick up relay 47 so that the correct indications will be given to this relay.

It will be noted that this induction device, unlike some other direct current induction devices, does not give a single impulse to stop the train. In other words, alternating current gives continuous impulses, and will function with the choke coil standing over the armature, whereas, direct current induction, whether induced from the locomotive or from the track is, of the single impulse type, and will only function to stop the train when the train is running at a certain speed to cut the required number of lines of force.

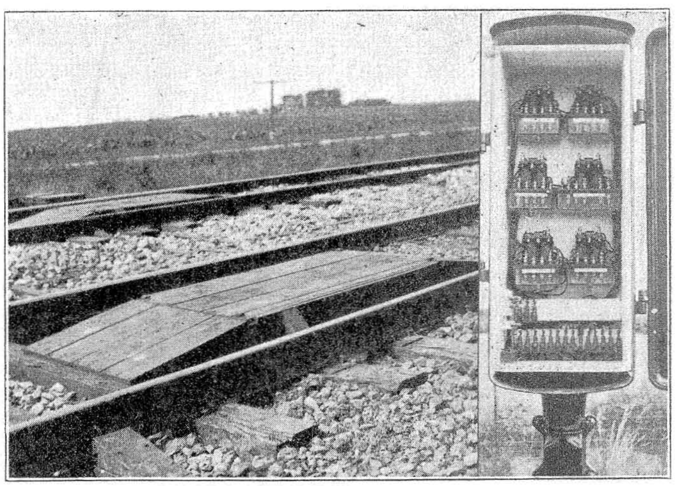
Chicago & Alton Installation of Train Control

THE Chicago & Alton placed in service 14 miles of double track train control of the intermittent induction type as manufactured by the National Safety Appliance Company on June 26. The installation extends from Normal, Ill., to Lexington on double track and 13 wayside track elements are in service. These track elements are located at the signals with an overlap to prevent any over-run. At 11 locations a simple



Double Location with Track Magnets at Signals

automatic stop feature is employed. One location, the first signal north of the southbound distant signal for the Normal interlocking plant, is arranged with a combination stop and speed control feature. The track section which governs the speed of the train through this block is of such length as to prevent its exceeding a rate of more than 40 m. p. h., and is arranged to govern the approach of the train to the distant signal on the Normal interlocking plant. The southbound distant signal for the



Track Magnets with View of Adjacent Relay Case

Normal interlocking plant is equipped for speed control only, with a speed limit of 30 m. p. h., in order to compel the engineman to approach the home signal under control.

Eight engines are equipped with the apparatus and four engines are used in passenger service as follows: One engine is operated on train No. 7 leaving Bloomington, Ill., at 10:30 a. m., northbound, and on No. 12, leaving

Bloomington at 6:00 p. m. One passenger locomotive is in service on train No. 11, arriving at Bloomington at 4:30 a. m. and another is used on No. 43, arriving at Bloomington at 1:00 p. m. These are the 4-4-2 class.

Of the four engines used in freight service two of them are used on way freights and these are of the 2-6-2 class. Two locomotives are of the 2-8-2 class, which serve for hauling heavy drags. By the assignment of motive power, as above outlined, it is the feeling that intensive tests can be made of the apparatus under all ordinary operating conditions. The system is so designed that should it be necessary to run trains against the current of traffic, or to back up, that trains will not be stopped unnecessarily provided the track ahead is clear. The circuits for the apparatus are similar to the installation on the St. Louis-San Francisco, which was described on page 284 of the July, 1923, issue of the *Railway Signal Engineer*.

F. J. Sprague on Train Control

THAT the railroads are hoping a change will be made in the law regarding the installation of automatic train control was the opinion expressed by F. J. Sprague, of the Sprague Safety Control & Signal Corporation, in talking to the western signal engineers in St. Louis on July 19. It was his thought that if any changes were made they would probably be along the lines of increasing the penalty which those roads not complying with the order in the time specified would have to pay. Before discussing his system of train control, Mr. Sprague talked on train control in general and its application to railroad service.

It was not surprising, Mr. Sprague said, that railroad men have had a prejudice against train control and, were he a railroad man, he, too, would also feel that way because of conditions surrounding its development. However, it is his feeling that this attitude is changing. In speaking of the elimination of signals, Mr. Sprague said the government does not require that they be dispensed with. Congress had come to the conclusion that signal indications should be enforced. If enginemen could always see the signals, always understand and always obey them, there would be little need for train control, as the signal failures are so few that they are practically negligible.

In speaking of his development work, Mr. Sprague said his conclusion is that train control is an adjunct to a signal system. Continuing, he felt that what one should seek in a train control system is the least interference with the manual control of trains; the last thing to be desired is the automatic control of trains. Regarding the number of times train control will come in operation, Mr. Sprague said that but few people realized how infrequently it would be called on to act. An analysis would show that it might function perhaps twice on a run between St. Louis, Mo., and Chicago (284 mi.). On some roads it would function perhaps one time in 500 blocks or in many cases perhaps not oftener than once in 1,000 blocks.

In speaking of the tests made on the New York Central, Mr. Sprague said his idea was to try out his apparatus by intensive tests and under the most unfavorable conditions that could exist for an inductive type of apparatus. For that reason, a test section in the electrified zone near New York City was selected in order to study the effects of the fields set up by the electric propulsion current on the inductive train control apparatus. In this section electric locomotives and multiple unit trains are operated on 660 volts d. c., and heavy currents are carried in the rails. Mr. Sprague showed a number of lantern slides illustrating the magnetic fields set up by his track elements and by the currents flowing through the rails and explained how the apparatus was designed to prevent interference from extraneous fields.

Some trouble had been experienced from the physical standpoint, Mr. Sprague said, through coal and other obstructions on the track coming in contact with the collector plates and casting housing located on the engine. Coal at coal chutes would fall between the rails and as the engine moved, the lumps would slide along until they came to a depression, when they would either be crushed or set up a lifting moment. Tests were made with the collector standing over hot ashes and then over snow and ice in order to observe the maximum temperature effects on the apparatus. These tests, Mr. Sprague stated, led to the design of a collector so strong that it can pass through anything that the pilot can. It was also designed so that extreme temperature effects would cause no trouble.

Mr. Sprague said that there were three ways in which train control apparatus could apply the brakes. These are: (1) Pull the train pipe open; (2) open the train pipe and let it blow down to a fixed pressure, and (3) make a definite reduction in an equalizing reservoir, with the train line reduction following a like amount. Mr. Sprague was of the opinion that the first two methods were wrong; that the method employed by him provides for a predetermined fixed reduction regardless of the variation of brake pipe pressure. With his system of control, Mr. Sprague would provide a semi-automatic angle cock on the engine tender in order to prevent accidents occurring like that at Dunkirk, N. Y., when a trespasser shut off the angle cock thinking he could stop the train by so doing.

Mr. Sprague described the operation of his device by means of illustrated slides and drawings. The equipment is divided into two parts:

A.—Trackway elements, comprising: (1) A brake-application magnet in each block, carried on the ties well below the plane of the rail-heads, with means for deflecting the active magnetic field for "clearing," and under either manual or automatic control of traffic conditions. Where traffic is sufficiently dense, or at interlocking plants and drawbridges, two or more application magnets may be used in a block.

(2) A reset magnet, under control of traffic conditions. Where it is not deemed essential to hold a train under low speed control, the track reset may be omitted and a limited engine reset provided instead.

B.—Locomotive apparatus, comprising, according to operative demand, a part or all of the following elements:

A single or double magnetic impulse receiver; relays and vent valves; indicating lights and audible alarm; interchangeable engineer's brake-head; differential control valve and selector cap; single or duplex service brake valve; quick-acting brake valve, and speed-brake controller. (A description of the Sprague system and its operation appeared on page 226 of the June, 1922, issue of the *Railway Signal Engineer*.)

With respect to track capacity, Mr. Sprague stated that