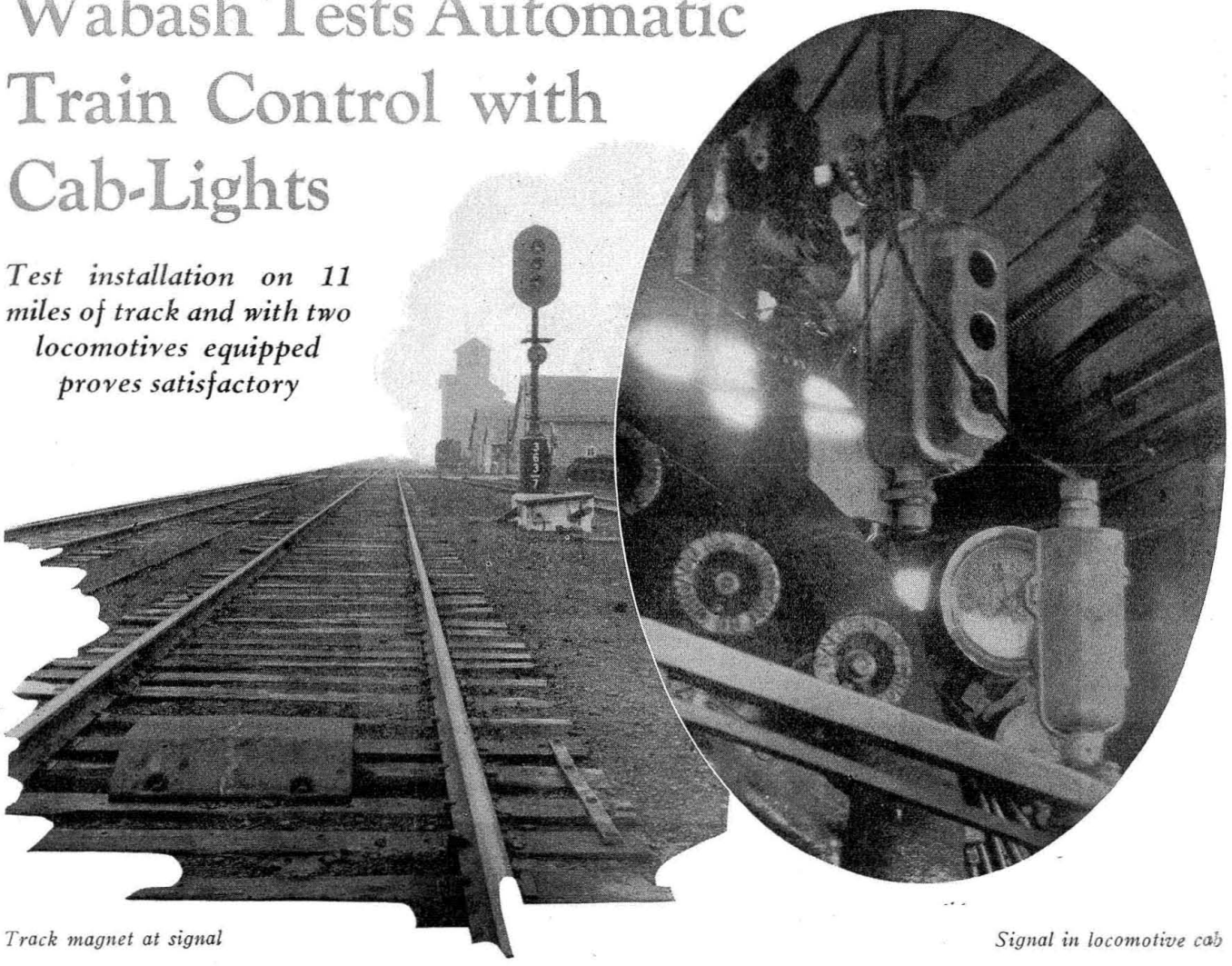
Wabash Tests Automatic Train Control with Cab-Lights

Test installation on 11 miles of track and with two locomotives equipped proves satisfactory



Track magnet at signal

Signal in locomotive cab

THE Wabash recently made an extensive test installation of the Strowger automatic train control system manufactured by Automatic Electric, Inc., Chicago. This apparatus is of the intermittent magnetic inductive type of control, with a special arrangement for the control of cab-light indications. The wayside control units were installed at eight signal locations on the eastbound track of a double-track line between Decatur, Ill., and Bement. Engine equipment was provided for two different locomotives, which were operated over this territory for several months. A complete set of detail tests were made on December 14 and 15.

Description of the System

The Strowger Automatic train control system provides, in brief, the following features:

1—A complete duplication of the wayside signals in the cab of the locomotive, on passing, and also at braking distance from, each signal.

2—A positive check on the locomotive apparatus at every indicating location.

3—An automatic brake application, unless forestalled, at stop and caution signals and at braking distance therefrom.

4—An audible warning when passing every signal and at braking distance from each signal.

5—Immunity from the effects of foreign current.

6—An acknowledging device by means of which the engineman may forestall an automatic application.

7—A universal magnetic receiver on the locomotive, operating with the locomotive running either forward or backward with the current of traffic.

If desired, the system may be operated without the automatic brake control in which case the system functions as a cab-light device complete in itself. The pneumatic apparatus, added to the electrical, provides automatic control of the brakes, hence the electrical and pneumatic apparatus combined constitutes the train control and cab-light signal equipment.

The roadside equipment includes two inductors *A* and *B* which are provided at each signal location (and also at braking distance from the same). The *A* inductor, consisting of a set of permanent magnets, checks the locomotive signaling and control apparatus and puts it to "zero" position, at every roadside signal location and at every braking distance point therefrom.

The *B* inductor is an electro-magnet with two windings through which the direction of current may be reversed, and the flow controlled in accordance with the condition of the track circuits ahead. The purpose of the *B* inductor is to set up either a green or a yellow light in the locomotive cab. The current for operating the *B* inductors is derived from an independent train control battery located at each signal.

The roadside train control apparatus was superimposed on the existing standard system of signaling. Referring to Fig. 2, which illustrates a complete scheme of operation for one-way traffic on double track, it will be seen that the relay *G* is connected in parallel

n the green light in the color-light automatic block gnal so that the negative pole of the train control bat-ery is connected to the common return only when the green light is illuminated and to the positive pole of the battery when the green light is out.

Following the course of the dotted heavy lines it will be seen that the first *B* inductor (at braking distance) will be energized when a train is in track circuit *TC2*, by the pick-up of approach relay *W*, and the second *B* inductor at the signal will be energized by the pick-up of the approach relay *V*. The complete operation and control of these two *B* inductors is given as follows:

The first *B* inductor—when energized to set up a green indication, requires: Relays *G*, *Z*, *Y* and *W* to be up. To set up a yellow indication requires: Relays *Z*, *Y* and *W* up and *G* down. The second *B* inductor—to set up a green indication requires: Relays *G*, *Z* and *V* up. A yellow indication requires: Relays *Z* and *V* up and *G* down.

A distance of 70 ft. is allowed between the insulated rail joints of the track circuit and the *B* inductor to insure that the leading wheels of the locomotive will not come onto the next track circuit in advance and de-energize the *B* inductor before the receiver has passed over it. In other words this distance is allowed to prevent possibility of conflict between the roadside and the locomotive cab indications, as the locomotive passes into the advance block. The distance of 30 ft. between the *A* and *B* inductors at the signal location is allowed to insure that an audible blast of the train control cab whistle of sufficient duration to be heard, shall be given when passing clear signals at high speed.

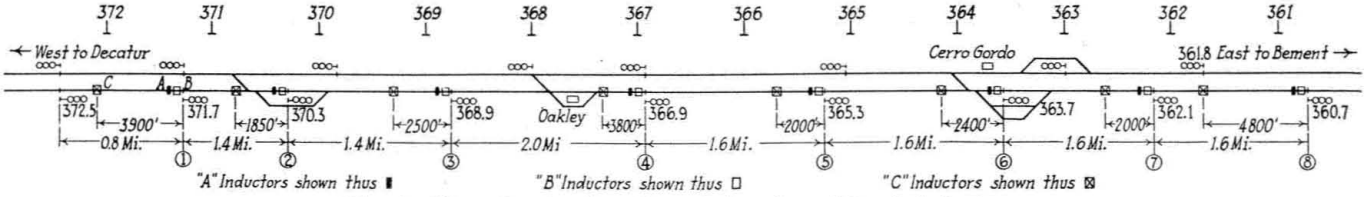


Fig. 1—Plan showing location of signals and track inductors

Locomotive Apparatus

The locomotive apparatus includes one receiver mounted under the tender; one electro-pneumatic valve including a warning whistle; one automatic train control valve including the double-heading cock; one air reservoir; one acknowledging plunger and relay box; and three sets of cab signal lights, one of which is on the engineman's side, one on the fireman's side and one at the rear of the tender for the information of the engineman on a helper engine.

The locomotive equipment requires but little explanation. Referring to Fig. 3, the mode of operation is as follows: In the normal position set for a green cab indication, all of the armatures are at the "IN" position. When set for caution, a yellow cab indication, as shown in Fig. 4, all armatures "OUT," after passing *B* inductor, but *C* and *D* are restored by acknowledgment to the "IN" position (to avoid a brake application). When set for zero, the armatures are deflected either to the right or to the left, giving an "out of phase" condition which breaks down all circuits. Armatures *C* and *D* must be restored by acknowledgment to avoid a brake application, and to set up a red light.

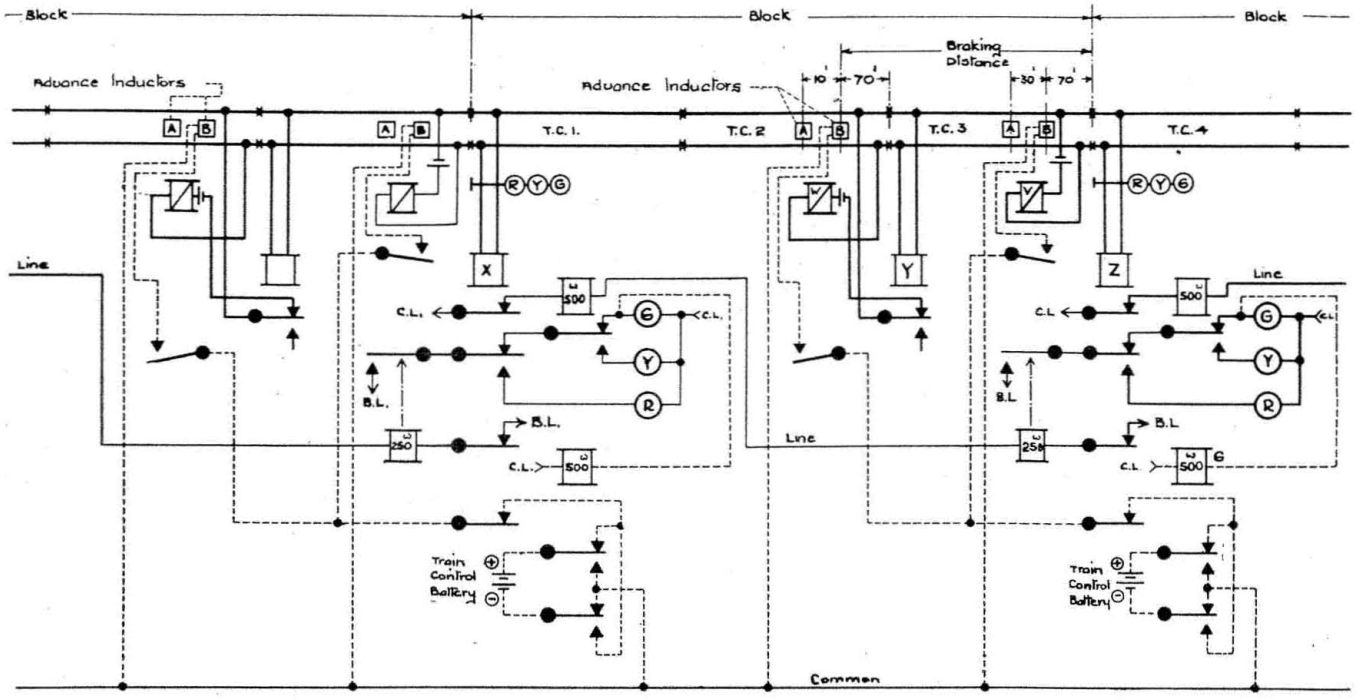


Fig. 2—Typical arrangement of inductors and control circuits for one-way traffic

Electrical Control of Cab Signals and Automatic Brake Valve

Referring to Fig. 3 the positive lead *1* and *2* is normally connected to the receiver armatures *A*, *B* and *D*, but is cut off when the acknowledger *P* is operated, which diverts this circuit through the reset coils on armatures *D* and *C*. If *P* is held down more than four seconds an automatic brake application will occur.

When all the armatures are "IN" as shown in Fig. 3,

the green cab lights are illuminated through lead 4. The coil *G* of the relay is also energized. The E-P valve is energized only when armatures *D* and *C* are *IN*, (trace circuit through lead 11). When armatures *A, B* are "OUT," as shown in Fig. 4, the yellow cab lights are illuminated. The coil *Y* is energized through lead 7. When *A* and *B* are "out of phase," the red cab light appears, but only after *D* and *C* are restored to the "IN" position after acknowledgment. Contact *R* is closed only when coils *Y* and *G* are de-energized.

The "Shear Loop" as shown in all digrams in lead *2* is provided for the purpose of cutting the main positive lead (which extinguishes the cab signal lights and gives a brake application), whenever the receiver is accidently dislodged from its normal position, thus notifying the engineman of its damaged condition. As this loop cannot be restored except by the maintainer, it ensures that the receiver cannot be struck and possibly damaged without the knowledge of the engineman.

Pneumatic Apparatus on Locomotive

The electro-pneumatic valve, located in the locomotive cab, serves two purposes: To control the warning whistle and the train control brake valve. When cab-light signals only are required, the air pipe *MR* is connected to the main reservoir of the existing air brake system; with automatic train control it is connected to the *B* chamber of the train control brake valve. As the whistle is the only E-P valve air outlet to atmosphere there is always ample pressure to sound the whistle with a distinctly audible blast.

The combined train control brake valve and double-heading cock is installed in the brake pipe under the engineman's automatic brake valve, where it replaces the double-heading cock. This valve is designed to accomplish the following: To initiate an automatic brake application at service rate of reduction in brake pipe pressure; to provide a double-heading cock in lieu of the ordinary double-heading cock displaced, and to permit of a manual emergency application of the brakes to be made with the engineman's automatic brake valve, while the double-heading cock is closed, or while an automatic application is in progress.

An automatic brake application is initiated in the following manner, see Fig. 5. When the electro-pneumatic valve is de-energized, the *B* chamber is exhausted through the warning whistle attached to the E-P valve to atmosphere at a greater rate than brake pipe air enters the *B* chamber through port *A*. After the *B* chamber pressure reduces to a point where the pressure on the right-hand side of the automatic application piston *2* is sufficient to compress the spring *3*, the piston *2* and its attached slide valve *4* will move to the left closing port *C*, and open the brake pipe to atmosphere through by-pass *D* to service rate exhaust port *E*, thus initiating a service rate brake pipe reduction and a consequent automatic brake application.

To release the brakes after an automatic brake application has been accomplished, the engineman first places his automatic brake valve handle on lap, and then operates the acknowledging plunger *P* which resets the receiver, energizes the electro-pneumatic valve and stops the exhaust of *B* chamber air to atmosphere. The pressure in the *B* chamber then rises to a point where

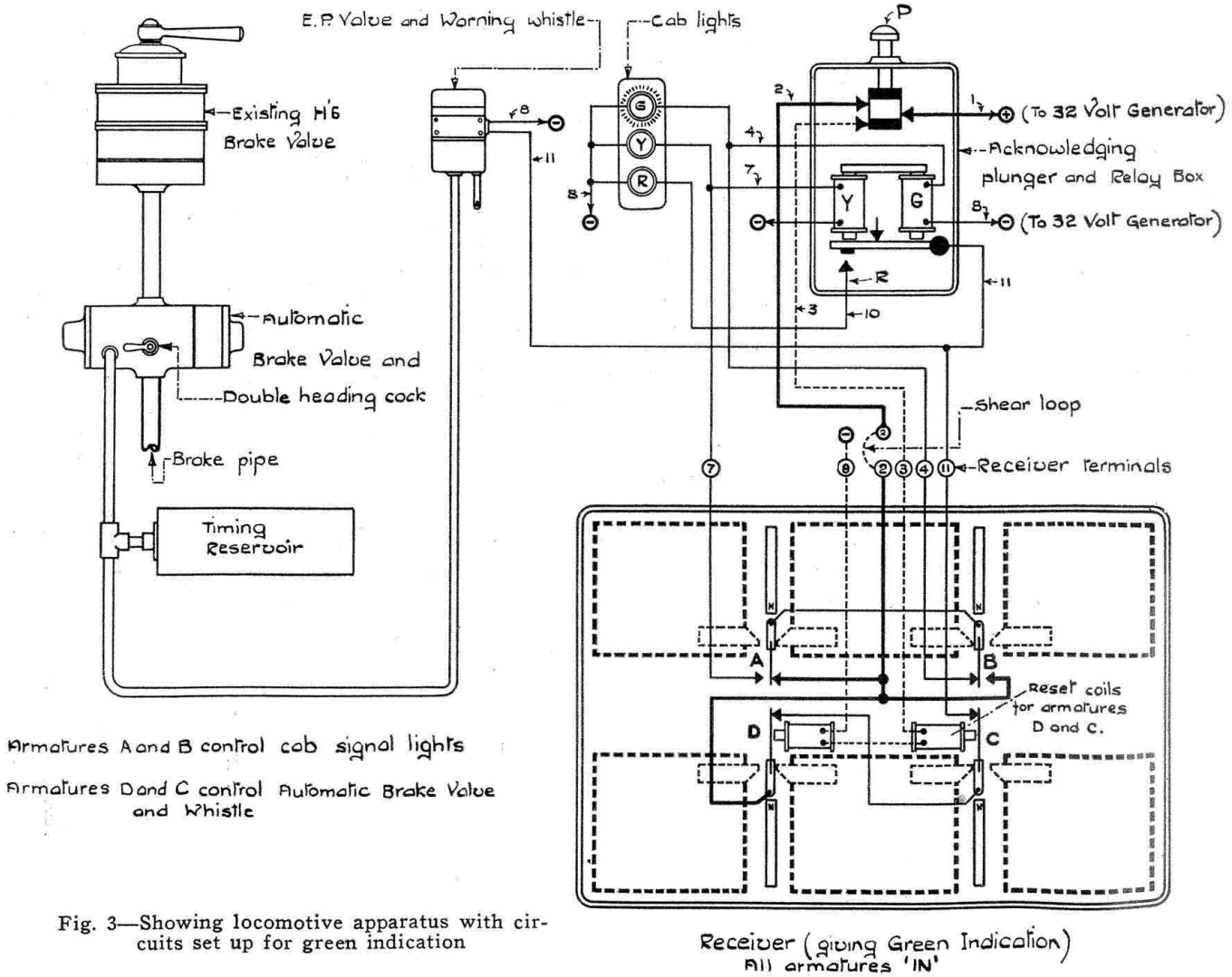
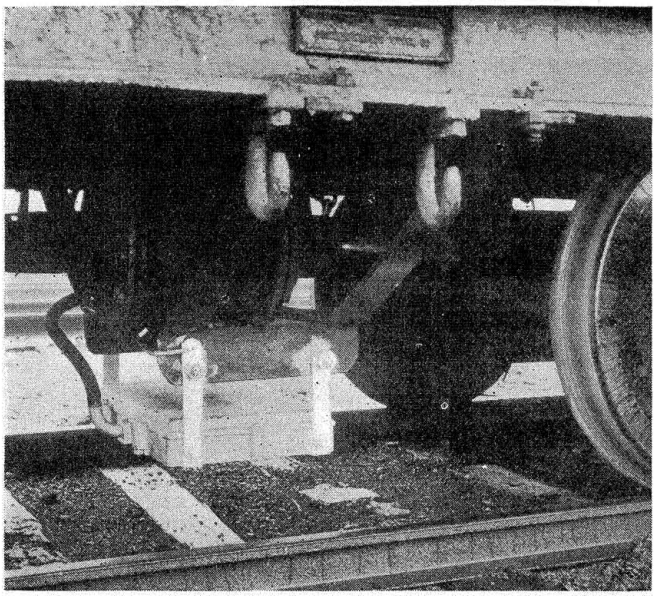


Fig. 3—Showing locomotive apparatus with circuits set up for green indication



The receiver is mounted under the tender

it approximately balances the pressure on the right-hand side of the service application piston *2*, spring *3* then returns the piston *2* and slide valve *4* to normal position (as shown in Fig. 5), thus closing the service rate exhaust port *E* to atmosphere and opening the port *C* to brake pipe, the engineman may then manually release the brakes in the manner prescribed by the air brake rules of his road with his automatic brake valve. Valve *6* is provided for the purpose of cutting the train control brake valve out of service when necessary. This is accomplished by screwing same up to its stop.

Operation of the System

The normal-running condition under clear signals is indicated by a green light in the cab. When passing a signal at clear, the existing cab light is extinguished, and the audible warning given, when passing the *A* inductor, but the green cab light appears when passing the *B* inductor. When passing a signal at caution, the existing cab light is extinguished and audible warning given when passing the *A* inductor, but automatic brake application occurs unless acknowledgment is made within a reasonable time interval after audible warning begins. The yellow cab light is set up automatically.

When approaching a signal at stop the existing cab signal light is extinguished, an audible warning is given, and an automatic application is made unless acknowledgment is made within a reasonable time interval after audible warning is given, but if acknowledgment is made, the red cab light is set up. When passing a signal at stop the cab indication is extinguished, an audible warning is given, an automatic brake application is made unless acknowledgment is made within a reasonable time interval after audible warning begins and if acknowledgment is made, a red cab light is set up. The above operations occur at braking distance as well as at the signal itself, the first pair of inductors acting as a repeater.

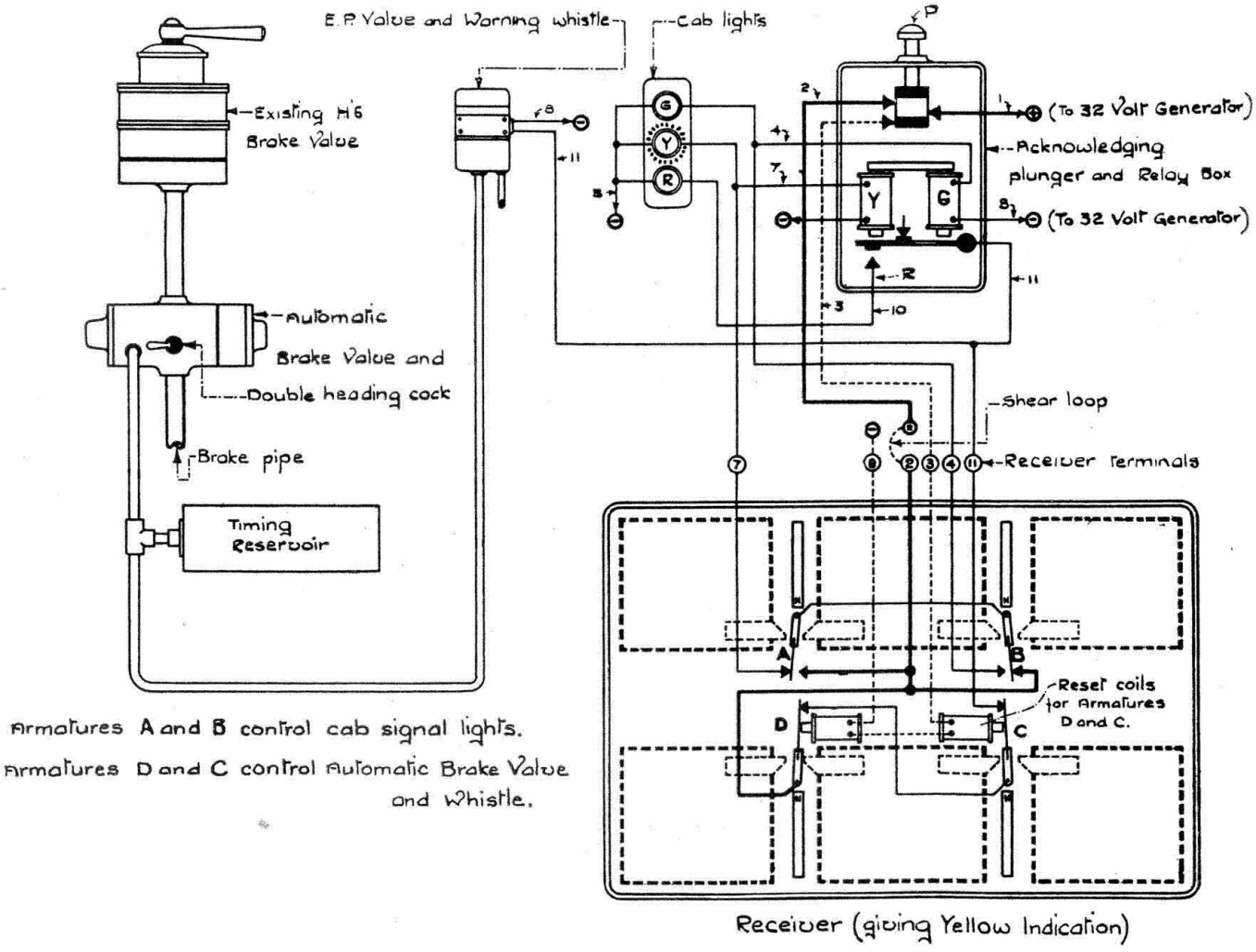


Fig. 4—Showing locomotive apparatus with circuits set up for yellow indication

Road Tests

Tests were made with train-control equipped Wabash locomotive No. 671, dynamometer car, coach and caboose; the cab lights being reproduced in the dynamometer car. The purpose of the tests with this light train were to demonstrate the cab lights. Before leaving Decatur, the train control apparatus was set for the red cab indication. The receiver was set four inches above the rail.

(1) On approaching the train control zone, Signal 371-7 displayed a green light, which was reproduced in the locomotive cab at the advance and signal locations.

(2) Signal 370-3 displayed a yellow light which was reproduced in the locomotive cab at the advance and signal locations.

The engineman promptly acknowledged the warning whistle to prevent an automatic application of the brakes at both the advance and signal locations.

(3) Signal 368-9 displayed a red light, which caused the cab lights to be extinguished and the warning whistle to sound. The engineman promptly acknowledged at both the advance and signal locations, and the red cab light was set up.

(4) Signal 366-9 displayed a green light which was reproduced in the locomotive cab lights.

(5) Signal 365-3 and Signal 363-7 also showed a green light which was reproduced in the locomotive cab.

(6) Signal 362-1 displayed a yellow light, which was reproduced in the locomotive cab lights. The engineman promptly acknowledged to prevent a brake application.

(7) Signal 360-7 displayed a red light. The engineman took no action other than to close the throttle partly after the train control brake valve started to make a brake-pipe reduction.

The train came to a stop from a speed of 50 m. p. h., in 1,600 ft., requiring 40 sec. The engineman then acknowledged and released the brakes in the usual manner. The train then proceeded to Bement.

At Bement the receiver was raised to six inches above the rail.

The train then crossed over to the westbound main and backed up to Sangamon, then crossed over to the eastbound main and backed up to Signal 372-5.

(8) The train proceeded eastward and repeated tests 1, 2, 3 and 4.

(9) After the train had passed signal 365-3, which displayed a green light, the switch to the north passing track at Cerro Gordo was opened. Signal 363-7 displayed a green light, but the advance inductors for signal 373-7 gave a red cab indication because of the open switch. The engineman promptly acknowledged the red cab indication, and the train entered the siding and was brought to a stop. The receiver was then lowered to two inches above the rail.

(10) The train was backed on to the main line and proceeded to Bement, repeating tests 6 and 7.

The locomotive was turned at Bement and proceeded to Cerro Gordo against the current of traffic. The

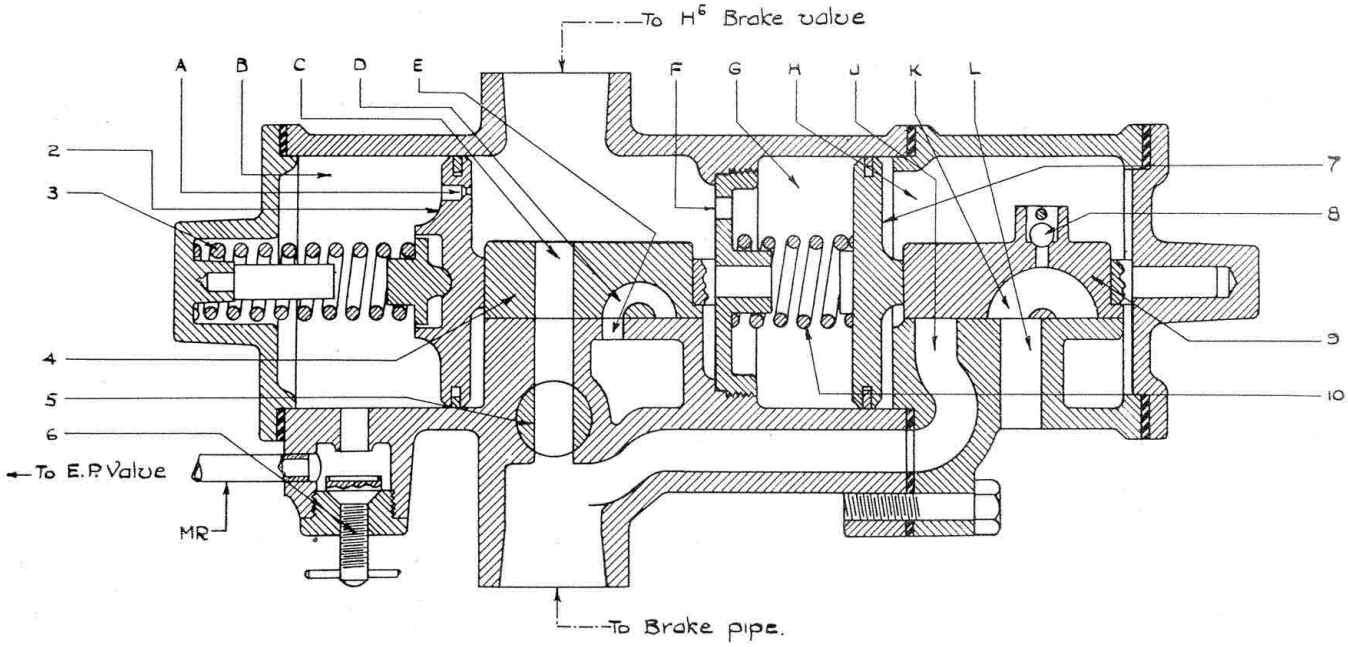
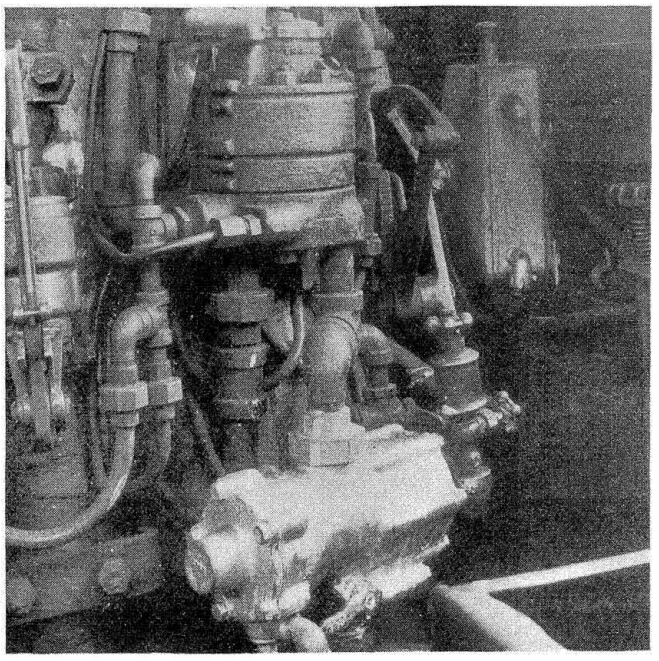


Fig. 5—Cross-section of special train control brake valve



The train control brake valve below regular engineman's valve—Note acknowledger at right

engineman promptly acknowledged the red cab indications given by every signal and its advance inductors passed against the current of traffic. At Cerro Gordo, the locomotive was switched to the east end of the train and proceeded to Bement with the locomotive running tender first.

(11) Signal 363-7 displayed a "light-out" indication, but was set at green. A green cab indication was picked up at this location.

(12) Signal 362-1 displayed a "light-out" indication, but was set yellow. A yellow cab light was set up in the cab and the engineman acknowledged the warning whistle at both the advance and signal locations.

(13) Signal 360-7 displayed a "light-out" indication, but was set at stop. The engineman promptly acknowledged the warning whistle at both the advance and signal locations, setting up a red cab light, and proceeded to Bement.

Freight Train Tests

Tests were then made with train-control equipped Wabash locomotive No. 671, dynamometer car and with thirty freight cars.

(1) A brake-pipe leakage test was made by placing the H-6 brake valve on lap for 2 min., and the fall in B. P. pressure was 5 lb. per min.

(2) After the leakage test was completed the brake system was recharged to the standard pressure of 70 lb. and, with the H-6 brake valve, a 20-lb. brake-pipe service reduction was made. It was noted that 24.5 sec. was required for the brake pipe proper to reduce its pressure 20 lb.

(3) After completing the H-6 service reduction time tests, three similar trials were made with the automatic brake valve, the time required by the A. B. V. to reduce the B. P. pressure being an average of 37 sec.

Comparing the results of tests 2 and 3 shows the difference in the time between the H-6 and the A. B. V. in making a 20-lb. B. P. reduction. The time of the A. B. V. was somewhat longer than that of the H-6 for a full 20-lb. reduction. The timing of the A. B. V. however is easily controlled by changing the size of its port.

(4) After completing the A. B. V. service reduction time tests, and the system recharged to 70 lb., the double-heading cock was closed and an emergency application was made with the H-6 brake valve.

Test 4 demonstrated that the engineman on the helping locomotive, placed in any location in the train, can effect an emergency application of brakes at any time he had occasion to do so, and also that he can hold the brakes applied as long as he desires.

(5) Signals 371-7 and 370-3 displayed a green light.

(6) Signal 368-9 displayed a yellow light.

The engineman did not acknowledge the warning whistle at the advance inductors, but took an automatic application of the brakes with the throttle open, the train being stopped from a speed of 23 m.p.h. in a distance of 1,800 ft. The throttle was closed after the train stopped, the engineman acknowledged, released the brakes in the usual manner and proceeded.

(7) Signals 366-9, 365-3 and 363-7 displayed a green light.

(8) Signal 362-1 displayed a yellow light. The engineman acknowledged same and proceeded.

(9) Signal 360-7 displayed a red light. The engineman took no action, permitting the automatic application of the brakes to stop the train with the throttle open. The train was stopped from a speed of 39 m.p.h. in a distance of about 5,150 ft., in 2 min. 8 sec.

The time and distance required for stopping trains was somewhat excessive, but these factors are easily reduced to anything desired by a change in size of the orifice in the application valve. After the train stopped the engineman acknowledged and proceeded to Bement.

Failure to Observe Signals Cause of Rear-End Collision

FAILURE properly "to observe and obey automatic block signals and other restrictive indications," is given as the cause of the rear-end collision between a freight train and an express refrigerator train on the Delaware, Lackawanna & Western, near Greendell, N. J., on September 17, 1929, according to the report of the Bureau of Safety. The accident occurred on a double-track line at a point about six miles east of Greendell tower. On this line, trains are operated by time-table, train orders, and an automatic signal system.

The automatic block signals involved, signals 528 and 520, are of the two-arm, two-position, lower-quadrant semaphore type, and are located 7,160 and 3,000 ft., respectively, west of the point of accident. Owing to an overhead arch bridge, which spans the tracks at a point 843 ft. west of signal 520, the view of that signal is somewhat obstructed, but under favorable conditions, a clear view can be had of both arms of this signal when it is 1,848 ft. distant. It was daylight, but raining very hard, at the time of the accident, which occurred about 6.31 a. m.

Eastbound freight train extra 2,227 departed from the eastbound passing siding at Greendell, at 5.55 a. m., and Flagman Cawley put down two torpedoes and left a yellow fusee. On reaching a point just east of signal 520, and before entering Roseville tunnel, he dropped off another yellow fusee. Shortly after the caboose emerged from the opposite end of the tunnel, at which time the train was traveling at a speed estimated to have been between 12 and 20 mi. p. h., it was struck by extra 1,192. Eastbound deadhead equipment train extra 1,192 passed Greendell tower, at 6.17 a. m., according to the train sheet, and a copy of the following message was delivered to both the head and rear ends of the train:

"C&E Exa 1,192 East:

"Clear at Roseville siding for No. 14."

The west switch of the eastbound passing siding at Roseville is located about 2¼ miles east of where the collision occurred. Extra 1,192 exploded the two torpedoes placed in the vicinity of the east switch of the eastbound passing track at Greendell, passed signal 528, which was displaying a caution indication, passed signal 520, which was displaying a stop indication, passed the lighted yellow fusee that had been dropped off in this immediate vicinity by the flagman of extra 2,227, and collided with the rear end of that train while traveling at a speed estimated to have been between 30 and 35 mi. p. h.

The report of the Bureau of Safety concludes: "This accident was caused by the failure of Engineman Walker, of extra 1,192, properly to observe and obey automatic block signals and other restrictive indications.

"This accident again directs attention to the necessity for automatic train control devices to enforce obedience to restrictive signal indications when not observed or heeded by enginemen. For a period of several weeks prior to this accident the traffic over this line averaged about 48 trains daily, with approximately the same number in each direction."