Automatic Interlocking for Drawbridge

Derails are dispensed with because installation is in automatic train control territory . . . Call-on signals speed up traffic

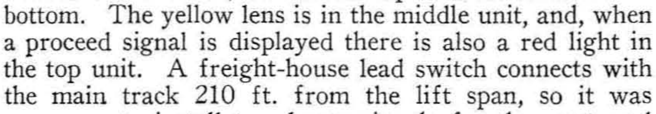
View showing signals at the east end of the bridge

THE Chicago, Rock Island & Pacific recently built a new double-track drawbridge with a 300-fit. lift span over the new Illinois waterway at Joliet, Ill. This division is completely equipped with automatic block signaling including automatic train control, so it was decided that no derails would be used and that the interlocking protection for the drawbridge would be arranged to operate automatically.

Color-light signals are used throughout. The home signals for normal running are the two-unit type, displaying red, yellow or green in the top unit, and red or yellow in the lower unit. The color-light dwarf signals for reverse movements are of the three-indication type with two red lenses, one at the top and the other at the bottom. The yellow lens is in the middle unit, and, when a proceed signal is displayed there is also a red light in the top unit. A freight-house lead switch connects with the main track 210 ft. from the lift span, so it was necessary to install two home signals for the westward track. The second or repeater signal is located on a signal bridge 980 ft. in the approach to the close-up westward home signal. On account of the curve approach for reverse traffic on the westbound track, a dwarf repeater was located 425 ft. in the approach to the dwarf home-signal. The signal lamps are rated at 10 volts 10 watts, and are fed normally on alternating current, a power-off relay transferring the feed to a storage battery in case of a power failure.

The signals, which are continuously lighted, normally indicate Stop, but change to the proceed indication when a train enters the approach section, provided the bridge is in its full down position and no train is occupying the plant. Thus, the interlocking signals operate entirely automatically.

On account of the numerous switch-engine and suburban-train movements over this bridge, it was necessary to provide call-on signals in order to facilitate traffic. Since there are no levers for the direct control



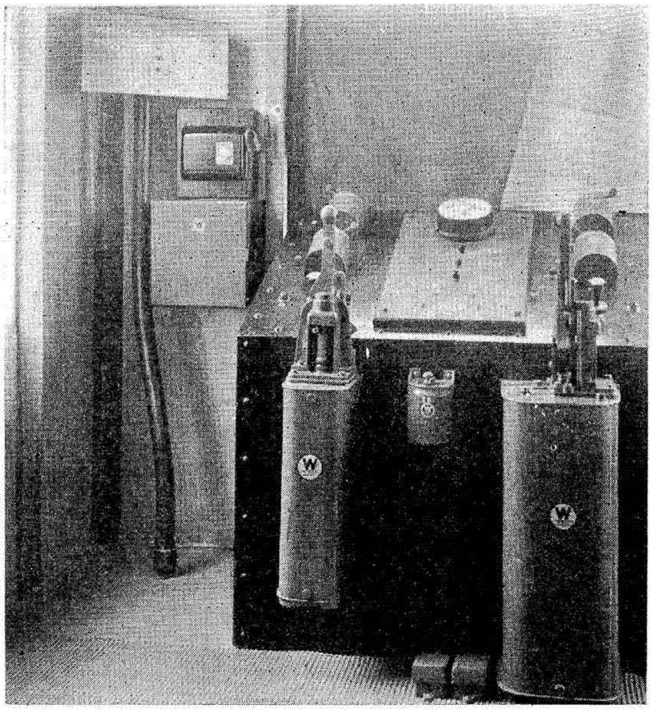
Track and signal plan

of these signals, it was necessary to provide a method of using a long approach clearing section for the clearing of the high-speed signals and a short approach section for the call-on signals. With this arrangement, if the block is unoccupied the high-speed signal will clear first and the call-on signal control circuit will be opened to prevent the call-on signal from clearing. If the block is occupied, the high signal can not clear, and the train, when entering the short approach section, will cause the call-on signal to clear, even though the plant is occupied by a preceding train. The call-on signal does, however, check the normal position of the bridge in the same manner as the high signal checks the bridge. The train-control system is so arranged that all trains approaching a home signal displaying a stop indication will receive a Stop train-control brake application at a point breaking distance in the approach to the home signal. The reverse-traffic movements are protected by Stop ramps, located at the dwarf signals, and the engineman is required to forestall while passing over the ramp even though a clear signal may be displayed.

When the bridge-tender desires to lift the bridge for river traffic, his first operation is to throw the handle of an enclosed-type knife switch to the up position, and, by so doing, all signal control circuits are opened and a 110-volt a-c. circuit is made which feeds an a-c. high-current-capacity circuit-breaker. The control for the operating coil of this device is carried through certain signal relays which check the normal position of all signals and the plant track circuits. In brief, if the signals are all normal and no trains are on the bridge, the a-c. circuit-breaker will pick up immediately, and thereby close the 220-volt power supply which is used for the operation of the power-control panel, so that the bridge tender can operate the bridge.

However, if any track section in an approach is occupied and a signal is clear when the bridge-tender throws the enclosed switch, a time-element relay, set at two minutes, starts operating, and, after it has run down, the 110-volt a-c. circuit breaker will pick up, providing that no train has passed the home signal in the meantime.

When the bridge-tender operates the enclosed knife-switch to the up position, a circuit is closed, feeding battery to the bridge relay (BR), which in turn controls the a-c. circuit-breaker that delivers the power to the bridge operation apparatus. As soon as the lifting of the bridge is started the bridge-relay normal pick-up circuit is broken, due to track-relay circuits being broken and the rail-checking-device circuit opening. It was, therefore, necessary to provide a hold-up circuit for this relay in order that the bridge operator will continue to have power available during the complete bridge-operation cycle. The description of this circuit follows: The "BR" relay circuit is closed to battery by the knife switch, in the up position, then the circuit is carried through a back contact of the signal control relay (SR) and a front contact of a signal lock relay (MP). The latter relay checks all the normal indication signal stick relays, plant track circuits, the bridge-normal rail-checking devices and is broken down as soon as the lifting of the bridge is started. To retain the "BR" relay in its up position, it was necessary to make it slow release so that it would hold up during the interval that the "MP" relay contacts changed from the energized to the de-energized position and provide a stick hold-up circuit through the back contact of the "MP" relay and one of its own front contacts.



Bridge controller, showing illuminated track and signal diagram at upper left

On completion of a bridge operation, the enclosed knife switch is returned to its original or down position, and the act of so doing causes the power to be cut off from the bridge control apparatus due to the "BR" relay circuit being opened. The signal control relay (SR) is again connected to battery through a pole on the knife switch, the circuit being carried through back contacts of the "BR" relay and a-c. power circuit breaker in order to check the cutting off power to the bridge-control apparatus. The bridge having been returned to its normal down position, and the signal relay "SR" again energized, the home relay circuits controlling the signals are ready for the next automatic operation when a train enters an approach section.

In order that the bridge-tender may be informed as to the position of trains within the plant and in the approach sections, a small illuminated track diagram is mounted to the left of the bridge-controller machine. Each track circuit is repeated by a small white lamp which is lighted when the corresponding section of track is occupied. A small green lamp below the track diagram is lighted when the bridge is closed. Another lamp is mounted on the diagram to indicate that all home signals are at stop. If the time-element relay is operating, then this lamp will not be lighted until the full time element has elapsed.

The track circuits between the home signals include the rails on the lift span and are carried from the lift span to the fixed spans by means of a track circuit coupler, each consisting of a piece of 3/8 in. by 1½ in. galvanized iron 2 ft. long set on edge, one end being fixed in a brace set on a tie on the lift span, the other end extending to a contact slip set on the fixed span. The end section of the coupler bar, as well as the clip, is covered with sheet copper welded in place. As the bridge is lowered in place, the coupler bar slips into the clip, thus completing the circuit. The contact section on the coupler bar is long enough to permit movement longitudinally to compensate for the expansion or contraction of the movable section of the bridge.

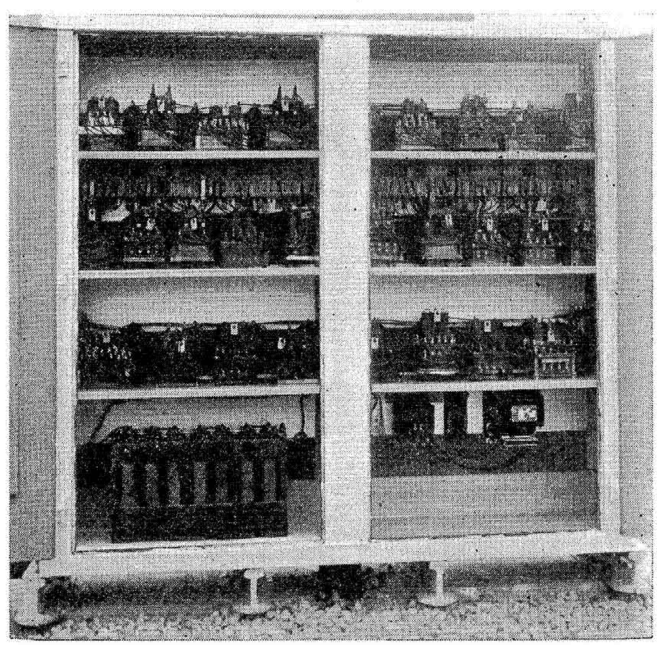
The position of each rail, when the bridge is closed, is checked within 3/16 in. by a special circuit controller, mounted on the fixed span, with a plunger extending up to the bottom of the base of the rail. These controllers were designed and made by the signal shop, using interlocking circuit controllers and other miscellaneous signal apparatus.

Outside Construction

The relays, battery, rectifiers, etc., required in the vicinity of the bridge are located in a sheet metal case 23 in. deep, 6 ft. high and 9 ft. long. The rear of the case has removable panels to provide access to a rear compartment, 6½ in. deep, used for incoming cables. The insulated wires are connected to porcelain-based terminals mounted on boards back of each shelf on which the relays are set.

The energy for the control circuits and for the signal standby is taken from storage battery, a set of 7 cells of Edison battery being provided at each home signal. Three cells of Edison primary battery are used on each track circuit.

The underground wiring throughout the plant is all parkway with lead covering and two wraps of steel tape. The track connections are of No. 9 single-conductor parkway with no lead sheath. The signal-control circuits



A large sheet metal case is used for housing the relays and battery

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Track-Circuit Battery Saving Scheme

By F. A. Tegeler

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QUESTION No. 3 on page 141 of *Railway Signaling* brings up the problem of battery saving for track circuits, a matter which I have studied for years. Some time ago, I experimented with a track-circuit model which uses an 0.3-ohm relay in series with the battery, with connections through the contacts to cut in an extra limiting resistance when the track circuit is occupied. The type of relay ordinarily used for approach lighting was very nearly adapted in general design to the special requirements encountered. However, the construction of this relay had to be altered so as to provide a heavier armature so that more pressure would be exerted on the back contact to give good contact. Another feature was to provide an adjustable back contact. It would also be necessary to provide adjustable armature stop pins or adjustable front contacts in order to make the release of the relay adjustable without changing the magnetic field, as this would interfere with a good strong pickup when the armature is down. With these alterations this type of relay could be used for this purpose.

The requirements were as follows: The resistance of the relay used would have to be low enough so that the circuit would operate satisfactorily with the ballast resistance at its minimum and the voltage of the track battery at its minimum just before the battery is due to be renewed. The above is a normal requirement of the adjustment of the limiting resistance in series with the track battery as used at present.

The relay must be so adjusted that the armature will not pick up with the battery voltage at its maximum, and the ballast resistance is at its minimum when the track is clear. For illustration, if the normal current flow to the track is 0.450 amp., the relay should be adjusted to pick up at sufficient margin above this to insure that it only picks up on a train shunt or some other short circuit of lower resistance than the minimum ballast resistance.

Likewise, the relay must be adjusted to release with the ballast resistance at its minimum and the battery voltage at its maximum. When there is no train or other shunt on the track, all of the above requirements are necessary, so that there will be no adjustments required from the time the track battery is set up until it is exhausted.

Under such conditions the maximum saving could be made. I believe the savings would justify a trial installation on circuits in yards that are occupied by trains or shunted by switches for any great length of time each day. It is quite apparent that this kind of a set-up would not operate if the circuit were subject to a very low ballast resistance.

The circuit is set up with a 0.3-ohm special relay, with the track-battery voltage at 0.5 volt, the controlled resistance at 0.7 ohm, the combined resistance of the 4-ohm track relay, and the ballast resistance of 1.25 ohms.

The following conditions are obtained with this set with the track battery at 0.5 volt and at 0.7 volt.

Voltage of battery	0.5 volt	0.7 volt
Current flow to rail with shunt and armature down	1.66 amp.	2.33 amp.
Normal current flow to rail	0.322 amp.	0.450 amp.
Current flow with shunt on and relay picked up	0.500 amp.	0.700 amp.
Current flow with no shunt on and relay up	0.22 amp.	0.310 amp.

According to the above figures, the relay should be adjusted to release at 0.35 amp. and pick up at 0.70 amp., with a back contact with considerable spring so that the armature would be part way up before the contact opens; by that time 0.500 amp. would pick it up the balance of the way.

I realize that such a relay is not as reliable as a standard track relay which was brought out in the answers to question No. 3 in the September issue. However, if it should not function as intended, the results would still be as safe as before the relay was installed. Of course, we recognize that such a circuit is more complicated than the average track circuit, but with the present standard of education of the majority of maintainers, there would be no question of proper adjustment.

Another scheme I have in actual service uses a normally-energized 20-ohm relay connected in parallel with the track battery on the track side of the normal limiting resistance, the back contact of this relay normally shunting a secondary limiting resistance. This was installed on a cinder-ballast track circuit 3,100 ft. long. The battery consisted of five cells of LeCarbone 500-a.h. cells in multiple. The track relay in use is a 4-ohm relay and releases at 0.036 amp. and picks up at 0.078 amp. In order to secure satisfactory operation, the normal limiting resistance was set at 0.9 ohm and the auxiliary resistance at 0.9 ohm.

We are using 0.9-ohm normal resistance and 0.9-ohm controlled resistance. The controlled resistance is cut in series with the normal resistance when the voltage regulating relay picks up. This relay is so adjusted that it picks up when the voltage on the rails at the battery end comes up to 0.75 volt and releases when the voltage drops to 0.45 of a volt.

The last time this circuit was tested, we obtained the following readings:

	Without Special Relay	With Special Relay In Use
Voltage at battery	1.3 volts	1.3 volts
Voltage track side of 0.9-ohm resistance	0.82 volts	With armature of special relay held down 0.818 volt.
Current flow to rail normal	0.5 amp.	With special relay picked up, 0.37 amp.
Voltage on track side of both of the 0.9-ohm resistance in series		With special relay picked up, 0.6 volts.

From the above it will be noticed that the saving normally is 0.13 amp. when the track circuit is dry and in cold weather the saving would be still greater.

Rock Island Drawbridge Interlocking

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are carried across the river channel in a cable made up of single-conductor insulated wires which is supported in messenger rings from stranded messenger attached at each end to the bridge towers on the fixed spans. A second catenary messenger supports the main messenger at two points. The cable rings and stranded messenger are of Copperweld material. The cable is so located that, when the bridge is raised to its full up position, the bridge sidewalk is only 5 ft. below the cable, making it very convenient for a man to work on this cable. All wires and cable were furnished by the Okonite Company, according to Rock Island specifications.

This installation was designed and installed by the signal department forces of the Rock Island.