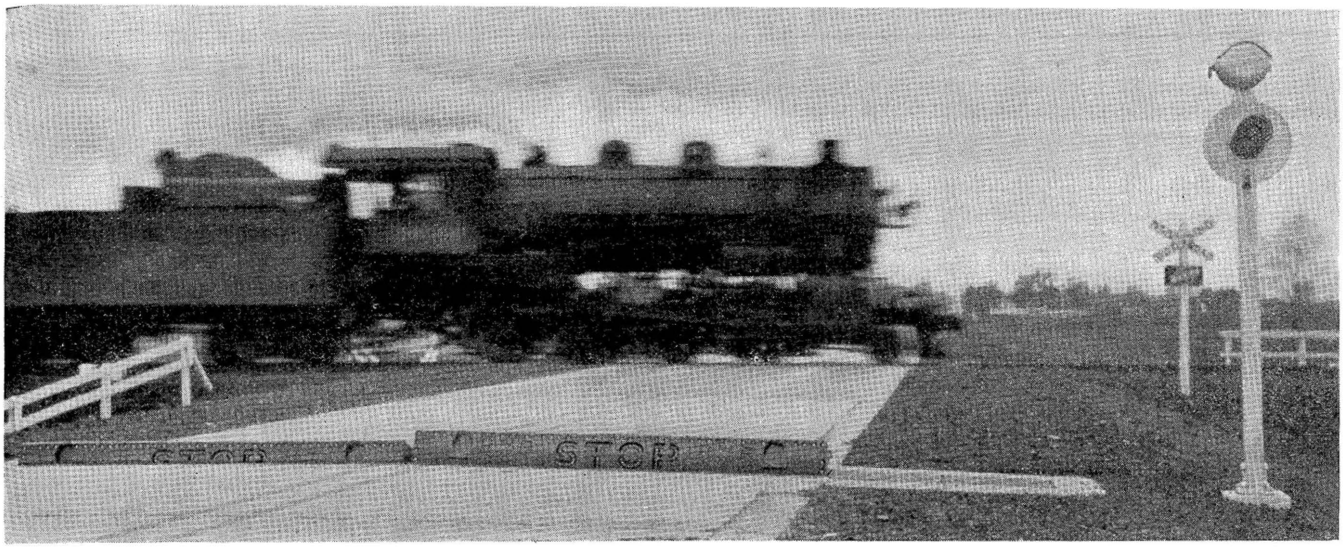


The barrier section at the right rises to a height of 9½ in. and the section at the left to 6 in.

Auto-Stop Installed on C. & N. W.

Automatically-controlled barrier type protection at crossing of single-track railroad with highway in Des Moines, Iowa, includes numerous improvements

A SYSTEM of barriers, known as the Auto-stop, which rises in the highway approaching the tracks, has been installed at a crossing on the Chicago & North Western in Des Moines, Iowa. The highway involved in this crossing was constructed about a year ago as a cut-off between two main routes and, although located within the city limits, is in open territory beyond the built-up section. Therefore, the speed of motor vehicles over this section of the highway is not restricted. A traffic count made at this crossing on May 1 showed 1,564 passenger cars, 125 trucks and 1 bus. The single-track railroad at this crossing is the main line of the C. & N.W. extending from Des Moines to a connection with the through route at Ames, Iowa. The crossing is located on tangent level track and, as it is four miles from the station, the train speeds are normal, ranging from 30 m.p.h. for freight trains to 50 m.p.h. for passenger trains. The traffic, on May 1, included 4 passenger trains, 8 freights and 2 switching movements.

General Features of the Protection

The Auto-stop protection consists of two barriers, each located in the highway 75 ft. from the track. The barriers are raised to prevent the movement of highway vehicles over the tracks when a train is approaching. An electric motor, controlled automatically by track circuits, operates each barrier.

The pavement is 20 ft. wide, being constructed with a 2-in. slope from the center to each side, and each barrier consists of two 10-ft. sections. On the face and near each end of each of the sections, there is a light covered by an 8-in. red lens, and these lights flash off and on 30 times each minute, similar to a flashing-light crossing signal. In the center of each section, the word STOP, 7½-in. high, is cut out in outline so that light shines through around the word and, in addition the letters are outlined with reflector buttons. On each side of the stop sign the symbol RXR is lettered and outlined with reflector buttons, the letters being 4⅜ in. high. The letters are painted black, while the face of the barrier, as a background, is painted tangerine yellow. A row of large reflector buttons, each about ¾-in. in diameter, extends along the top edge and down the ends of the face of the barrier.

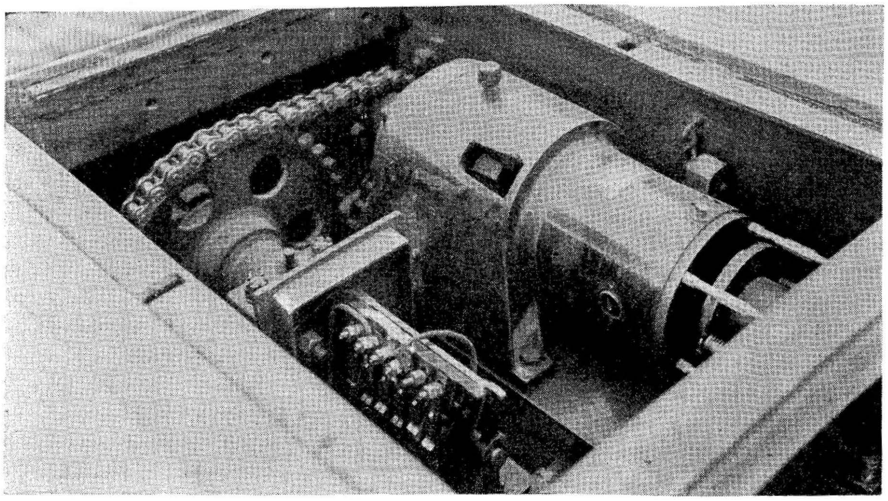
From the time the barrier starts to rise until it returns to the normal position again, the two red lamps at each end of each of the two sections are flashed and the word "Stop" is illuminated. These lights are strong enough to be seen readily in daylight and stand out prominently at night as a warning for vehicles to stop. Furthermore, at night, when the headlights of a car are directed on the barrier, the reflector buttons add to the effectiveness of the signs and outline the limits of the barrier.

In addition to the signals and signs of the barrier itself, a red boulevard-type stop signal normally extinguished, is mounted on a pole at the right of the highway approaching the track, at a point opposite each barrier. A loud-toned crossing bell is mounted above each of the signals.

Effect of Barrier In Stopping Vehicles

This Auto-stop installation is the second to be placed in regular service, and since the previous installation was made on the Grand Trunk Western at Valparaiso, Ind., as explained in *Railway Signaling* of October, 1934, the design of the barrier and the operating mechanism have been considerably improved.

The functioning of the barrier in stopping vehicles as effected by the face of the barrier has been modified from the previous design. Whereas the earlier model of the barrier pre-



Drum controller and motor with covers removed

sented a concave surface as an absolute obstruction to further forward movement of a vehicle, the new barrier as installed on the C. & N.W. is designed with a convex surface on the lower portion and slightly concave on the upper position. The effect is to throw a vehicle up, thus dissipating a considerable amount of the forward momentum by lifting the automobile.

Extensive tests on a proving ground, as well as in demonstrations at the installation in service, show that the effect of an automobile striking the barrier is equivalent to the application of effective brakes for a distance of 100 ft. when traveling at 60 m.p.h. When striking the barrier at speeds above 30 m.p.h., the usual result is for the major portion of the forward movement to be dissipated in throwing the front of the vehicle up and over the barrier, not enough momentum being left to carry the rear wheels over the barrier. Ordinarily, the spring shackles or steering connections on the automobile are broken. The effect on passengers in the front seat of a car when striking the barrier is to force them back and down against the cushions, rather than throw them forward.

On the day when the C. & N.W. installation was placed in service, a new 1935 Chevrolet sedan was driven against the barrier at a speed variously estimated as between 30 and 40 m.p.h. The front wheels went up and over the barrier but the car stopped before the rear wheels encountered the barrier. The knee-action and steering connections were damaged, but otherwise, no harm was done to the passenger or to the automobile. The barrier is claimed to be so constructed that it will withstand an impact of 3,000,000 lb. without damage. A 15-ton truck, traveling at 45 m.p.h., is said to exert a force of 2,000,000 lb. when striking one of the barriers.

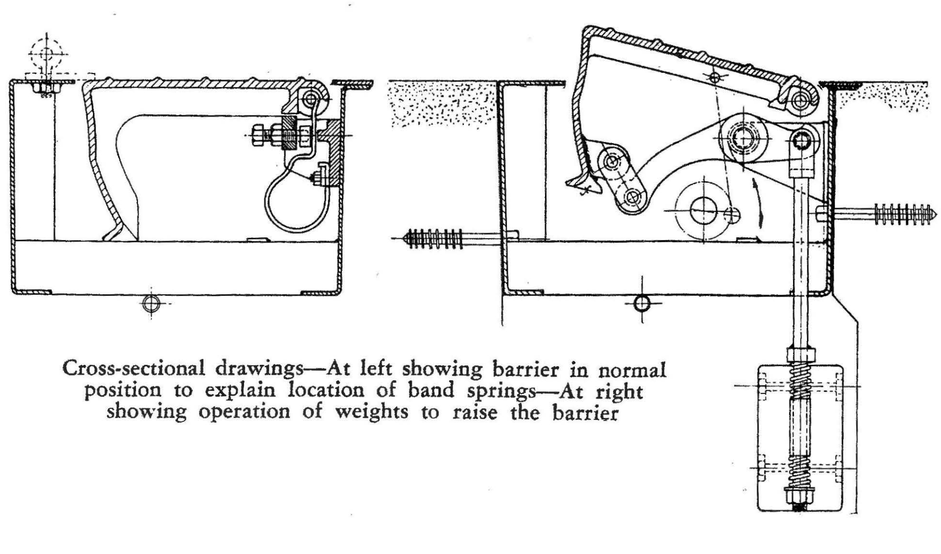
Cycle of Operations

When a train, traveling at 50 m.p.h. enters an approach-control track circuit, the boulevard-type red "stop" signals are illuminated and the bells start ringing. At the end of a 5-second period, the barriers start to rise, requiring about 2 seconds to rise to the warning height of 4 in., remaining in this position 10 seconds. They then rise on up to a full height of 9½ in., this requiring about 2 seconds more. These operations require about 19 seconds, the barrier being in the final position about 10 seconds before the arrival of a 50 m.p.h. train at the crossing, this period being extended for a slower train.

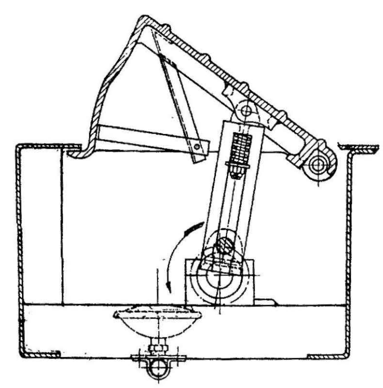
When the rear of a train clears the crossing, the barrier starts to lower, requiring about four seconds to return to its normal position. The light in the barrier, as well as the stop signals and bells continue to operate until the barrier is returned to its final position, level with the surface of the highway at which time the stop signal lights are extinguished and the bells cease ringing. The delay to highway vehicles depends on the speed and the length of the trains. On May 1, when there were 14 train movements and 1,690 vehicles over the crossing, only 27 of the vehicles were delayed, each of these an average of 71 seconds.

Construction of the Barrier

The entire barrier is normally located beneath the surface of the concrete pavement, being housed in a framework consisting of two steel beams 18 in. high, set 18¾ in. apart. Cross members and braces are welded in place, the frame being open at the top and bottom. This frame or box extends across the full 20-ft. width of the pavement and 5 ft. beyond at one side, this extra section being used to house the motor and control apparatus. An inspection chamber, high enough for a person to stand in, extends under the full length of the



Cross-sectional drawings—At left showing barrier in normal position to explain location of band springs—At right showing operation of weights to raise the barrier



Barrier in raised position showing connections to main crank shaft and position of lamps barrier frame. The walls of the passage-way form a foundation for the frame of the device.

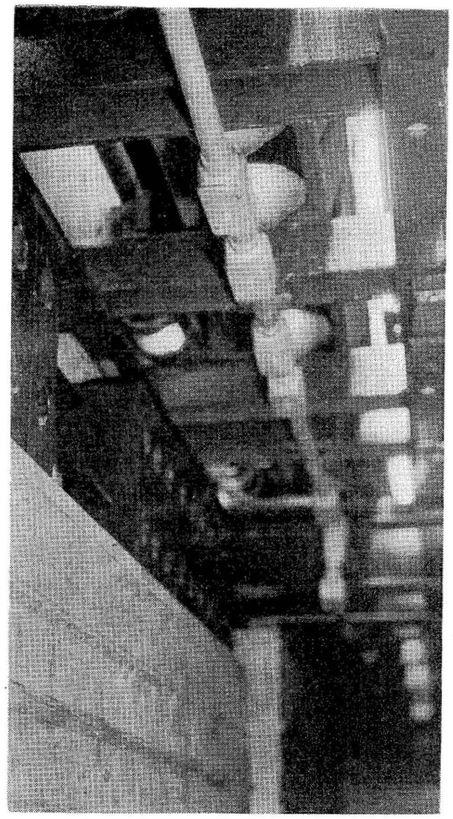
The barrier itself—the part which rises above the level of the highway—is constructed in two sections 10 ft. long, each of which extend half way across the highway. The top plate, normally on the level with the surface of the highway, and the face of the barrier, are formed from ⅞-in. steel plate, the cross members, end plates, braces and bearing lugs being welded in place.

Each section is hinged on the track side to swing upward as shown in the illustration. The four bearings on each section are supported by eight 5/16 in. by 1½ in. bar springs which provide means for adjustments and also act as a cushion in case a car strikes the barrier. When in either the down or up position, the front edge of the barrier plate fits evenly along the surface of the beam of the frame. No stress is carried by the bearings as a vehicle passes over a barrier.

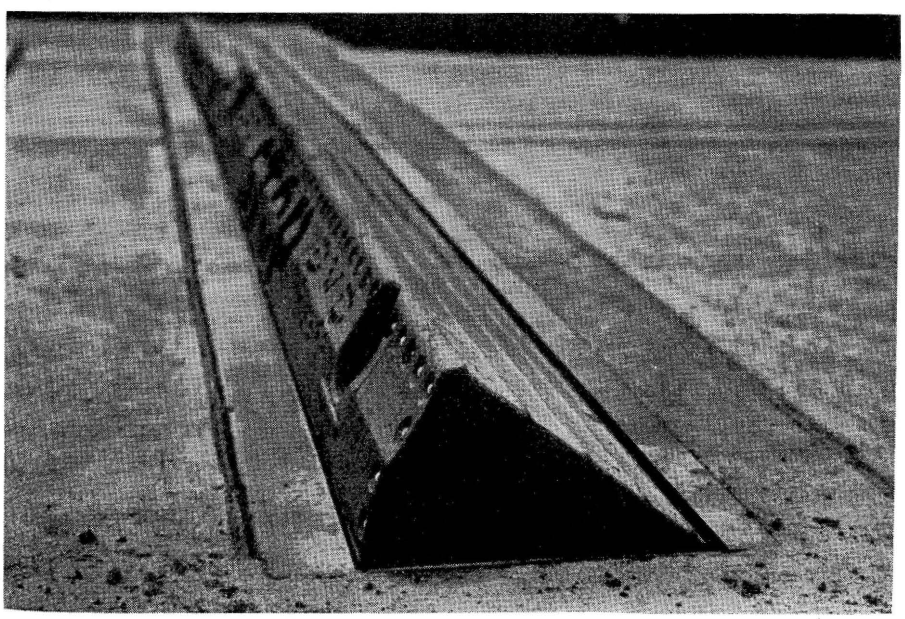
When in the warning or hesitation position, with the barrier at the four-inch height, a vehicle striking the barrier from either direction of approach forces the barrier down to the level of the pavement and passes on, the barrier again returning to this position. When in the fully raised position, 9½ in. high, the section on the right side of the pavement is locked. However, the section on the left, which rises to a full height of only 6 in. is not locked in the raised position and, therefore, if the barriers are raised while a vehicle is on the track side of the barriers, the driver is not trapped on the tracks, for, as the car is driven up the slanting slope of the left section from the track side, the barrier is depressed to the pavement and then rises again when the car passes.

Operating Mechanism

The driving mechanism, located in a pit at one end of each barrier, includes a ¼-hp. 32-volt d-c. General Electric Co. motor, which operates at 1,750 r.p.m., to drive a 105 to 1 gear reducer which is chain connected by sprocket wheels to give a ratio of 27 to 10. The larger sprocket wheel is attached to a 2-in. shaft which extends the 20-ft. length of the barrier, being supported in eight bearings. At equally spaced points under each of the two barrier sections, there are cranks in the main shaft, and from these cranks, link arms or connecting rods 10 in. long extend and are attached to bearings on the under side of the top plate of the barrier. The link arm is slotted on the crank shaft bearing, with the pin normally at the lower end of the slot, the purpose being that this drive mechanism operates to pull the barrier down from the raised position to the normal position but does not normally exert force to raise the barrier. The barrier is raised by force of gravity, using weights which are connected through cranks and link connections to the under side of the barrier and the drive shaft merely follows this operation. By means of this arrangement, the barrier can be pushed down when in the warning position or when rising to the full height, in case a car strikes it from the track side. However, a heavy coat of ice over the barrier will not hold it in the normal position because the first ½-in. rise is actuated by a cam on the main shaft which exerts a force of 16,000 lb.



View in passage-way under a barrier showing the weights at the left and mounting of lamps

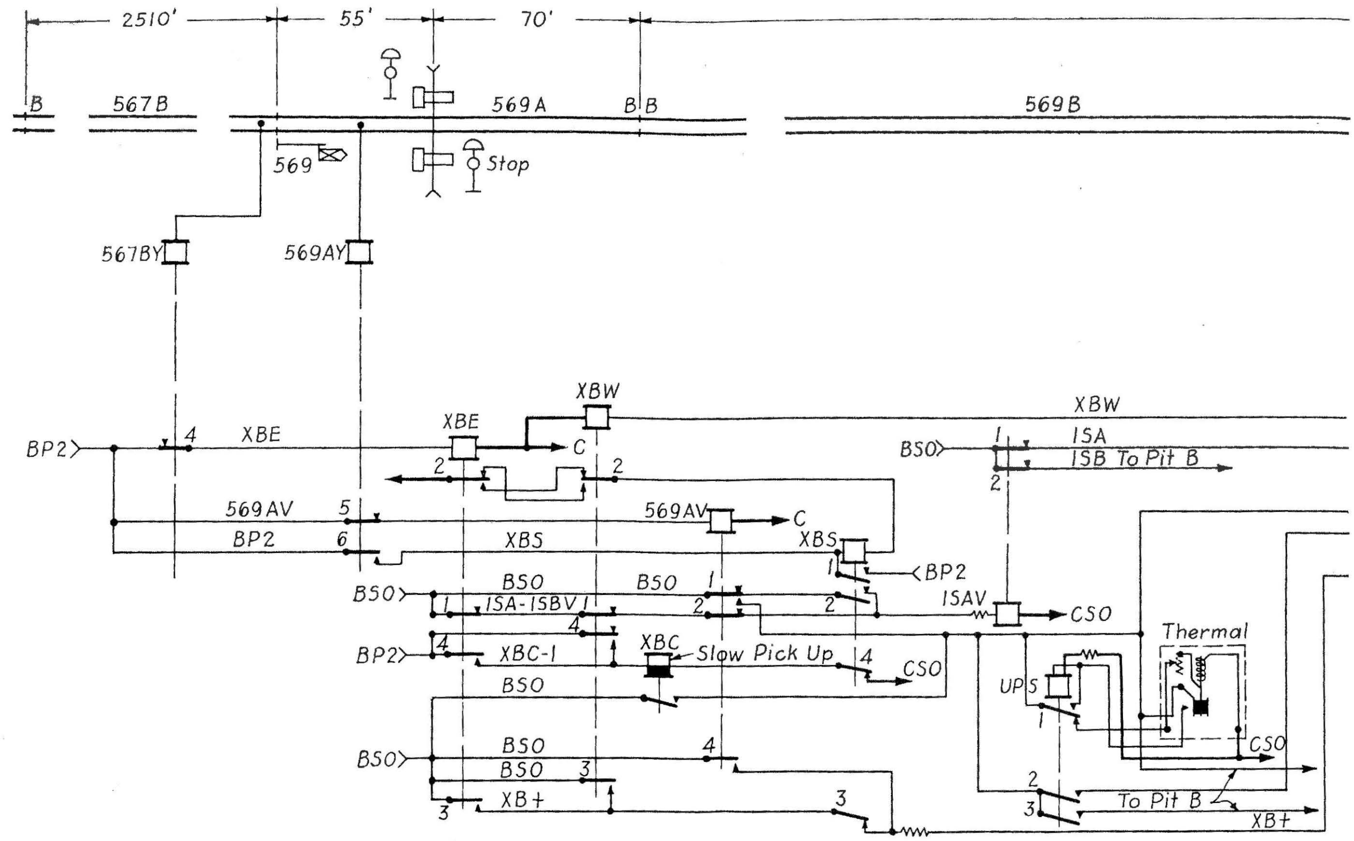


End view showing contour of face of the barrier

Although the motor is not used to raise the barrier normally, nevertheless the motor must turn the main shaft to permit the barrier to be raised by the weights. The operation of the barrier is controlled by the revolution of the crank shaft, which turns 90 deg. as the barrier rises to the warning position, then turns 90 deg. more when it rises to full height, and finally turns 180 deg. farther to complete the cycle when the barrier is being pulled down to the normal position. The drum controller, shown in the foreground of the view of the operating mechanism, consists of a controller from a 2-A semaphore signal. Overrunning is prevented by a magnetic brake on the motor.

Controlled by Trains

The control of the operation of the barrier is based on the occupancy of track circuits by trains. This line of the C. & N.W. is equipped with automatic block signals, and the track circuits of this system were rearranged to be used also to control the crossing protection. In addition to the approach control track circuits, a separate track circuit extends over the crossing so that the barrier does not start to lower until the rear of a train clears the crossing. Each track



Straight-line diagram of control circuits on line, track and in relay case

circuit is operated by three cells of 500-a.h. Edison primary battery. The usual stick-relay system of control is utilized to stop the operation of the signals and lower the barrier when the train passes beyond the crossing.

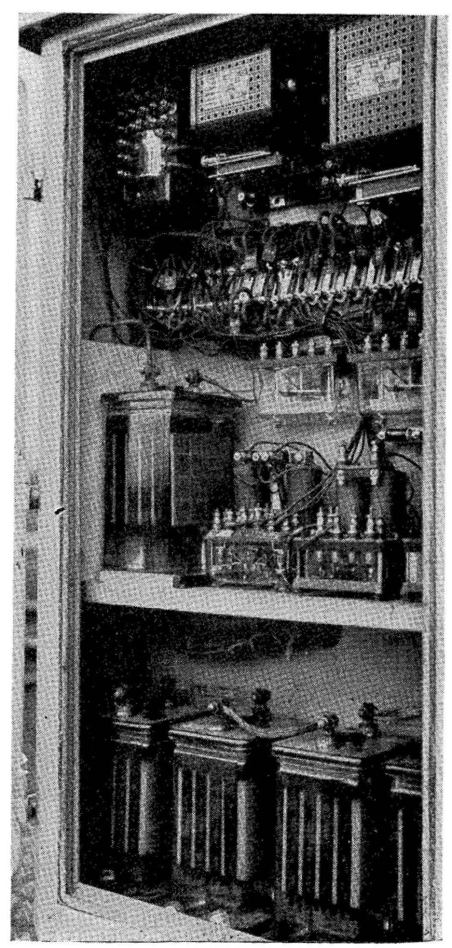
The two 32-volt d-c. motors which drive the two barriers are fed from a set of 16 cells of Exide DMGO-7 storage cells rated at 120 a.h. on an 8-hr. rate. This battery is on a-c. floating charge through a General Railway Signal Type-BT rectifier. As the motors each take 8.5 amp., the feed is controlled to each motor through a single-contact relay equipped to handle such currents. The operation of these relays is controlled through the drum controllers and through the signaling relays to effect the necessary factors of control.

Control of Lamps

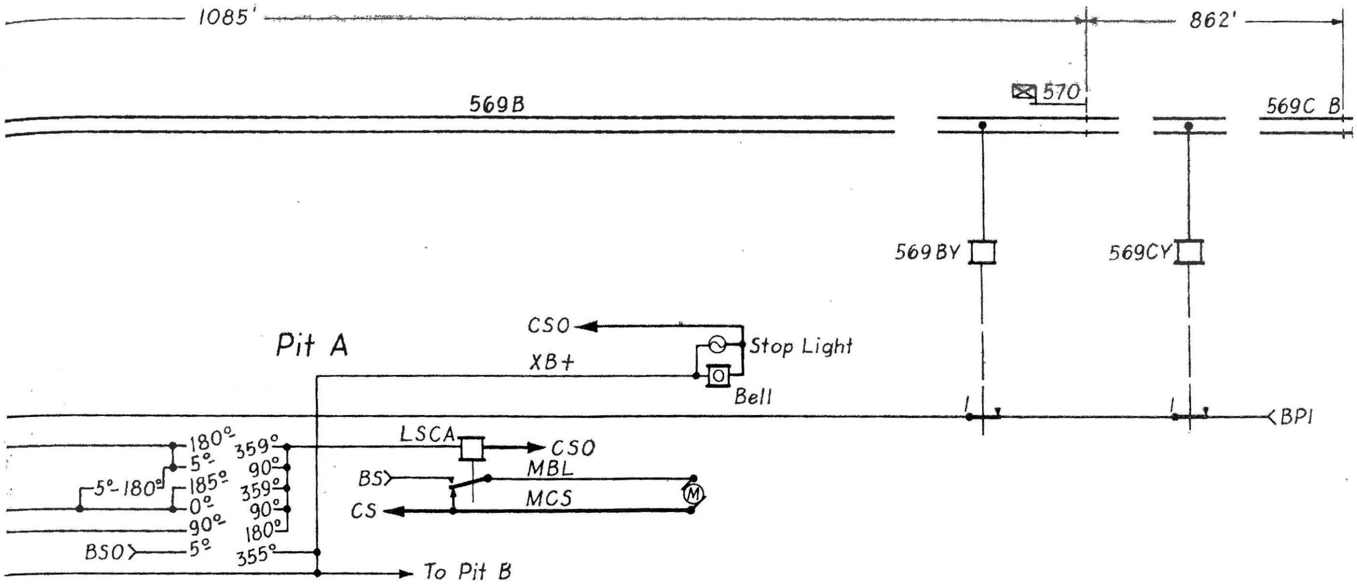
The electric lamps, which illuminate the barrier, are rated at 10 volts, 18 watts. Each lamp is mounted in a reflector with a clear glass cover, the fixtures being mounted on a pipe conduit attached to the beams transverse of the pit. The four flasher lamps in each barrier are so mounted as to direct the beams diagonally upward through the red lenses in the face of the barrier. These lamps are controlled through a G.R.S. Type-K flasher relay. The beams from the other lamps, which illuminate the word STOP, are directed up against the bottom of the top plate and are reflected outward through the cut-outs in the face of the barrier.

Control and Operating Circuits

Track relays with repeaters control a stick relay in the usual manner to control the operation of the crossing protection. The crossing bells and the lights in the boulevard stop signals are energized by circuits through back contact *3* in either *XBW* or *XBE,* the approach track repeaters. Back contact *4,* in either of these relays, controls circuits which energize slow-pick-up relay *XBC,* which requires 5 seconds for it to pick up, during which period the bells and boulevard stop signals are giving a preliminary warning to highway traffic. At the end of the five-second period, a circuit through contact *1* of relay *XBC* is closed to feed through a contact on the drum controller on the barrier, closed from 0 to 90 deg., this circuit extending to operate the relay *LSCA,* which controls the feed for the motor to operate the barrier. This relay is equipped with special contacts for breaking high currents. When the barrier raises to the 4-in. height, at 90 deg. revolution of the



Sheet-metal cases are used



Continuation of circuit to drum controller and motor

shaft, the control circuit is broken at the drum controller, relay *LSCA* drops and the motor stops.

The 10-seconds hesitation of the barrier at the warning height of 4 in. is effected by use of a thermal relay, which is energized by the circuit through front contact *1* of relay *XBC*. At the end of a 15-second period, the contact of the thermal relay closes, thus completing a circuit to pick up stick relay *UPS*, which sticks up through its own front contact and breaks the feed to the thermal relay so that the heating coil will not be overheated. The closing of front contacts *2* and *3* of relay *UPS* extends the control circuit through drum controller contacts, which are closed from 90 to 180 deg., and on to pick up the motor relay *LSCA*, causing the barrier to be raised to the full height of 9½ in. This set up of controls and position of the barrier continues as the train approaches. When, for example, a westbound train clears track circuit *567B*, and while the front part of the train is on track circuit *569B* with the rear on the track circuit over the crossing *569A*, then stick relay *XBS* will pick up and stick up through its own front contact and a circuit through contacts of *XBW* down and *XBE* up.

After Train Passes

When the rear of the train clears the track circuit over the crossing, relay *569A* and its repeater *569AV* pick up, closing a circuit through front contact *1* and front contact *2* of stick relay *XBS* that extends to relay *1SAV*. A circuit through front contact *1* of relay *1SAV* extends through contacts on the drum controller closed from 180 to 359 deg. and on to the motor control relay *LSCA*, causing the barrier to be lowered to its normal position, level with the surface of the highway, at which time the motor is cut out by the drum controller releasing motor relay *LSCA*. When the train passes out of the receding track circuit, relay *XBW* is energized, stick relays *XBS* and *UPS* are released, and the entire control is back to normal.

Special Control of Warnings

A circuit through back contact *4* in relay *569AV* maintains a circuit to keep the lights in the boulevard stop signal and the bells energized at all times when the track circuit over the crossing is occupied, independent of the occupancy of the approach control circuits or the position of stick relay *XBS*. If a second following train enters an approach control track circuit while a preceding train is in the receding circuit, stick relay *XBS* will be released and warnings will be given, and the barrier rise again as explained previously. The block signal system precludes the possibility of following trains being spaced so closely that time would not be allowed for the barrier to return to normal position between the movement of trains over the control track sections.

Another feature is a direct feed for the bells and boulevard stop signal lights independent of track circuit occupancy. Battery is fed through a contact on each barrier closed from 5 to 355 deg. so that the bells and signals will be operated if the barrier is not lowered to its normal position.

The lights in the STOP sign in the face of the barrier section are fed direct through limit switches, closed from 10 to 350 deg. The flasher relay, to control the flashing lights in the face of each barrier section, is controlled by the same limit switches, from 10 to 350 deg.

Equipment Used

The Auto-stop equipment for this installation was manufactured by the Evans Products Company, Detroit, Mich., and installed in the road way by the Iowa Rail & Highway Safety Appliance Corp. The signaling control apparatus was furnished by the General Railway Signal Company and was installed by the railroad signal department forces. The installation is being maintained under the supervision of the signal department of the Chicago & North Western.

This new crossing protection was placed in official service April 22, with the approval of the City of Des Moines, and the Highway Department and the Railroad Commission of the State of Iowa. It has operated properly since that date, and there have been no complaints or damage.

The installation has been made as a matter of demonstration, that is to prove its practicability and merit as a safety device at highway-railway grade crossings, particularly where grade separation might well be given serious consideration. For the purpose of obtaining correct data and information, observers are stationed at the crossing, but these observers have nothing to do with the operation, control, or maintenance of the device.