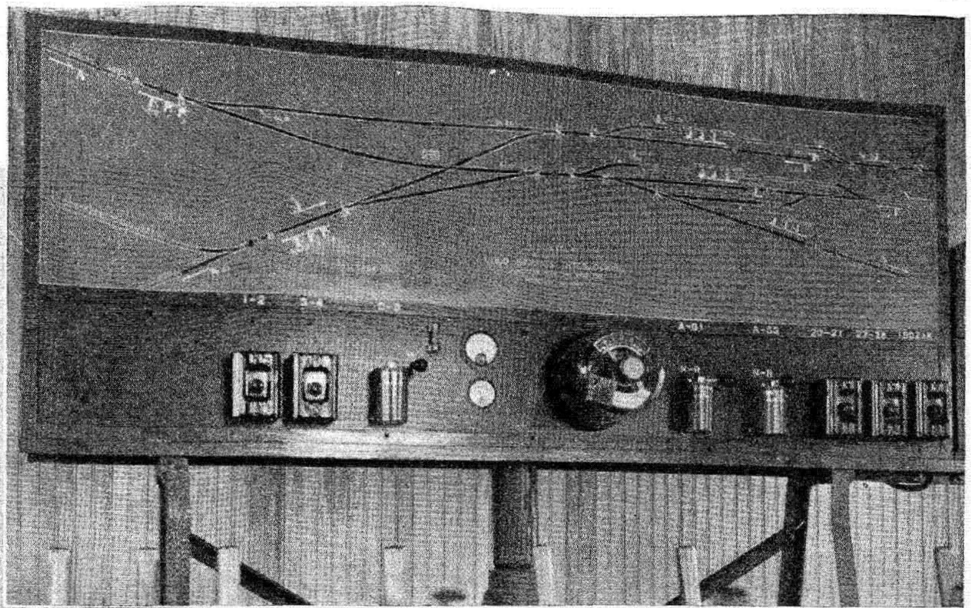
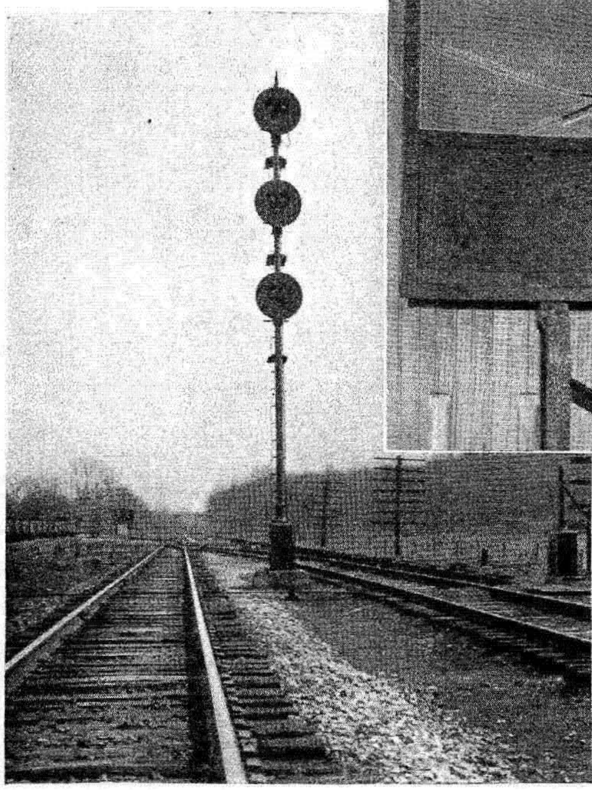
Right—The illuminated track diagram over the interlocking machine. Below—Eastward home signal A-28 on Big Four





Big Four replaces tower and interlocking machine, as well as modernizing complete plant in record time following destruction by a train accident

Mechanical Plant Modernized

At Cold Springs, 5.3 miles west of Springfield, Ohio, the Cleveland, Cincinnati, Chicago & St. Louis had a 48-lever mechanical plant, the tower of which, together with the interlocking machine, were demolished as the result of a freight train derailment at noon on February 1. A dragging emergency chain dropped from the tender and caught in a frog, thus causing the derailment of several freight cars which struck the tower and piled up on top of it. At the time of the accident, the towerman was out on the ground handing on train orders, and, when he saw the cars coming, he escaped without injury. A replacement and modernization program was started at once, and the new plant was placed in service on April 3.

As shown in the accompanying diagram, three tracks approach Cold Springs from the west. The upper track is the Springfield District of the Big Four extending from Indianapolis, Ind., through Cold Springs to Springfield. The track on the south is the main line of the Big Four between Springfield and Dayton. The next track above is a line of the Erie between Cold Springs and Dayton. As these two lines extend practically parallel between Cold Springs and Dayton, 19.7 miles, the two roads use these tracks for double-track operation, the Big Four track being used for eastward trains and the Erie track for westward trains. Just west of Cold Springs, a passing track is located along side each of the two lines, the switches at the east end of these sidings being included in the interlocking. The switch and signals at the west end of the passing track on the Big Four line are power operated and are controlled remotely from the Cold Springs tower.

East of Cold Springs, the Big Four track extends through the City of Springfield, and this track is used by Big Four passenger trains and local freight trains operated in either direction. The Erie track, east of Cold Springs, diverges to the northeast around the city 9 mi. to an interlocking known as Glen Echo, and from there the Erie track extends northward to Marion, Ohio. A crossover at Glen Echo connects the Erie with the Big Four single-track main line through Cold Springs and Springfield, and the Big Four double track extends eastward through Bellefontaine. In addition to the through freight trains of the Erie, the through freight trains of the Big Four are routed over the Erie single track between Glen Echo and Cold Springs, thus keeping these trains out of the main part of Springfield.

The average daily traffic through Cold Springs interlocking includes 12 eastbound and 11 westbound Big Four passenger trains, 7 eastbound and 12 westbound freight trains, and also one local freight train in each direction on the Springfield District of the Big Four. In order to serve local industries, this Springfield District local freight train is usually routed via the old Springfield division main line between Cold Springs and Springfield, as shown on the diagram, which means that it uses the Erie track between Cold Springs and the hand-operated junction switch east of Sig. D3 on the Erie. In addition, extra through trains are operated and various switching moves are made while setting out and picking up cars in interchange. A check of traffic for a month showed a total of 2,144 movements through the plant, 344 of which were switching operations and the remainder through train movements. This averages about 69 movements daily.

As soon as the interlocking was demolished, switch stands were installed and switch tenders were placed on duty to line the switches, each train being required to stop before passing through the plant. On account of the comparatively heavy traffic, the delays were excessive, and the importance of getting the plant back in service was quite evident.

What To Do Quickly

Although some thought was given to the installation of a power interlocking to replace the old plant, the time required to prepare plans and secure the equipment was a deciding factor in favor of a decision to replace the mechanical interlocking machine with similar equipment including mechanical locking between levers. While the opportunity was available, the plant was revised. The main line derails, as shown dotted on the diagram, were eliminated, and also two "inner" home signals on the Big Four were eliminated. A mechanically-operated semaphore train-order signal for eastbound trains on the Erie track near the tower, was replaced by a power-operated manual block signal, located opposite the Erie westward home signal 4.

In the old plant, each semaphore arm was operated by a separate lever, thus requiring 24 levers for 24 operative arms. By replacing the remaining mechanical signals with power-operated signals, of either the semaphore mechanism or the color-light type, the pipe lines were eliminated and the signals were controlled by relays, with selections governed by the position of certain switches, thereby making possible the control of the remaining 18 operative signals by 9 levers. The result of these revisions was that, whereas the old machine had 24 levers for 24 signals, 14 levers for 8 switches and 6 derails, and 7 levers for 11 F.P.L., totaling 45 working levers; the new machine has 9 levers for 18 signals, 11 levers for 8 switches and 3 derails, and 5 levers for 8 F.P.L. and 2 detector levers, thus totaling 25 working levers.

As soon as the requirements for the interlocking machine were determined, it was evident that the old tower, which was 25 ft. long, could be replaced by a 20-ft. tower, and such a building, out of service at another location was available. A building department crew was started at once at Cold Springs to construct the concrete piers for supporting the building and the concrete foundation for the leadout cranks, as may be seen in the illustrations herewith. Because the ground was frozen and extremely cold weather prevailed, about four weeks elapsed before this concrete work could be completed and the tower building transported and set up in place at Cold Springs.

Preliminary Work

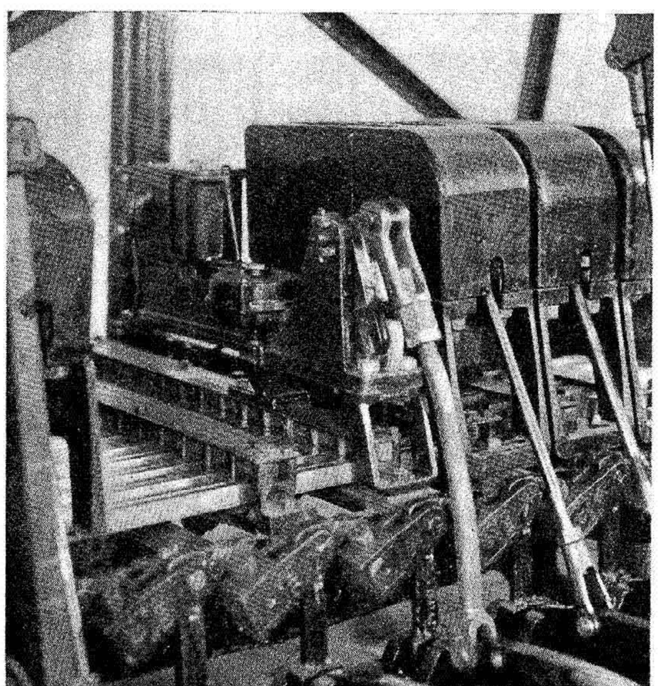
In the meantime, circuit diagrams were developed quickly, and materials were ordered. A mechanical interlocking machine to meet the new requirements was rebuilt in the Big Four signal shop at Indianapolis and shipped to Cold Springs. The forces of the signal shop also built an illuminated track and signal diagram to be mounted on an angle-iron frame to the rear of and above the interlocking machine, as shown in one of the illustrations. A panel, which forms the lower portion of this diagram, is used to mount push-buttons, meters, a clock-work time release, and drum controllers, the purposes for which will be explained later. A precast concrete house, 6 ft. by 6 ft. by 8 ft. high, was provided near the tower location in which to house the relays, batteries and rectifiers.

Complete New Circuits

The complete new arrangement of circuits, installed as a part of the improvement program, represent recent developments for protection at an interlocking using a machine with mechanical locking between levers, several of the modern principles now used quite generally in plants with non-interlocked levers, being incorporated to an advantage.

Each switch and each of the two derails on the passing tracks is operated in the usual manner by a pipeline connection from its lever. A switch circuit controller on each switch and each derail controls a two-wire polar circuit which operates a d-c. polar switch-repeater relay at the tower. The mechanical facing-point locks on the switches are operated by pipe lines. One lever and one pipe line, however, may operate two facing-point locks, as for example, F.P.L. 13 locks switches 14 and 15.

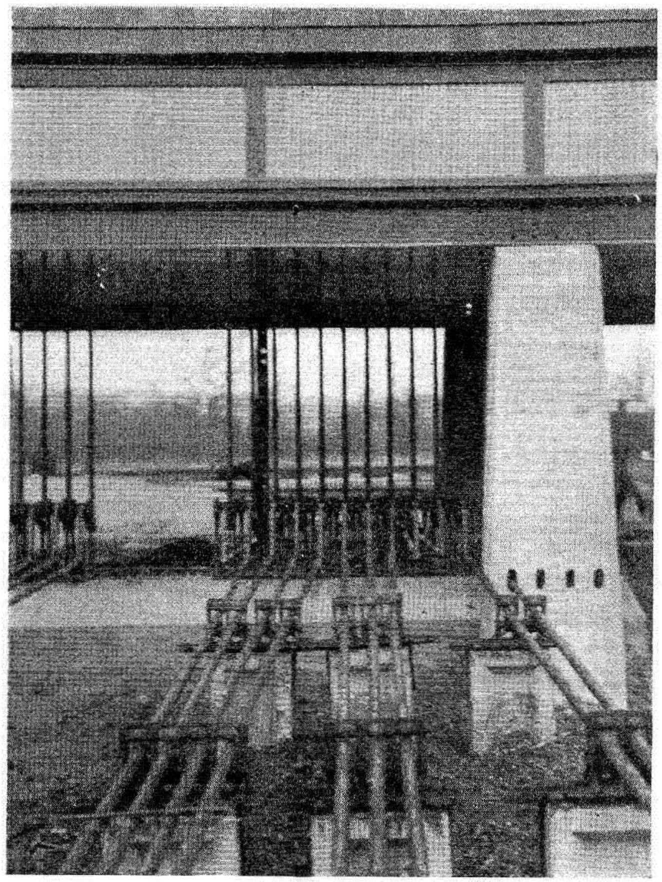
The aspect of each signal is repeated by a relay located in the instrument house at the tower, each of these relays being energized when the corresponding signal displays the Stop aspect, and being de-energized when a Proceed aspect is displayed. An ammeter, mounted in the panel below the diagram, is connected in the battery circuit which feeds the signal control relays, and by glancing at this meter the leverman knows whether the signal control relay has picked up after he reverses a lever.



Close-up view of a Type-K forced-drop electric lock with cover removed

The signals are power-operated and each is fed locally by a battery. Each signal is controlled locally by a d-c. neutral relay which is selected through a network circuit arrangement including selections through contacts in switch-position repeater relays, repeater relays for opposing and conflicting signals, track relays, switch lever contacts, contacts in signal lever position repeater relays, and relays controlled by push-buttons which are used to control the "call-on" aspects. Thus, in effect, the signal controls include all the selections and safety checks ordinarily provided in plants using a machine with non-interlocked miniature levers without electric lever locks.

The new tower is set on concrete piers and relays are located in a concrete house to rear of the tower



Lead-out cranks are mounted on concrete foundations below the tower building

One advantage of this network circuit arrangement is that portions of circuits including certain selections which are the same for the control of two or more signals that cannot be cleared simultaneously, can be used in common by the controls of all such signals, the result being that the number of contacts in relays and controllers is reduced to a minimum, safety is improved because the chance for a ground is reduced, and energization of one circuit prevents energization of the control for an opposing or conflicting signal.

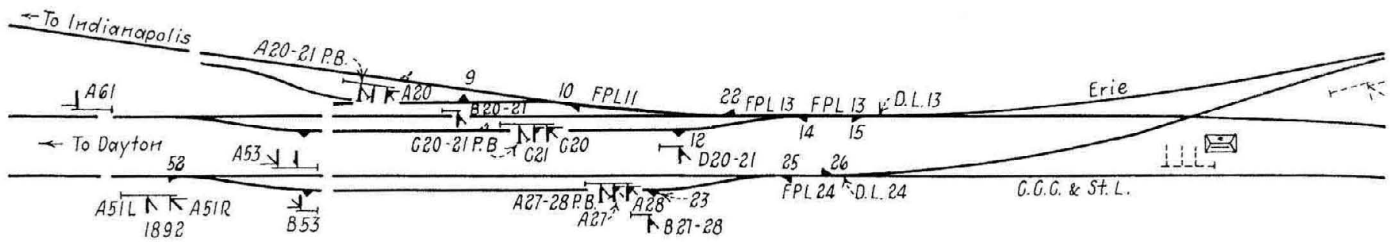
The design of the signal control circuits is such that the control relays of all signals, governing a route in either direction, check one network of switch repeating relays and switch lever contacts, thus reducing the number of contacts to a minimum.

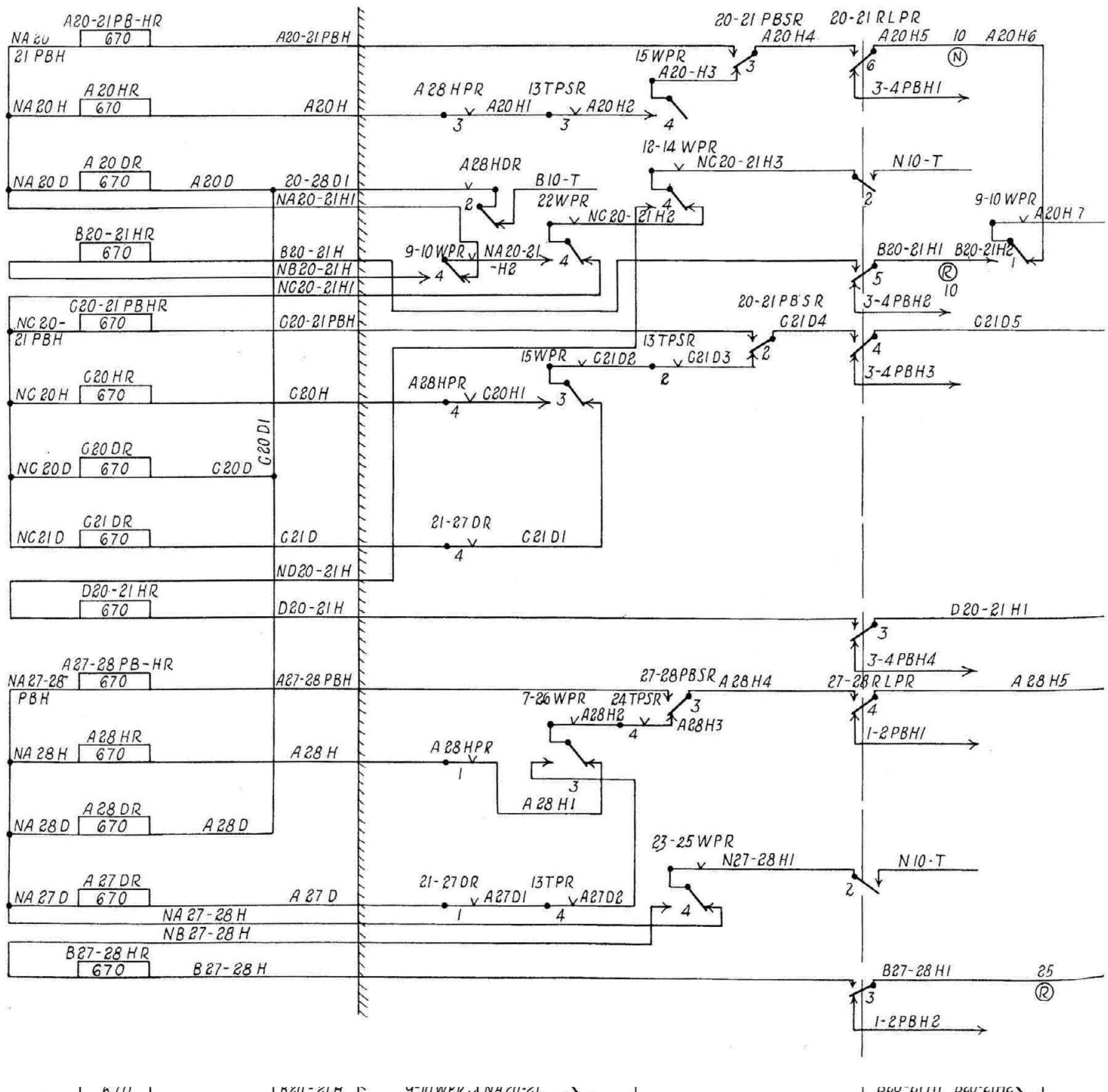
For example—circuits for the 45-degree control of the top arm, signal C20, start with relay C20HR. The positive wire of the coil extends as C20H through a front contact of A28HPR which repeats relay 6TR and line control relay A28HDR, first block in advance. Then the circuit continues through switch-repeating relay 15WPR, contact to left being closed, switch 15 having been reversed to complete a route governed by signal C20. The circuit then continues through a front contact of track-repeater stick relay 13TPSR. Going on, the circuit passes through a back contact of push-button stick relay 20-21PBSR which checks that push-button relay for signals 20 and 21 has not been operated; then through a front contact of lever-repeater relay 20-21RLPR, picked when lever 20 was reversed. The circuit continues as wire C21D5 through a normal lever contact of lever 22, then closed, and through polar as well as neutral contacts of four switch-repeater relays 22WPR, 12-14WPR, 15WPR, lever contacts 15R and 5N, and switch-repeater relay 5WPR. Then the circuit continues on wire 2H8 through a back contact of lever-repeater relay 1-2RLPR which insures that all opposing signals are at "STOP," then on wire A28H11 through mil-amp. meter to positive battery. Negative wire NC20H, extending from relay C20HR, extends on wire NC20-21H1 to the relay house at the tower where it checks through contacts in switch-repeater relays 22WPR and 12-14WPR, then through a front contact in lever-repeater relay 20-21RLPR, then closed, and to negative battery N10T.

The placing of a signal lever in the reverse position does not cause a signal to be cleared unless the signal control circuit is completed through the other various selections. Furthermore, by using electric lever locks on certain facing-point lock levers to lock them reversed, there is no need for normal-indication electric lever locks on the signal levers, because no hazardous condition will result from thus releasing the mechanical locking because the F.P.L. levers are locked by the electric lever locks, the switches are locked by the F.P.L. as well as mechanical locking between the F.P.L. levers and the switch levers, and furthermore, no other signal can be cleared until all opposing and conflicting signals are displaying Stop aspects, as checked by the contacts of the signal-repeater relays.

Having eliminated the need for electric lever locks on signal levers, a study was made concerning the use of such locks on switch and F.P.L. levers. By taking advantage of the fact that the F.P.L. levers in a route can be locked through the mechanical locking by a F.P.L. lever in a parallel route, electric lever locks were required on only three levers which are the F.P.L. levers 6, 13 and 24. New General Railway Signal Company Type-K, forced drop electric lever locks were applied on these levers. The old electric locks, which are of the type mounted at the rear of the locking bed and operated by connections from the locking shafts, did not have the forced-drop feature. These old locks were overhauled, the locking arrangement and coils being removed, and they were reapplied as circuit controllers, an advantage being that these controllers are operated by lever latch action.

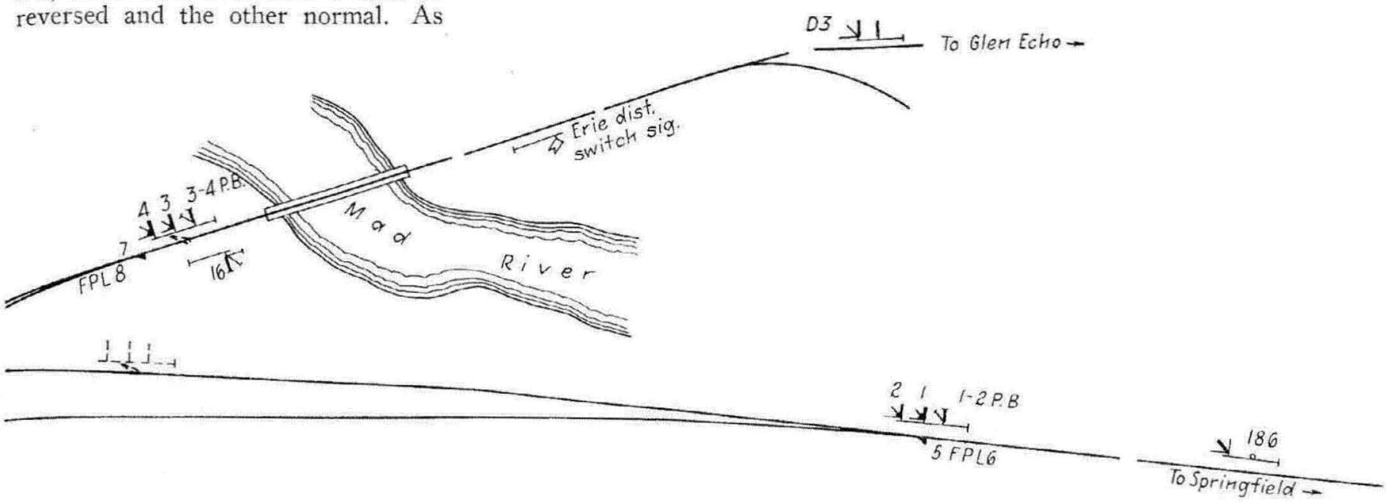
These controllers did not have a sufficient number of contacts for all the circuits to be checked through the signal lever circuit controllers. For this reason, reverse-position lever-repeater relays and circuits were provided. Only four such relays were required because the control of one such relay can be selected through contacts on the lever controllers for

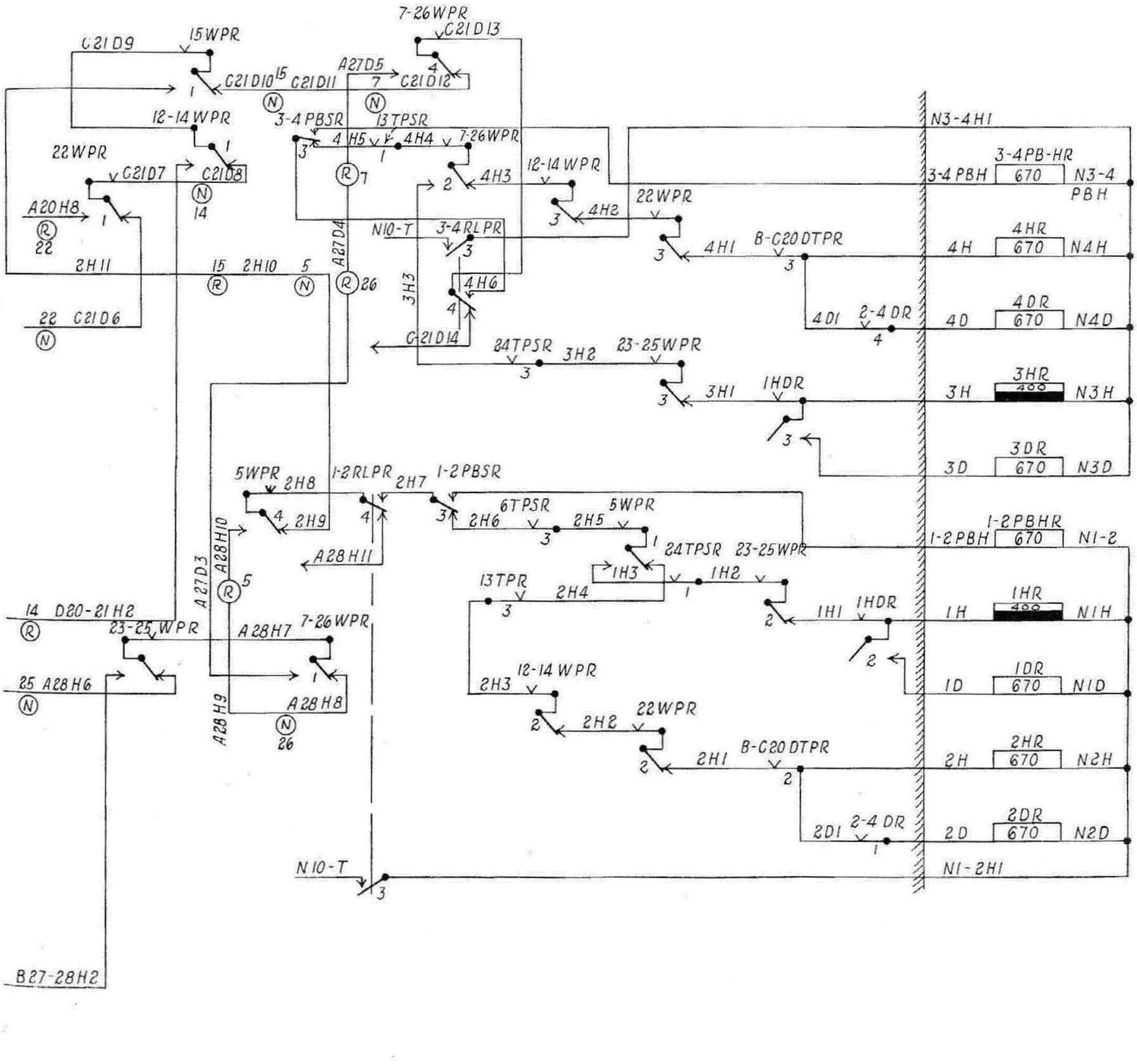




both levers used to control the signals on one home signal mast, as, for example, levers 1 and 2. In order to energize reverse lever position relay 1-2, either lever 1 or lever 2 must be reversed and the other normal. As long as both levers are normal, the relay is released and a short is maintained on the coils. The circuit equivalent of mechanical locking between levers is thus accomplished.

(Continued on page 503)





ten-car train on a three-per-cent descending grade

$$R_g = -0.03 \times 21.93 \times \frac{1,220,000}{1,320,000} = -0.61$$

miles per hour per second.

In the typical calculations shown, symbols which have not been fully discussed are as follows:

V, speed, miles per hour, at the end of each second

V_a average speed during the second

D, distance in feet traveled during the second

SD, total distance traveled since brake handle was placed in service position

d, equivalent distance (D-p) brakes were fully applied during the second

Sd, total equivalent distance brakes have been fully applied to end of second

Sd_a total equivalent distance brakes have been fully applied to middle of second

After the final braking distance for a given speed and grade has been calculated and the required over-all length of the restrictive blocks obtained, the minimum length of a single block is found. On descending grades we have four restrictive blocks in the rear of the occupied block and three restrictive blocks where the grade is level or ascending. Our standard rail length is 39 ft. and where practicable the block length is a multiple of 39 ft. or of one-half of 39 ft.

In order to check the length of two blocks for braking from the 25 control, and of one block for the 17 control, calculations must also be made for braking from 27.54 and 18.87 m.p.h. For the project under discussion, braking distances were calculated for level grade, one, two, and three per cent descending, and one, two, and three per cent ascending grades.

In the typical tabulations shown, all calculations were made with slide rule. The formulas given herein for various functions of speed are not considered applicable to train speeds greater than 50 m.p.h.

Mechanical Plant Modernized

(Continued from page 493)

The electric lever locks on levers 6, 13 and 24 are controlled by the usual circuit arrangements to prevent placing these levers normal when approach, route or detector locking is in effect due to track occupancy by trains, or by signals displaying an improper aspect. The lock controls include contacts in directional control stick relays, track and plant repeater stick relays, time element stick relays, track relays, etc., in the usual manner. In order to reduce battery consumption, the circuit for the coil of each electric lock is connected through contacts in a floor-push, which the leverman must step on when the lock is to be energized.

The clockwork time release, mounted on the lower panel on the illuminated track diagram, serves to effect a release of any of the three electric lever locks when approach locking is in effect.

Control of Call-On Signals

In some instances cars are set out and picked up in interchange at Cold Springs, and in such moves, proceed aspects must be displayed while certain track circuits within home signal limits are occupied. For these reasons, a third "arm" is provided on the home signals, this arm in each instance being used to display a "call-on" aspect. When a call-on aspect is to be displayed, the switches and F.P.L. in a route must be lined up, the signal lever reversed, and the corresponding push-button operated. The push-buttons for these controls are mounted on the panel below the illuminated diagram. Operation of one of these push-buttons completes a circuit to energize a corresponding push-button stick relay, which sticks up as long as the corresponding signal lever is reversed. Contacts in these stick relays open the control circuits for the upper "arm" aspects of signals. Through a front contact in the stick relay a circuit is completed to feed a lamp in the illuminated track diagram as a warning to the leverman that a call-on aspect is being displayed.

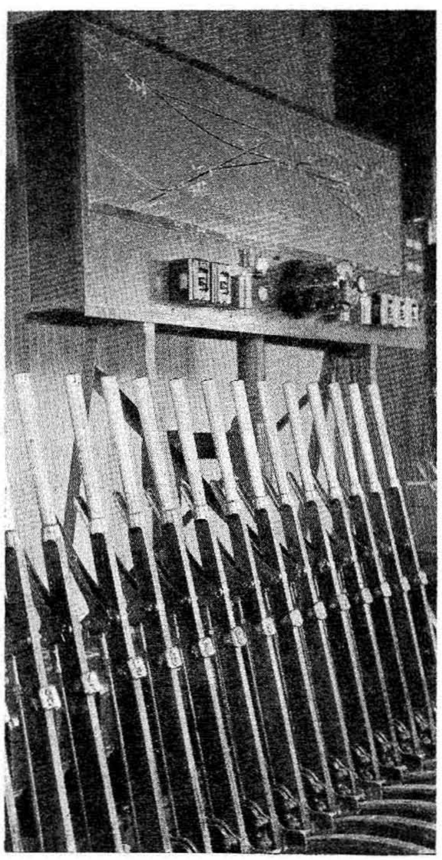


Diagram on angle-iron frame

Train-Order and Manual Block Signals

Also mounted on the panel below the illuminated diagram are three drum-type rotary switches, each of which is used as the equivalent of a non-interlocked lever to control a manual block signal. Signals A-61 and A-53 are manual block signals, which are located as shown in order that trains can be run through the interlocking and then held until a manual block is clear. If these trains were held in the sections approaching home signals, routes for other trains would be obstructed. Signal D3 is a combination distant signal and also is used as a "hold-out" signal to stop westbound trains when the old Springfield Division branch line trains are using the portion of the Erie track between Cold Springs and the hand-operated junction switch.

When the handle, or rather lever, of one of these drum controllers is in the center position, the corresponding signal displays the Stop aspect, when the lever is thrown to the left, the 45-deg. aspect is displayed, and when thrown to the right, the 90-deg. aspect is displayed.

Remote Switch Control

The switch at the west end of the passing track on the Big Four is operated by a G. R. S. Co. Model 5A low-voltage switch machine, and this switch together with the signals for directing train movements, is controlled by a desk-type circuit controller unit. This arrangement was in service prior to the modernization program, and the only changes with respect to this equipment was to mount the controller on the right end of the new illuminated track diagram as shown in the illustration.

The rehabilitation and modernization of the Cold Springs interlocking was planned and constructed by the signal forces of the C. C. C. & St. L. under the direction of B. J. Schwendt, assistant signal engineer, the major items of new equipment being furnished by the General Railway Signal Company.