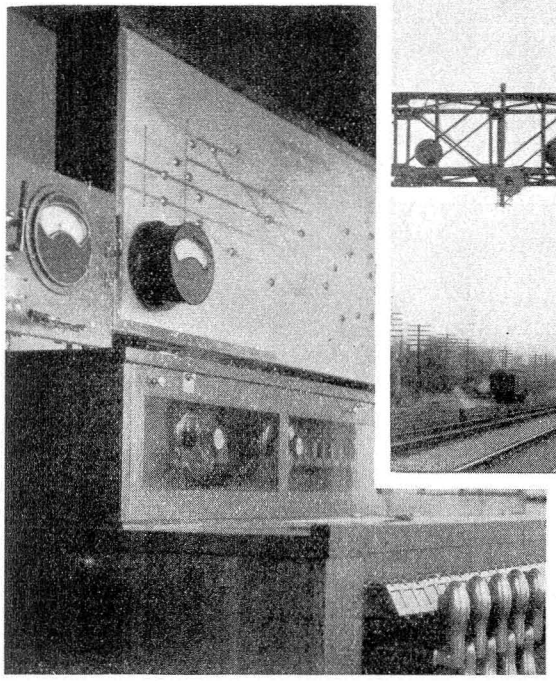
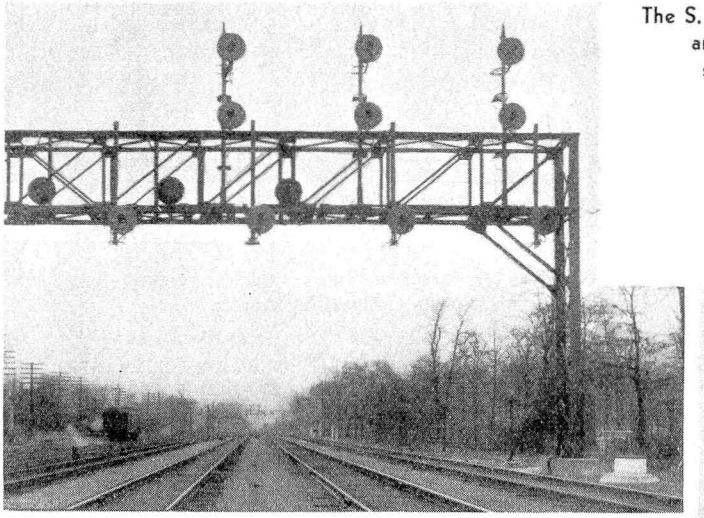
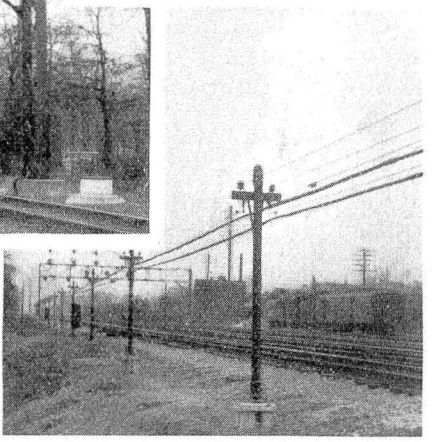


Interlocking machine---ground detector



The S. A. type of signals are mounted on signal bridges



Aerial cable line

New Control System Used at Electric Interlocking on the Burlington

Independent control and indication circuits make for simplicity, reliability and freedom from grounds

By W. F. Zane

Signal Engineer, Chicago, Burlington & Quincy, Chicago

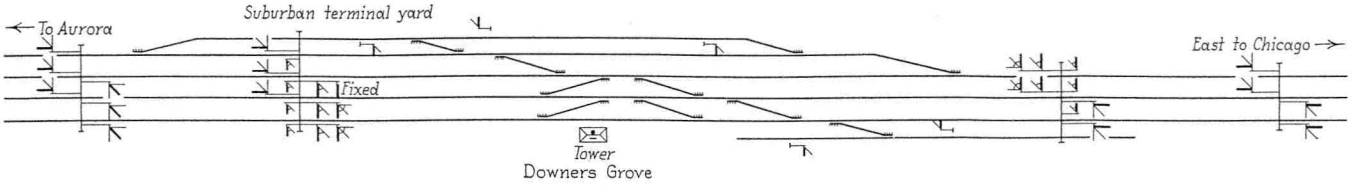
THE Chicago, Burlington & Quincy recently installed, at Downers Grove, Ill., an all-electirc interlocking plant, the design and construction of which are characterized by several novel features. Downers Grove is located in suburban territory on the main line 22 miles west of Chicago and 17 miles east of Aurora. Located at Downers Grove is a suburban passenger terminal where trains, that do not run through to Aurora, terminate for yard and roundhouse handling. Originally, a three-track system extended between Cicero and Aurora, a distance of 26.6 miles, and carried all main line passenger, freight and suburban service.

At Downers Grove the terminal and main line crossovers were operated by an old mechanical interlocking plant, semi-modern because of the addition of electric route and detector locking. The three main lines were signaled with color-light automatic signals, with semaphore signals at the interlocking plants. The south main was signaled for eastward movements, the north main for westward movements and the center main for both eastward and westward movements. All operation was by signal indication, no train orders being in use. A complete system of check locking between towers placed all trains under the control of operators, who directed train movements according to rules and instructions.

During 1930, a fourth track was constructed from Downers Grove westward to Eola, 12.3 miles. This construction embraced certain grade separations at street crossings and island platforms at the several stations, as well as signal rearrangement, additional signals and interlocking replacements. At Eola the mechanical interlocking plant was enlarged in kind, excepting that the semaphore signals were replaced with Style-SA color-light signals. The existing color-light automatic signals were re-arranged, and others were added to signal the new fourth track. The new arrangement provides directional signaling on the two outside tracks, as in the original installation, and signaling in both directions on the two center tracks. At Downers Grove the new electric interlocking plant was a vital operating requirement of the entire project.

In order to handle more efficiently the present volume of traffic, as well as the anticipated increase during the 1933 World's Fair, the officers of the railroad realized the importance of a modern interlocking plant at Downers Grove, one which would be fast in operation. With

this in mind, the signal department designed an interlocking plant which embodied the General Railway Signal Company, Type 5-C control-and-indication circuit system. The plant was placed in service December 10, 1930.



Signal layout plan

Traffic Handled

The number and classification of trains moving through this plant are shown in the following table. In addition, there is some switching.

Eastbound Traffic

Suburban passenger trains originating at the plant	25
Suburban passenger trains originating at Aurora	13
Through main line passenger trains that originate west of Aurora	16
Carded freight trains	9
Extra freight trains	7
Total trains eastbound	70

Westbound Traffic

Suburban passenger trains terminating at the plant	26
Suburban passenger trains terminating at Aurora	12
Through main line passenger trains that terminate west of Aurora	16
Carded freight trains	11
Extra freight trains	7
Total trains westbound	72
Total trains through the plant, both directions	142

Tower and Power Equipment

The tower building, which has two stories and a high basement, is 15 ft. wide by 22 ft. long. Since it is of brick construction with concrete floors it is absolutely fireproof. The windows are of metal sash, the lower part opening outward, and are placed to give a maximum of light, ventilation and view.

The basement is divided into three rooms, separated by brick walls, and is mostly above ground, which accounts for large windows and an entrance flush with the ground at the rear of the building. The furnace room, the first entered from the outside, is 11ft. 7½ in. by 6 ft. 1 in. and contains an Arcola heater and a sink with running water. Opening off the furnace room is a coal room 9 ft. 4 in. by 7 ft. 1 in.

The battery room is 7 ft. 10½ in. by 12 ft. 11 in. and has provision for natural lighting. In the center of the room is the battery rack, built pyramid shape with the shelves constructed like stair steps, on which the cells are located. This permits the maintainer to inspect the battery and to take readings while standing on the floor. A battery of 58 Exide EMGO-9 cells, for operating the switch machines, is charged by a Union 220-volt, 60-cycle Type RP-81 copper-oxide rectifier, which is located on the floor next above. This battery has a center tap to supply the 55 volts required for the operation of cells on floating-charge through a Balkite rectifier, the cell of which stands by the group it charges, while the transformers are located on the floor next above. Two the master relays. In addition there are three groups of Exide KXHS-7 storage battery, each consisting of five of these groups supply current for all 10-volt circuits other than the switch machines and the master relays. Each of the two groups supply an equal number of circuits, while the third group is a standby for emergency service. This arrangement of battery supply makes it possible to increase the protection against crosses and foreign currents.

The second floor houses all the relays required at the tower, the copper-oxide rectifiers, the Balkite transformers, the main switch and test board, and the power switch board, as well as all terminal blocks, because all cables, both aerial and parkway, terminate on the second floor. In fact, all apparatus other than the interlocking machine is located here in a convenient manner for inspection and testing. The relay rack is constructed of ½-in. Johns-Manville asbestos board secured to a frame of 1 in. by ⅜ in. angle-iron. This rack is 12 ft. long and 5 ft. 7 in. wide and 6 ft. high, and so constructed that there are 5 shelves for relays on each side, facing the room. Each end is equipped with a door which gives access to the interior of the rack where the terminals are located, just back of the relays, and so arranged that the jumper wires pass through small holes to the relays. Wire chases of the same material as the rack run parallel to the shelves on the inside, which are equipped with hinged lids so that all wires laid in them require no pulling through ducts. All cables, both aerial and parkway, terminate inside of the rack, which produces a fireproof housing, convenient and lasting. The rack was constructed by the Railroad Supply Company. The neutral relays are the Burlington standard type and are arranged and grouped so as to facilitate convenient testing.

Interlocking Machine

The top floor contains the interlocking machine, the operator's table with its telegraph and telephone equipment, and three check-lock machines of the table type. The interlocking machine is the Model-2 unit-lever type, consisting of 31 working levers and 9 spare spaces in a 40-lever frame. One lever is assigned to each high-speed route signal, each diverging route signal, each restricting speed route signal (both suspended and ground type) and each single switch. However, there is a radical departure, in the arrangement of levers for crossovers, which is a marked contrast with former General Railway Signal Company's practice. In this machine only one lever is used for each crossover, and as there are eight crossovers, the machine is smaller by eight levers than would have been the case if past practice had been followed.

Five clock-work time releases are mounted in a glass enclosed compartment on top of and a part of the machine. Those for the restricting speed signals are ad-

justed to a time interval of 10 sec. and those for the high-speed route signals to a time interval of 1 min. The illuminated track diagram is located on top of the machine and is a picture of the track arrangement with lights for approach annunciation, signal indication, the indication of the starting signals controlled by the check lock circuits, and for the indication of track occupancy.

The check locking between this and adjacent plants is controlled by three table-lever machines placed over the operator's table. One machine is for the center track of the three-track system extending eastward, and the other two machines are for the two center tracks of the four-track system extending westward. A ground detector, placed on the machine, is so arranged that the operator can operate and report any grounds to the maintainer. This detector is Brach R-1504-A, which type has been standard with the railroad for several years.

Outside Construction

The outside apparatus and arrangement is somewhat original, and was engineered and installed to give a long life to the entire plant with a resultant low maintenance cost. No conduit or trunking was used in the entire installation, and apparatus is so designed as to be dirt and mouse-proof. The aerial cable, used for all control circuits and field busses, is supported on 9-ft. iron cable posts, set on sectional concrete foundations and spaced 60 ft. apart. At the top of the post is a two-pin cross arm carrying the two wires of a 110-volt 60-cycle, single-phase a-c. charging circuit. These wires are No. 6 triple-braid, weatherproof copper. The control circuits are carried in cables suspended in rings from a 1,600-lb. test messenger, suspended just below the cross arm. These cables are of No. 16 wire and are made up according to C. B. & Q. specifications, each including the exact number of wires required. Located in the rings with the cable are several No. 8 single-conductor field busses, which carry the 110-volt d-c. for the operation of the switch machines.

Located on the iron cable posts, and opposite each switch or switches where two or more are adjacent, is a relay box that houses the terminal blocks where the aerial cable is terminated, as well as the parkway cable. Also in those boxes which are near a signal, is the other field apparatus, such as relays, rectifiers, power-off relays and all other apparatus required at such a location.

Parkway cable is used for all track wires, control wires from the relay terminal box to the switch machines, dwarf signals and the buss wires. The parkway cable ends are sealed, with compound, in the relay case, as well as at the dwarf signal, where suitable sealing compartments are provided. At each switch machine the parkway terminates in 3½ in. by 18 in. iron pipe set vertically and extending 1 ft. in the ground. Enough lead, steel tape and jute is removed from the parkway to permit the individual conductors to reach from the pipe to the switch machine, and the pipe is filled with compound so that the end of the lead and steel tape is sealed and only the conductors extend out of the pipe. On top of this pipe is fastened a flanged elbow from which a flexiduct connection, 18 in. long, reaches to the switch machine and through which the wires pass.

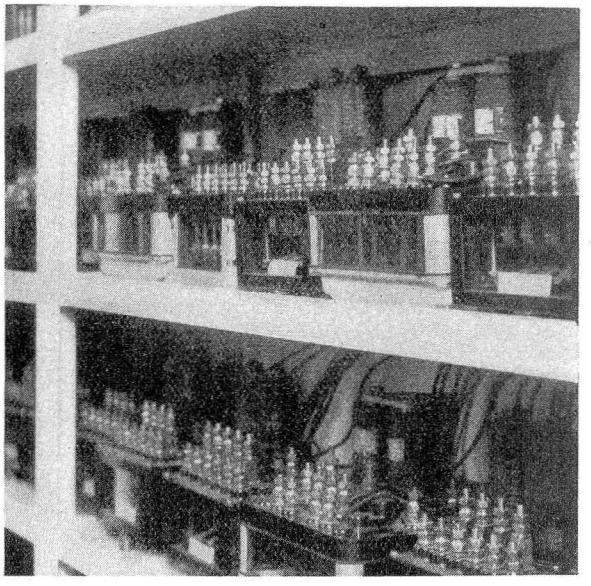
In accordance with Burlington standards all high-speed, diverging route and restricted speed signals for main lines are Type-SA single-lens color-light types. All signals governing main-line movements, as well as movements from main line to side tracks, are on signal bridges. The high speed and the diverging route signals are above the bridges on poles, the high speed signal being above the diverging route signal. The restricting speed signals governing routes off the main lines are suspended below the bridge. On side tracks, the restricting speed signals are of the ground color-light dwarf type. No call-on signals were used as all signals are controlled entirely through the route they govern.

The switch machines are of the Model 5-C type equipped with lock rods and point detectors, and have an operating speed of from three to four seconds in which to complete an entire operation and to lock. The machines are placed on top of unframed ties, with the throw, lock and detector rods properly offset to compensate the difference in level. This removes the machine from the ground and reduces frost trouble. In order to reduce the chance for damage from derailments and dragging equipment, the machines are placed 7 ft. from the center of the track, which is farther than in usual practice.

The switches are fitted so as to hold them in place and to eliminate running. The gage plates are cut in the center of the track instead of being insulated. These plates are ¾ in. by 7 in. and 2 ft. 8 in. long, and are fastened to the ties with lag screws. The three ties under the points and the first tie in front of the point are so equipped. Racor rail braces are used through each switch and are so installed as to hold the track in both directions. In addition, anchor straps, 12 ft. 2 in., with one end bolted to the web of the rail, are attached to 11 ties. The rail through these switches is 110-lb.

Control and Indication Circuits

The circuits are novel, being known as "Type 5-C control and indication circuits" and this plant represents the first application of these circuits. A two-wire circuit is used for the control, and a separate two-wire circuit for the indication, of each switch, while 110-volt d-c power, for switch operation, is distributed by busses extending the length of the plant.



A section of the relay racks

A controller is housed in and forms an integral part of each G. R. S. Model-5C switch machine. This controller consist of a polarized master relay, two operating contactors, two overload relays and related protective devices. The master relay controls the operating contactors through which the 110-volt switch operating cur-

rent is controlled. These contactors are provided with magnetic blow-outs which will suppress any arc occurring in the ordinary operation of the machine or when the machine may be stalled. The overload relays act to open the circuit to the proper operating contactor only when and if the switch machine becomes stalled.

The master relay is controlled by a 55-volt d-c. two-wire circuit extending directly to the circuit controller on the respective switch lever in the interlocking machine. This relay is normally short-circuited, being energized momentarily when the lever is being moved to either position. The two master relays for both ends of a crossover are controlled in multiple over a two-wire circuit, the same as for a single switch.

A separate pair of wires, entirely independent of the switch control wires, is used exclusively for the 10-volt switch indication circuit and extends unbroken from the KR, or switch indication, relay in the tower to the point-detector in the switch machine. The KR relay is in accordance with the railroads standard practice and there is one such relay for each single switch or for each pair of switches in the case of a crossover.

Outstanding among the advantages of this system of switch control and indication is the method employed to secure immunity from crosses and grounds.

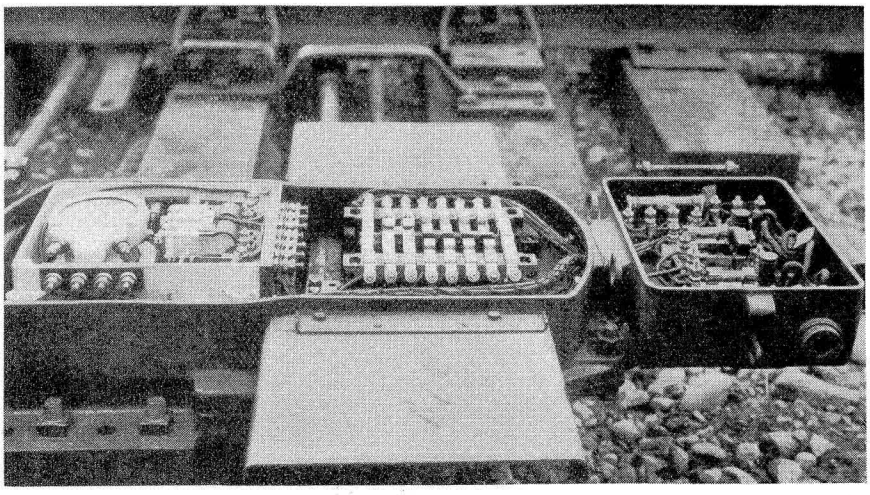
Locking and Signal Circuits

An examination of the illustrated simplified circuit for the operation of a single switch will reveal some interesting points. The MR relay shown is of the tractive armature type, built especially for switch-locking purposes. These relays are mounted within the same enclosure housing the time releases and can be seen in the photograph of the interlocking machine. The switch-locking circuit is designed so that, for example, the operating lock is energized through the latch contact and the locking relay, or relays. When the switch has started its movement, the KR relay becomes de-energized, and the MR relay becomes energized through a back contact of the KR relay. When the switch has completed its movement, the indication magnet, M, is energized momentarily through the front contacts of both the KR relay and the MR slow-release relay in series, the MR relay remaining energized a sufficient length of time to operate the indication magnet, M, after the KR relay has picked up. Thus, the operating and indication locks are normally de-energized, and are energized only when their operation is needed. It will be noted, also, that this circuit provides the possibility of working the switch points back and forth, when necessary, to overcome any obstruction that may hinder their movement.

The signal-control relay circuits extend unbroken from the signal relay box directly to the relay rack in the tower, where the greater part of all the circuit selection is concentrated. The signal circuits are not selected through the switch machine circuit controllers, but the alinement of the switches is checked by the selection of the signal circuits through the KR relays in the tower. This fact plays an important part in effecting the relative immunity from grounds and crosses between circuits.

The Style-SA signals are lighted directly from the a-c. line circuit, which is stepped down to 9 volts. A stand-by storage battery, however, through the medium of a power-off relay, lights them when power is interrupted. This battery is charged by a Type RT-10, copper-oxide rectifier.

The installation, circuits and arrangement of the plant were designed by the signal department, and the construction was made by the regualr construction forces of the signal department. The plant was placed in service only after complete checks had developed that all work was complete and after electric and operating tests had been made, and it was known that there was no engineering installation or operating errors present. The plant has operated satisfactorily and there has been no necessity for the making of any changes or correction.



Switch machine with cover removed---note master relay at left

The switch operating circuit Is separate from and independent of the switch indicating circuit