Automatic Signals on the Chicago Great Western

A Description of the Block Signaling Recently Installed Between Oelwein, Iowa, and Chicago

BY J. BEAUMONT*

The Chicago Great Western was reorganized on September 1, 1909, on which date it was taken out of the hands of the receivers and the new company took charge. Extensive plans were made for the physical rehabilitation of the properties, including the installation of automatic block signals, the purchase of new equipment, reduction of grades, double-tracking that portion of line subject to heavy traffic, the construction of new terminals, laying of new rail and a general system of rejuvenating of the entire property.

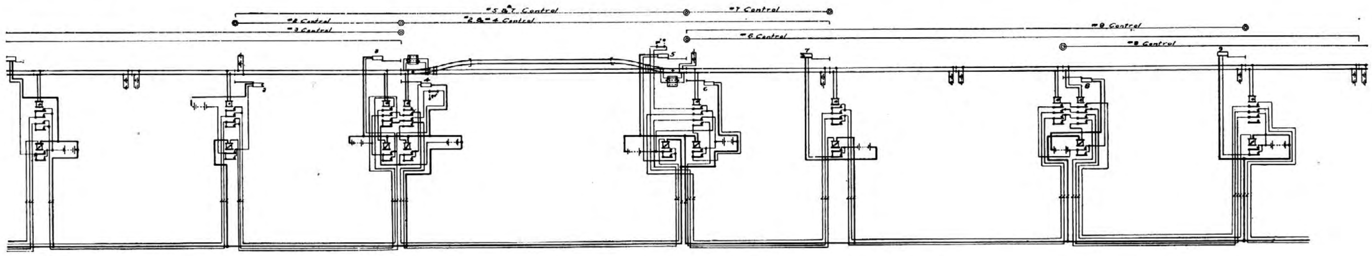

Fig. 1. Typical Location and Overlap Plan on Single Track.

The Great Western has direct lines between the cities of Chicago, St. Paul, Minneapolis, Omaha, and Kansas City. At Oelwein, Ia., the line diverges into three branches, which extend respectively to St. Paul and Minneapolis on the north, Omaha on the west, and Kansas City on the southwest. The traffic over the line between Chicago and Oelwein is necessarily very heavy; it has been necessary to double-track a large portion of this line, and during the past year a complete installation of all electric automatic block signals has been put in service.

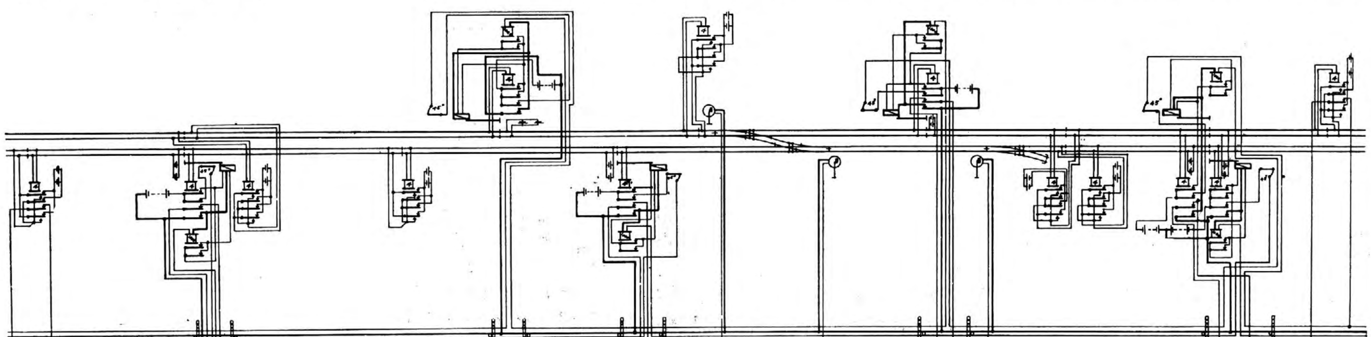

Fig. 2. Typical Location and Circuit Plan on Double Track.

Fig. 3. Signal Location West of Maywood, Ill.

The automatic signal installation includes 333 General Electric type M-116 d. c. electric motor signals of the upper right-hand quadrant semaphore type, normal clear with bottom-post mechanism. Each signal is operated by 16 R. S. A. standard primary cells of caustic soda battery connected in series. Energy for the respective track circuits is supplied by three gravity batteries in multiple, and track circuits approximate 3,000 ft. in length. All track relays are of four ohms resistance, and line relays are of 1,000 ohms, all conforming to R. S. A. specifications.

The construction of the line circuits necessitated the placing of an additional cross arm on the telegraph pole line. Copper-Clad steel line wire of No. 10 B & S gauge was used exclusively; double-braid weather-proof wire was used for all single-track circuits, and bare wire for the double-track circuits.

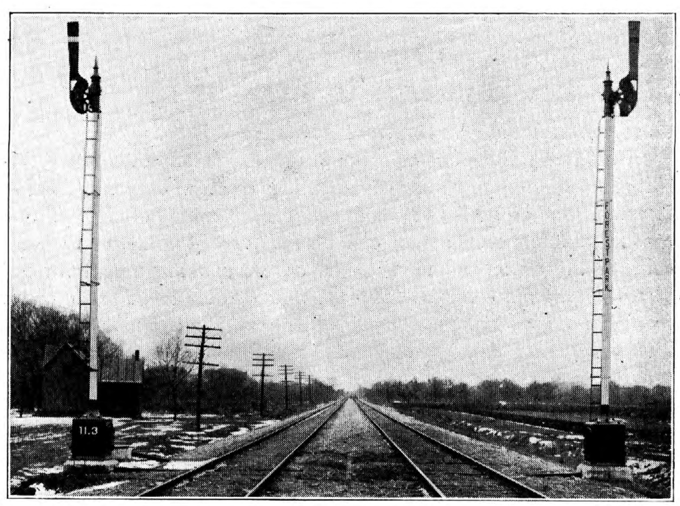

Fig. 4. East and West-Bound Signals West of Forest Park, Ill.

Primary batteries are housed in Massey type "B" battery wells, concrete battery chutes being used for track cells. Junc-

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tion or cable-post foundations were provided and made up complete with anchor bolts. The concrete signal foundations used throughout the installation are of the sectional type and were made and delivered in three sections, the idea being to have the lower and middle sections placed in position by the steam derrick at the same time that the battery wells were placed in position, the middle and lower sections to be leveled and joined, and anchor bolts placed by a force working in connection with the pioneer construction force. The object of this type of founda-

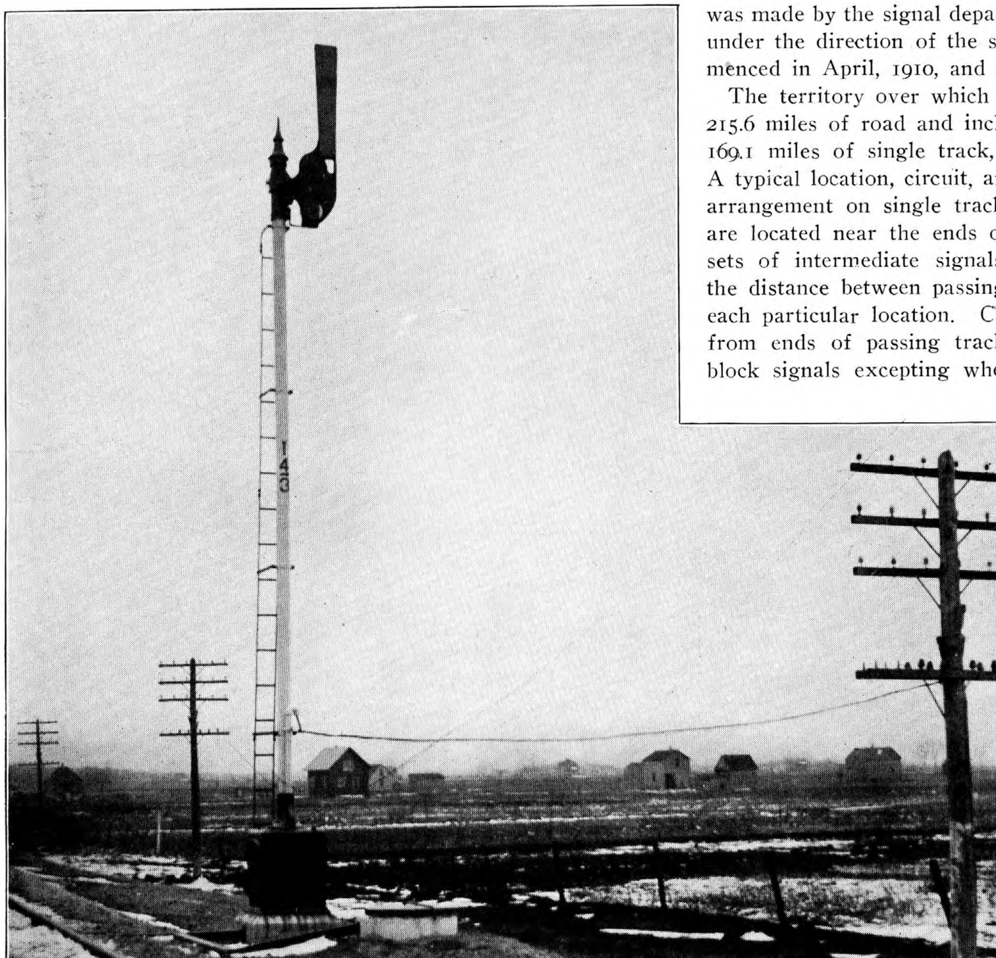

Fig. 5. Signal East of Elmhurst, Ill. Fig. 6. Signal, Switch Indicator and Cable Post at Location West of Bellewood, Ill.

tion is to avoid the necessity of distributing and protecting the loose concrete materials usually employed, and to reduce to a minimum the trouble and loss of time involved in the supply of water for concrete work where such foundations are made in the field.

The signals, relays, relay shelters, switch boxes and switch and tower indicators were furnished by the General Electric Company, Schenectady, N. Y.; electric slots, electric locks, lightning arresters and circuit controllers by the General Railway Signal Company, Rochester, N. Y.; concrete battery wells and chutes, signal and junction post foundations by the C. F. Massey Company, Chicago, Ill.; R. S. A. primary cells by the Banks Electric and Mfg. Company, New York. Line wire was furnished by the Duplex Metals Company and the Chicago Insulated Wire Company; insulated wire by the Kerite Insulated Wire & Cable Company; gravity batteries by the Central Electric Company, Chicago, Ill.; bond wires and channel pins by the Railroad Supply Company, Chicago, Ill.; insulated joints by the Rail Joint Company, New York, and ground cones by the Paragon Sellers Company, Chicago. The entire installation was made by the signal department of the Chicago Great Western under the direction of the signal engineer, the work being commenced in April, 1910, and completed in March, 1911.

The territory over which the installation is distributed covers 215.6 miles of road and includes 46.5 miles of double track and 169.1 miles of single track, or a total of 262.1 miles of track. A typical location, circuit, and overlap plan showing the general arrangement on single track is shown in Fig. 1. Two signals are located near the ends of passing tracks, with one or more sets of intermediate signals between stations, depending upon the distance between passing tracks and the conditions affecting each particular location. Caution signals are provided 3,000 ft. from ends of passing tracks to regulate the approach to the block signals excepting where the local conditions make a departure from this distance necessary. All signals on single track operate in two positions, except where the block signal is used to regulate the approach to an interlocking plant, when the third, or 45-degree, position of the block signal arm is employed to indicate caution in case the home signal at the interlocking is at stop. Otherwise, this position of the signal arm is not used in connection with single track.

Switch indicators are provided where it was found impracticable to locate signals in the vicinity of main track switches, as at crossovers between the main track and the passing track when located midway between the ends of long passing tracks and in yards.

A typical drawing showing the arrangement of signals and circuits governing train movements over the double-track territory is shown in Fig. 2. Indicators are provided for all non-interlocked switches, and the circuits in connection therewith are arranged to overlap the second signal in advance of the switch. Three-position signals are used on double track. These are spaced approximately one and one-half miles in each direction, the actual locations, of course, depending upon local conditions.

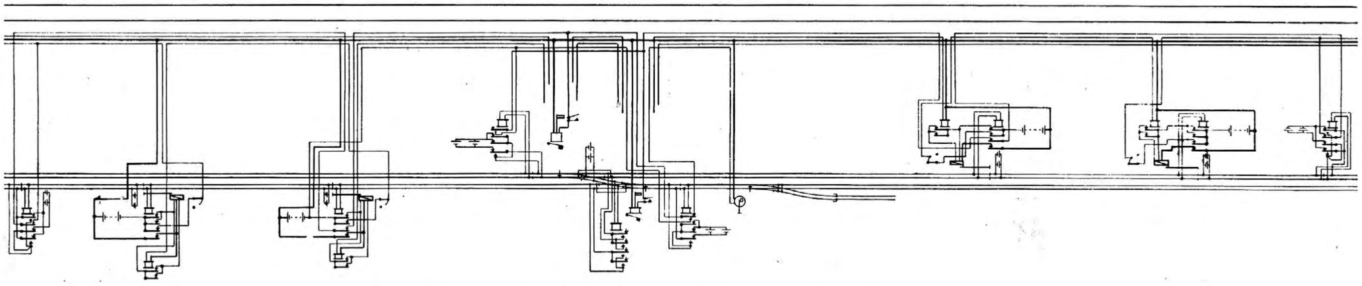

Fig. 7. Typical Electric Lock Protection Circuit.

Between Forest Park and Elmhurst, Ill., there are 9 signals governing movements over 6.5 miles of double track, some of which are illustrated in Figs. 3, 4, 5 and 6. Fig. 4 shows the east and west bound signals just west of Forest Park; Fig. 3 shows the location just west of Maywood, Ill.; Fig. 6, the signals just west of Bellewood, Ill., and Fig. 5, the location just east of Elmhurst.

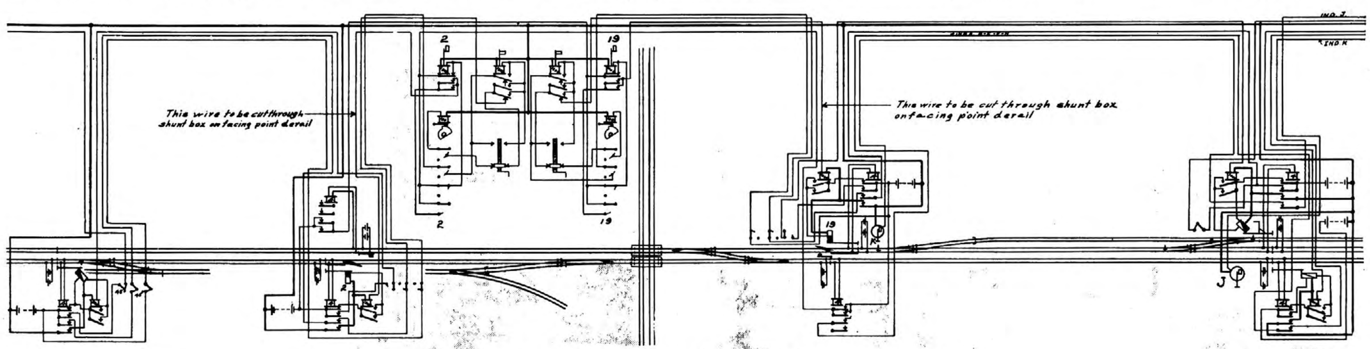

Fig. 8. Circuits for the Interlocking Plant at Bellewood, Ill.

Important main-track crossovers in double main-track territory are provided with electric locks to prevent the operation of the switches after a train on the main track has entered the block, as shown in Fig. 7. The arrangement provides a release circuit immediately ahead of the switch points, so that no inconvenience is caused in the operation of switching movements.

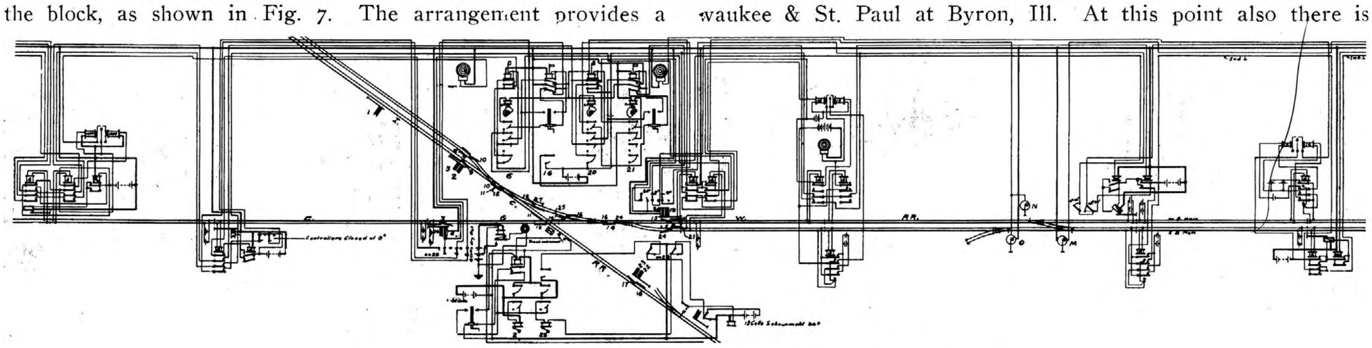

Fig. 9. Circuits at the end of Double Track, Elmhurst, Ill.

In Fig. 8 is shown the arrangement of circuits used in connection with electric lock protection at interlocking plants, the illustration being that of the interlocking plant at Bellewood, Ill., at the crossing of the Indiana Harbor Belt. Power-operated home signals are employed, and approach, route and indication locking are provided through the limits of the interlocking plant.

The signal and circuit arrangement used to protect the end of double track at Elmhurst is shown in Fig. 9. This interlocking includes the crossing of the Illinois Central. The automatic signal circuits are maintained by the Chicago Great Western. As will be noted, there is a separation of circuits between the two railroads.

Between Elmhurst and Kent, Ill., there are 170 signals governing movements over 108.1 miles of single track. This section includes four interlocking plants, the home signals of which are fitted with electric slots, approach indication being given by a third position of the automatic signal located with due consideration to the home signal at the interlocking plant. A plan of the circuit used at the interlocked crossing of the Chicago & North Western at Sycamore, Ill., is shown in Fig. 10. At this point two automatic signals are located within the limits of the passing track to increase the capacity of the track and to provide protection for main-track movements within yard limits.

The signal and circuit plan in Fig. 11 shows the arrangement at the interlocking protecting the crossing of the Chicago, Milwaukee & St. Paul at Byron, Ill. At this point also there is a separation of the maintenance of circuits between the respective roads.

Between Kent and Winston, Ill., there are 37 signals protecting movements over 27.2 miles of double track, which includes the main track through the terminal district at Stockton, Ill. All switches through the terminals are provided with indicators, and main-track crossovers are arranged with separate crossover circuits. The automatic signals are placed near the clearance point of all connections to the main track, and caution signals are suitably located to govern approach thereto.

From Dubuque to Fair Grounds, Ia., 2.2 miles of double track, 4 signals are provided, one of which regulates the approach to the interlocking at Fair Grounds. The signals at this point are electrically slotted, but no electric locking was applied for the reason that the interlocking will be moved in the near future on account of the transfer of the freight terminals from Dubuque, Ia., to Stockton, Ill. Between Fair Grounds and Aurora, Ia., 99 signals regulate the train movements over 61 miles of single track. This territory includes the beautiful Maquoketa Valley, in which are the villages of Durango and Budd, Ia.

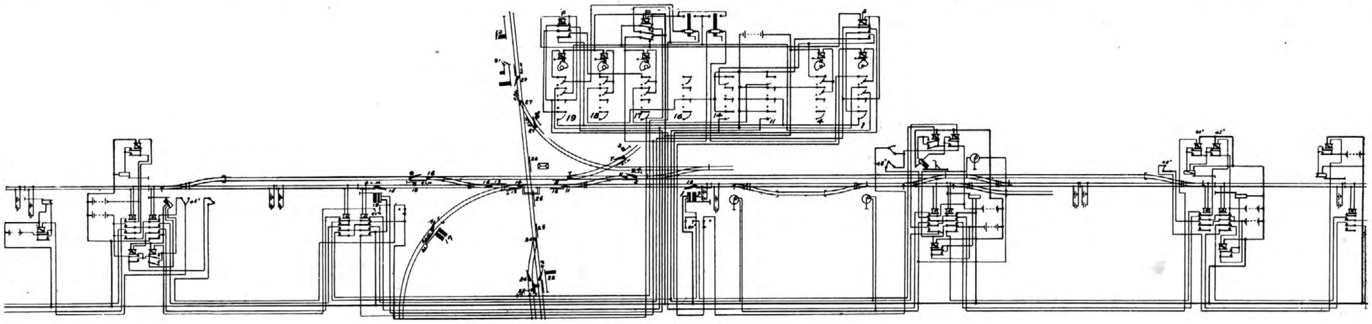

Fig. 10. Circuits for the Interlocking Plant at Sycamore, Ill.

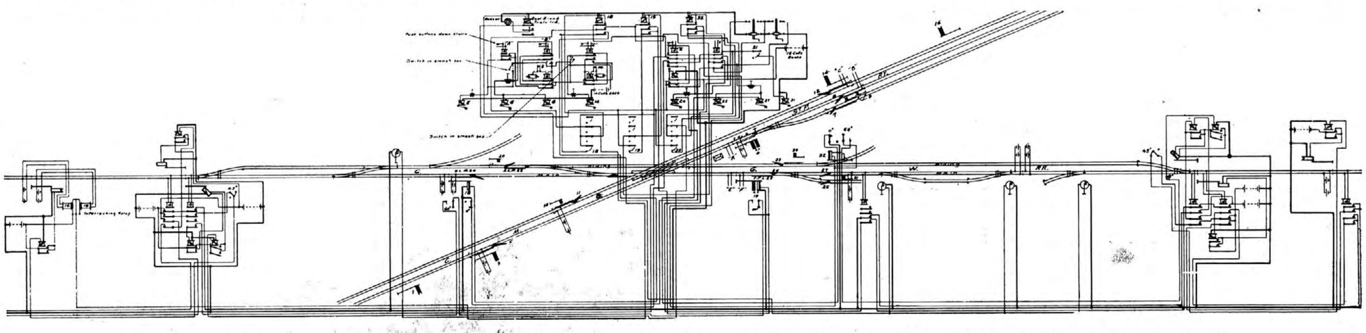

Fig. 11. Circuits for the Interlocking Plant at the Crossing of the Chicago, Milwaukee & St. Paul, Byron, Ill.

to the end of the passing track is shown in Fig. 13, the location being that of the east-bound distant signal at Budd, Ia. It will be noted that the station name is stenciled on the distant signal and that stop signals are provided with numbers. The naming of the distant signal has obviated the necessity for the mile boards formerly used. The numbers on stop signals designate the distance from Chicago in miles and tenths, the odd numbers in tenths being shown on all west-bound signals and the even numbers on all east-bound signals, thus conforming to train numbers. The figures or letters are six inches in height, four inches in width, and one inch in width of outline.

Fig. 12. Double Signal Location on Single Track West of Durango, Ill.

Fig. 13. East-Bound Distant Signal Near Budd, Iowa.

The signal location, Fig. 15, shows the arrangement at the east end of the passing track at Durango, Ia., and Fig. 12, a view of the west end of Durango.

A typical view of the distant signal governing the approach

Between Aurora and Oelwein, Ia., there are 13 signals protecting movements over 10.6 miles of double track, and in connection therewith an interlocking plant at the end of double track at Aurora, arranged as shown in Fig. 14. This interlocking includes slotted home signals and detector and route locking.

The method of trunking and track wiring is shown in Fig. 18, the illustration being that of a typical cut section. The connection from the battery chute to the relays is made with No. 12 B & S flexible wire, all underground wires connecting the track with the terminals at the relay box being of No. 9 B & S solid wire. The bootleg is the Chicago Great Western

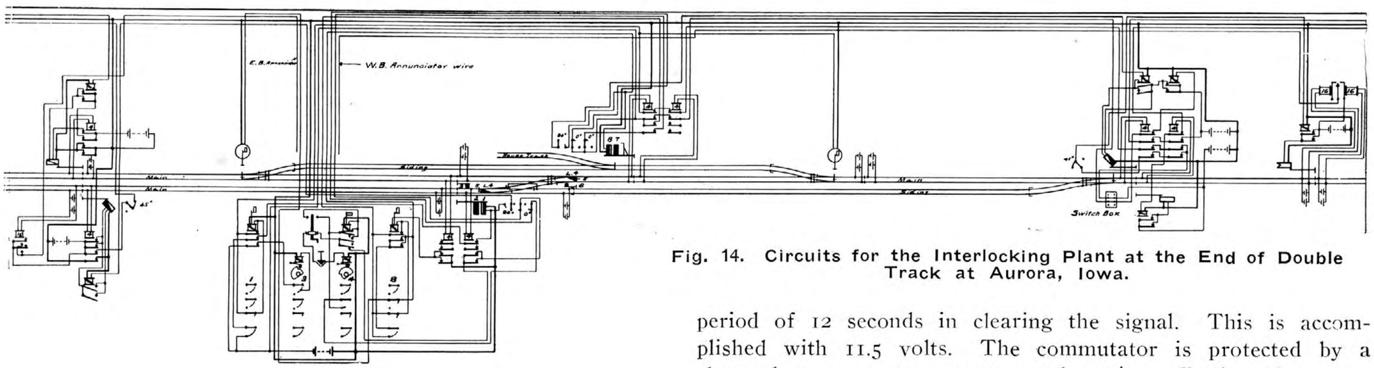

Fig. 14. Circuits for the Interlocking Plant at the End of Double Track at Aurora, Iowa.

standard, and consists of a piece of trunking eight inches long, securely nailed to a piece of capping, the latter being bored to provide space for the adjustment of the underground connecting wire. Two Copper-Clad bond wires are shaped around the trunking and secured thereto with staples. This arrangement provides protection against mechanical injury to the insulated wire and sufficient flexibility between the bootleg and the rail.

A view of the signal mechanism as it appears when wired

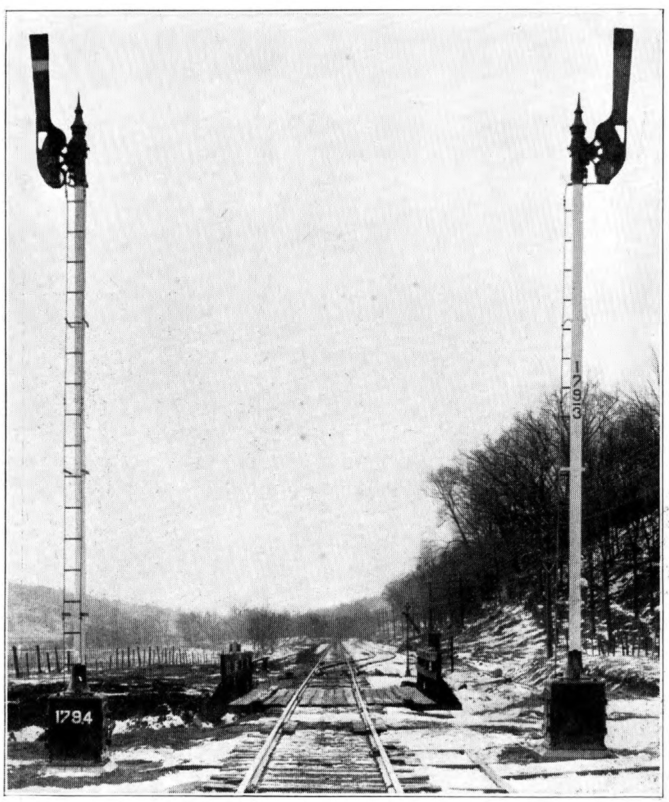

Fig. 15. Signals at the East End of the Passing Track at Durango, Ill.

complete and in service is shown in Fig. 16. This type of signal is similar to the M-113 top-post mechanism in all of its essential features, except that it is arranged for bottom-post operation. The shaft ordinarily used for the operation of the signal arm, or the spindle shaft, is connected to a similar sheave attached to the spindle at the top of the post, by means of chains connected by a piece of No. 9 BWG steel signal wire, with an adjusting screw to fix the proper length. It will be noted that this signal pulls to the proceed position, a departure from the "push clear" principle usually employed.

The Loree-Patenall spectacle casting, arranged for 8⅜-in. roundel, is used. This casting is fitted with a signal arm of standard width and four feet in length.

The motor is series wound, and is of high efficiency, having a current consumption of approximately 1.8 amperes for a period of 12 seconds in clearing the signal. This is accomplished with 11.5 volts. The commutator is protected by a clear glass cover to prevent condensation affecting the parts. This cover is secured to the outer bearing by a knurled nut. The motor is provided with a magnetic field friction brake, the engaging surface of which is non-metallic material having a high co-efficient of friction, and highly efficient and uniform in operation. The motor brake is protected by a copper cover to prevent the interference of foreign particles with operation. The retaining or slot mechanism is the medium between the

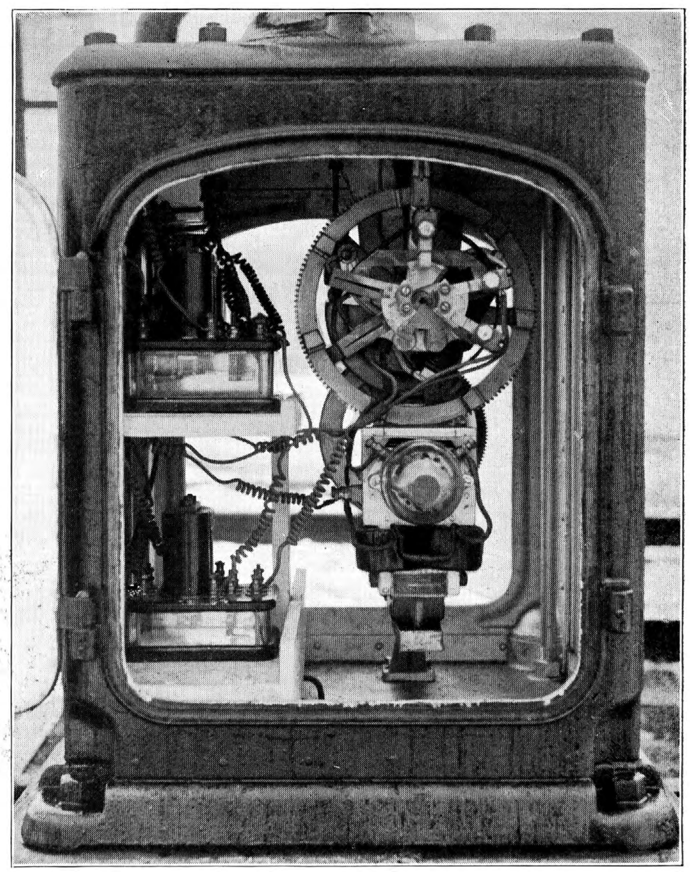

Fig. 16. View of Signal Mechanism.

driving mechanism and the semaphore, providing a means for the engagement and disengagement of these parts. When the slot coils are energized the pawl on the slot arm is brought into such a position as to engage with one of the projections on the main gear wheel, which revolves, thus moving the slot shaft and clearing the signal. When de-energized, and with the signal in the stop position, the slot armature rests upon the pole pieces, thus requiring no great amount of current to "pick up," as it is already in position. When the signal is clear, as shown in the figure, the conditions are reversed, the armature being in such a position as to drop away from the slot coils by gravity when the circuit is open. The slot coils are compound wound, the low resistance or clearing winding being in series with the motor and the high resistance or holding coils in shunt with it.

The circuit controller governs the movement of the signal when current is supplied through the motor and to the slot coils by making and breaking these circuits at the appointed instant. It is placed on one end of the shaft where it is most convenient for inspection, and consists of contact fingers made of hard German silver, which engage with contact sectors composed of non-corrosive metal. The motor contact is arranged for quick break to prevent arcing. There are ample contacts provided for such additional circuits as may be required in the future.

The buffer, or dashpot, is mounted on an eccentric attached directly to the main shaft, thus providing a positive means for the operation of the oil buffer cylinder. The eccentric strap and cylinder are cast in one piece so that a direct connection between the shaft and cylinder is obtained. The eccentric is so arranged as to have little or no movement during the initial part of the signal movement, the semaphore arm dropping about 30 degrees from the clear position before the buffer offers any appreciable resistance. A quick and positive drop away from the clear position is thus insured because of this low retardation.

The circuits through which the operation is performed are shown in the diagram in Fig. 17. By reference to this diagram and Fig. 16 a clear conception of the operation may be secured.

ing or slot magnets. Current will also flow in another circuit through the motor contact sector, the low-resistance winding of the slot magnet, and the armature and field coils of the motor. As the retaining magnet is energized the pawl is held in the path of the driving lug on the main gear, and as the motor revolves one of these lugs will be forced against the pawl, thereby turning the main shaft with the slot arm and coils, thus clearing the signal. When the signal arm has been

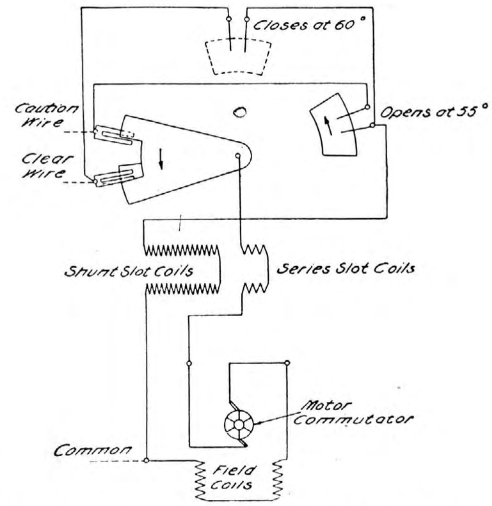

Fig. 17. Automatic Signal Mechanism Wiring Diagram.

carried to the proceed position the motor circuit is broken by means of the controller, the magnetic brake comes into action, and the motor immediately comes to rest.

As will be noted in the diagram, Fig. 17, this signal may be used in two or three positions. When used in three positions the caution position wire is connected to the upper spring and the normal position wire to the lower spring. Where a two-position signal is desired it is only necessary to connect the caution and clear springs together to accomplish the purpose.

In three-position signaling, when the operating conditions are such that the line relay opens before the track relay, the semaphore will be moved by gravity from the normal-speed position to that of caution.

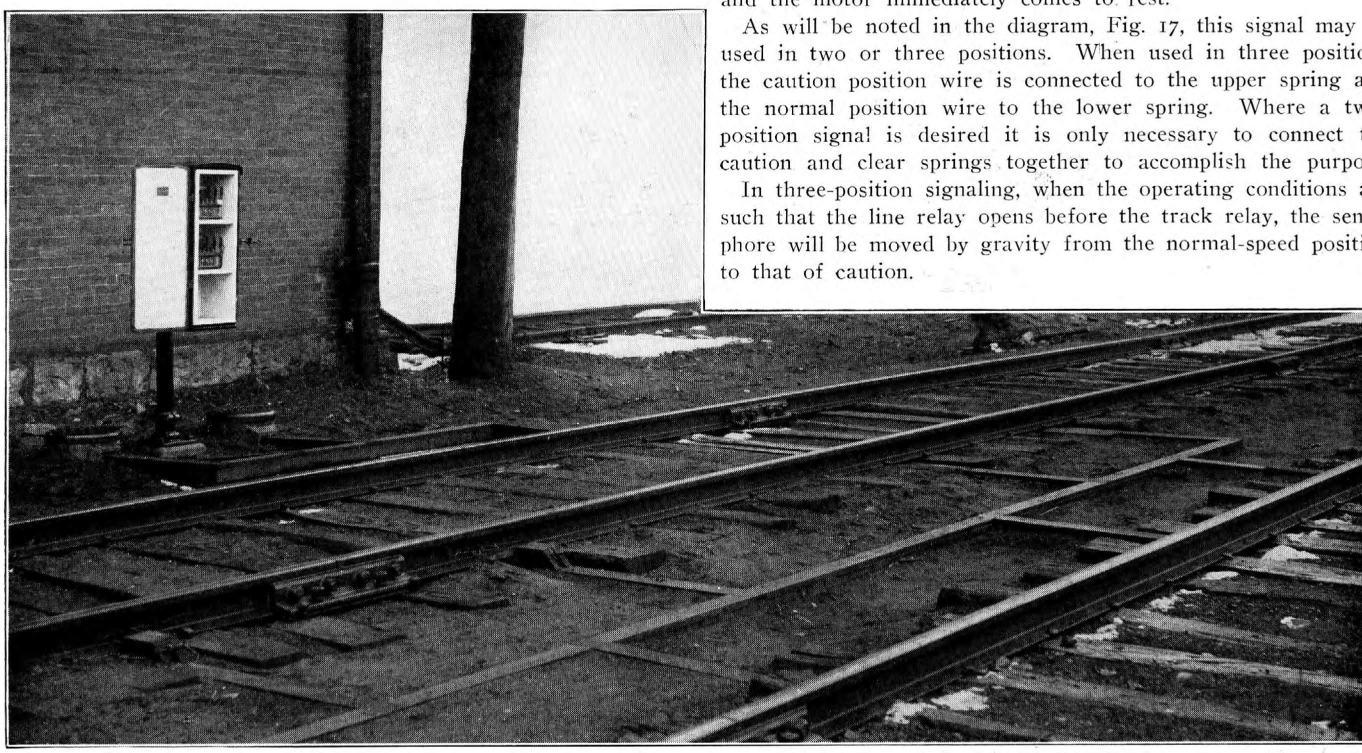

Fig. 18. Showing Trunking and Track Wiring at a Typical Cut Section.

It would be well to bear in mind that the reatining or slot mechanism and the electric contacts are fastened rigidly to the main shaft, that the semaphore arm is substantially connected thereto, and there is never any movement between these parts—that they all move together in operation; also that the main gear wheel with its driving lugs revolves freely about the shaft which carries the slot coils and contacts until it is engaged with the slot mechanism by the energizing of the magnet coils.

When the signal circuit is closed the current will flow through the locking sector and the high-resistance winding of the retain-

This has been arranged for by providing the main gear wheel with seven lugs, properly spaced, so that when the signal moves from the normal-speed position it slightly passes the caution position and completes the motor circuit through the caution spring, thus sending the starting current through the motor and the series coils of the magnet. This increases the strength of the magnet momentarily to such an extent that it is able to withstand the blow given by the moving slot arm, and at the same time the motor quickly moves the contact sector forward, breaking the motor circuit at the 45-degree position of the signal arm.

The progress diagram shown in Fig. 19 is of interest in that it shows the progress of the work for each month during the entire installation.

This form is used in making the monthly progress report to the chief engineer. The vertical column at the left shows the stations in their proper order; the second column, the miles of track; the third column, the miles of pole line or miles of road; the fourth column, the number of signals between the respective stations; and the other columns, the proportion of work completed from time to time under the different classifications, the latter being shown in horizontal lines at the head of the figure. Symbols or colors are used on this form to show the progress made during each month of the construction period.

A study of the report will show that foundation and concrete work, erecting and trunking, drilling, bonding, and line work were completed as nearly as possible before severe cold weather set in, and that the work was carried forward throughout the winter without intermission. It will be noted that 232 signals, 151.3 miles, were placed in service during the severe

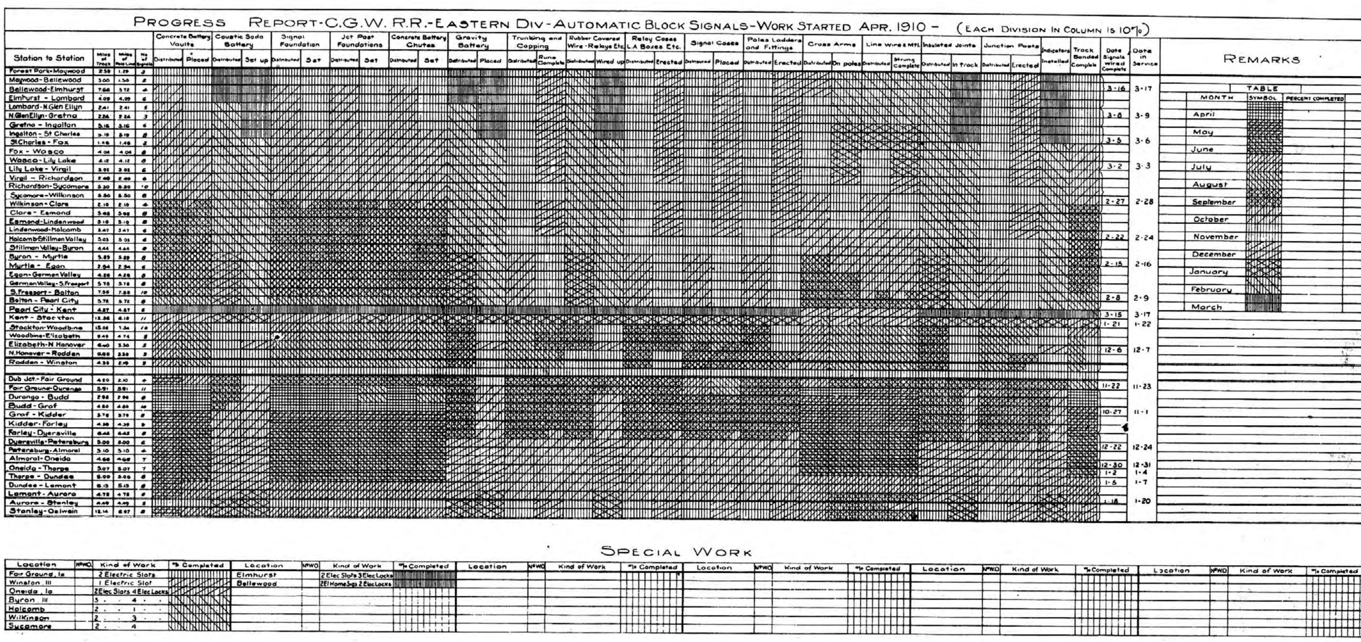

Fig. 19. Automatic Signal Progress Report.

part of the winter, 53 signals, covering 36.7 miles, being placed in service in January; 118 signals, or 74.5 miles, in February, and 61 signals, covering 40.1 miles, during 17 days in March, the work having been completed on March 17.

The rules governing the operation of trains on single track require that a train finding the signal in stop position shall send out a flag immediately, and after waiting five minutes shall proceed through the block under control prepared to stop short of any obstruction—expecting to find an opposing or preceding train, broken rail, open switch or other obstruction. This rule is modified somewhat so that trains having "meet" orders at a station passing track, may, after making a full stop, proceed within the limits of the passing track, under control, prepared to stop short of any obstruction in the block.

On double track, trains finding a signal in the stop position are required to make a full stop, and then proceed under control, expecting to find an open switch, broken rail or other obstruction.

During the time from April 1 to April 12, inclusive, 272,544 signal movements were made without failures of any kind having occurred. The operation of trains under this system of signaling has been very successful, and this installation with the numerous other improvements now completed, including splendid equipment and improved roadway, presents in the Chicago Great Western the best and safest in both passenger and freight service.

SYMBOLS AND NOMENCLATURE FOR WRITTEN CIRCUITS.

BY F. L. DODGSON AND S. N. WIGHT.*

The time-honored method of drawing up circuit plans for signal installations of various kinds is to start with a track plan, more or less to scale, and on it show the symbols for the various pieces of apparatus. These are, in a general way, placed in their proper relative positions. This being done, lines representing wires are drawn to connect those points that should be electrically connected.

While this method has been of great value in the past and remains so at present for typical circuit plans and plans for smaller installations, it has become apparent that it is too cumbersome and entirely inadequate for the large installations of to-day. The plans run into such sizes that they become prohibitive. The wires, as shown on the plan, have to take such indirect courses that they are difficult to follow.

The fact is that the engineer, in designing a circuit of this kind, starts with some simple sketches, probably using symbols of his own invention. He draws straight lines representing wires and introduces into them the necessary circuit controllers. After he has checked his circuit over carefully and assured himself that he is right, he laboriously converts it into the form described above. When the man who is to install or maintain the installation receives the plan he must again reduce it to simple sketches. The question naturally arises—why not systematize these simple sketches so that the engineer in the office and the man in the field will understand each other and obviate the elaborate form heretofore used merely as a carrier?

Simplified circuits made up along this line, we have termed "Written Circuits." A set of plans in accordance with this method involves:

A location plan, showing the location of all apparatus and giving a name to it;

Typical plans of special circuits, showing what it is proposed to accomplish in route locking, etc., drawn up in the usual form, or in "written" form;

Typical plans of signals, circuits, switch circuits, etc.;

Special circuits, made up on "written" form.

These special circuits are separated so that circuits not connected together are kept entirely disconnected from each other, and even, in many cases, on separate sheets.

To accomplish this successfully it is necessary to use a

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