Burlington

For Light-Traffic

On 238 miles which ordinarily handle 9 to 15 trains daily, first cost of centralized traffic control project was reduced by installing power switch and control signals at only one end of each siding, with a spring switch at the other end, rather than following conventional practice of a power switch at both ends

When train is to stop and enter by hand-throw at a spring switch end of a siding, this "approach" signal displays red over two lunar white lights at 45 deg.

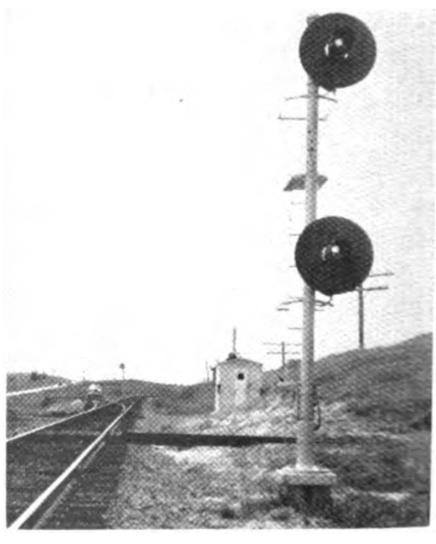
A SIMPLIFIED arrangement of centralized traffic control, designed to reduce first costs in proportion to requirements of comparatively light traffic, has been developed and installed on the Chicago, Burlington & Quincy on 238 miles of single-track main line between Ravenna, Neb., and Alliance, on the route between Chicago and Billings, Mont., via Omaha and Lincoln.

No Signaling Before

Previously no signaling was in service on this Ravenna-Alliance territory, the siding switches being hand-thrown, and the train movements authorized by timetable and train orders. Some form of track-circuit-controlled signaling was desired. Experience with conventional automatic block signaling on the Burlington showed that this form of signaling gives protection but it necessitates the continued use of timetables and train orders to authorize train movements. On the other hand, extensive experience on this road shows that the practice of authorizing train movements by signal indication in centralized traffic control territories is a means of saving train time, increasing track capacity, and improving the safety of train operations. Thus, an objective of cooperative studies on the Burlington was to adopt a form of centralized traffic control that was simplified to meet the needs of comparatively light traffic, and by this simplification, to reduce the equipment involved, so that the cost would be not much more than conventional automatic block, thereby being within the expenditure authorized for signaling on this territory.

The major reduction in cost was accomplished by installing a power switch machine and C.T.C. controlled signals at one end of a siding, and a spring switch and two controlled signals at the other end. The power switch and the signals to enter or depart from the spring switch end, are all controlled by one field code station at the power switch location. Such an installation reduces the cost at sidings about 35 per cent, compared with a power switch and complete signaling at both ends of a siding. A further part of this story was the cooperation of the operating and engineering officers with the signal department in determining the end of each siding at which the power switch machine was to be installed to fit in with train operations and grades. In general, the layouts were determined on the basis that loaded trains in the direction of the preponderance of traffic are to hold the main, and lose no time waiting for meets. This will be explained later, after a statement of the number of trains and character of traffic.

The scheduled traffic on this Ravenna-Alliance territory includes four passenger trains and four through freight trains, with a local



Home signal at power switch

Simplifies C. T. C. Single Track

freight train three days each week. An extra train, mostly loaded oil cars, is operated eastbound nearly every day. During autumn months, extra trains of loaded stock cars are operated eastbound, as many as four or more such trains being operated on some days. The four time freights are operated by diesel locomotives, and the other trains by steam locomotives.

The train usually enters the sidings at power switches as is shown here

Westward Grade

Except for a few breaks, the grade ascends gradually westward from an elevation of 2,000 ft. at Ravenna, to 2,972 ft. at Seneca, and to 4,000 ft. at Alliance. The maximum ascending grade westbound is 0.6 per cent. Eastward the grade is descending gradually, except for about 4 miles of 0.5 per cent ascending grade eastward just east of Halsey. This is the ruling grade eastbound, but is so light that it does not limit the tonnage. The length of sidings limits the number of cars in a train and this indirectly limits tonnage rather than being limited by grades. This applies for both eastbound and westbound trains. The maximum permissible speed is 65 m.p.h. for passenger trains and 50 m.p.h. for freight trains. The locomotives can handle trains consistently at these speeds in either direction.

The preponderance of loaded cars move eastward, including cars of agricultural products, live stock, oil and lumber. Westward traffic includes merchandise and manufactured products, and empty oil and stock cars. Eastbound trains, most of which are loaded cars, are given preference, this being an important phase of operation which entered into consideration of the layout of the C.T.C.

Nine Sidings Discontinued

Previous experience with C.T.C. on other parts of the Burlington showed that, with C.T.C., fewer sidings were needed. Because much of the cost for C.T.C. is involved at sidings, a program of revisions of sidings was planned and completed before installing the new signal system. Sidings at Litchfield, Mason, Berwyn, Dunning, Natick, Kelso and Lakeside were left in place, some of which were shortened and used as storage or business tracks, not to be equipped with C.T.C. control. Sidings at Wier and Duluth were removed. A new 130-car siding was constructed at Gavin which is midway between Litchfield and Mason at which sidings were discontinued. Thus, the net result is that there are now a total of 22 sidings equipped with C.T.C. control, as compared with 31 sidings previously used for meeting and passing trains.

Sidings not already long enough were lengthened; capacity varies from 128 to 158 cars. As a total of all siding changes and additions, 40,086 ft. of track was removed and 37,048 ft. installed. Short spurs, house tracks and stock pen tracks are located at all the towns. The hand-throw stands at these main-track switches were left in service, and electric locks were added as part of the C.T.C. system, a total of 44 switches being so equipped.

Power switch machines and complete arrangement of C.T.C. controlled signals were installed at both

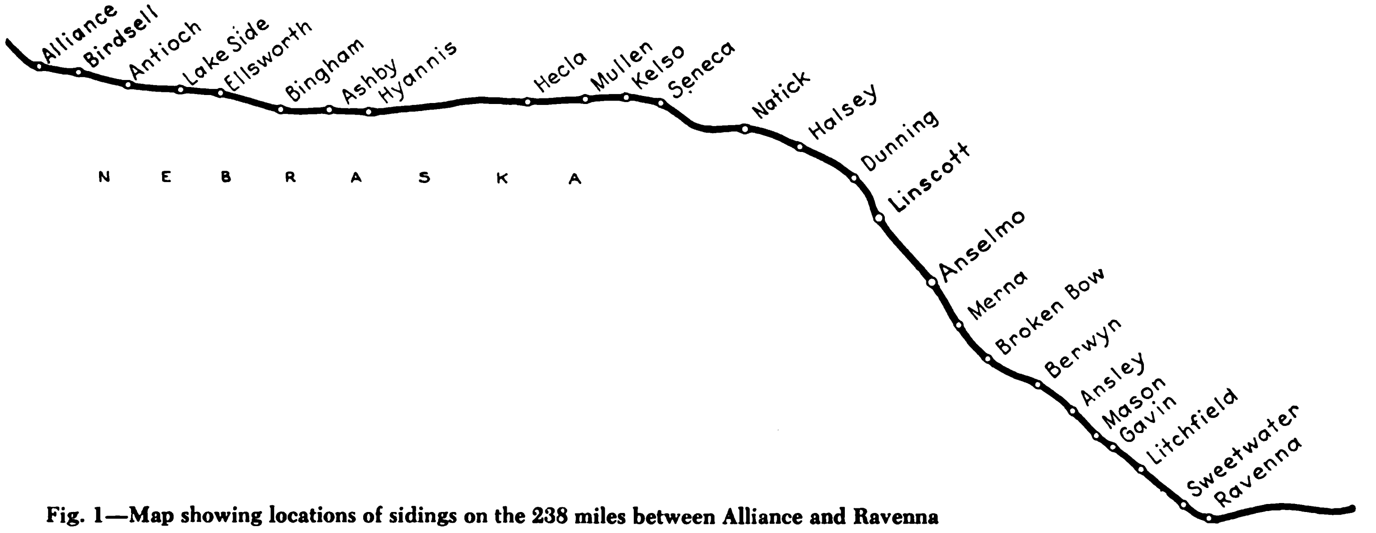
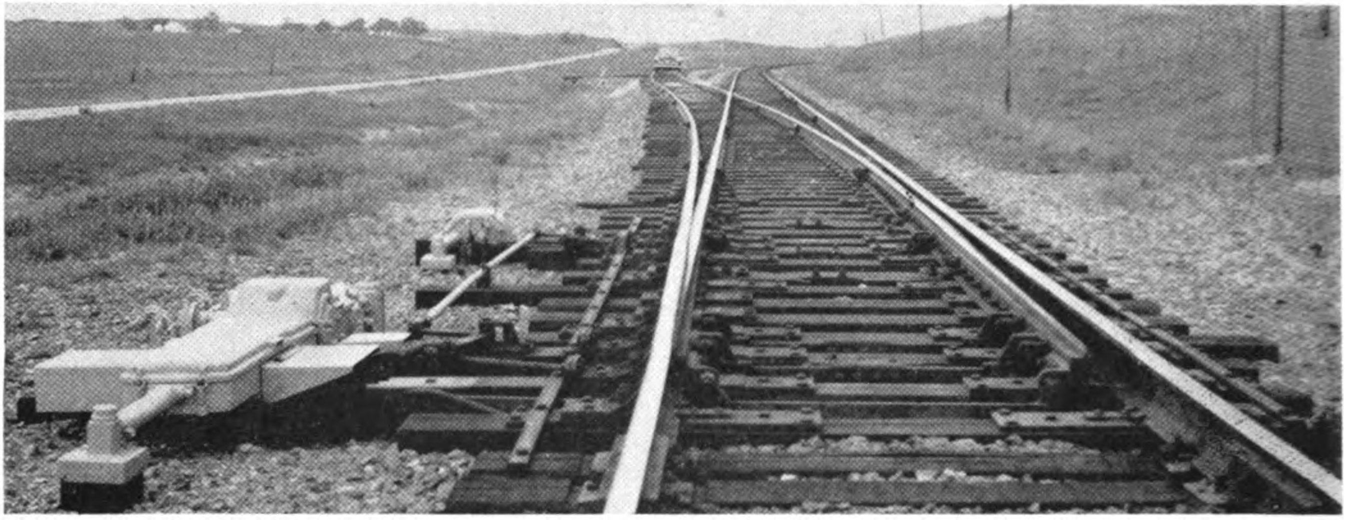


Fig. 1—Map showing locations of sidings on the 238 miles between Alliance and Ravenna



A spring switch with facing-point lock is located at the leaving end of each siding

ends of the terminals at Ravenna and Alliance, as well as at Seneca, which is the mid-point at which freight trains stop to change crews. Power switches were installed at both ends of Broken Bow, so that trains in either direction may enter the siding without stopping. This is also a heavy switching district, and, by such an arrangement, switching is permitted to continue without delay to main line movements. At places between Ravenna and Alliance, there are 18 sidings, at which there is a power switch and complete C.T.C. controlled signaling at one end, with a spring switch at the other end. At 15 of these 18 layouts, the power switch is at the east end, and at 3 sidings the power switch is at the west end.

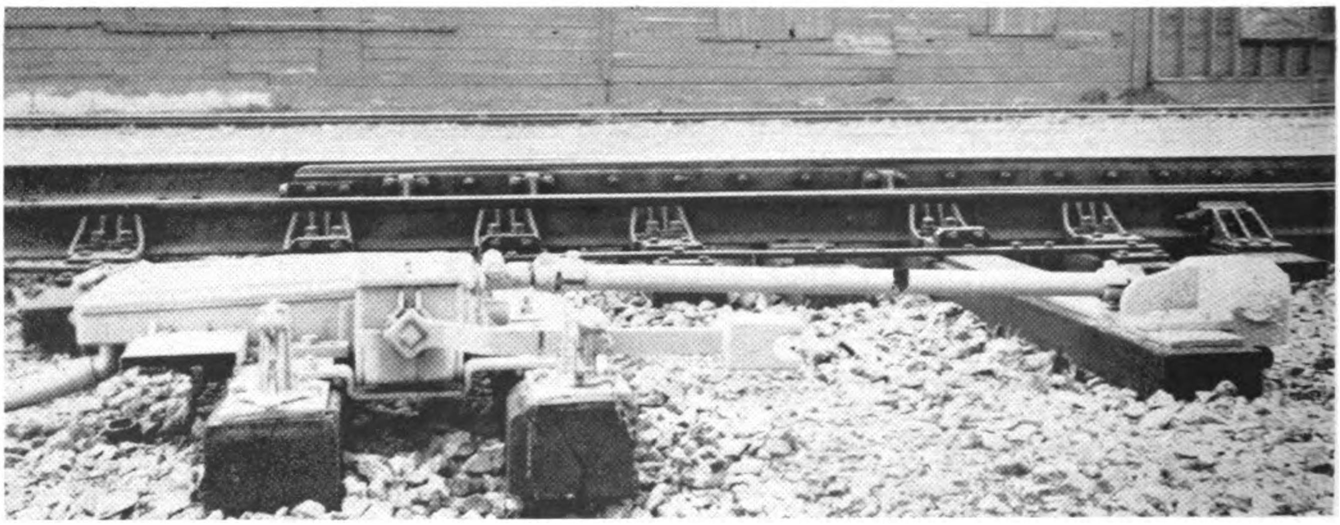
In general, the power switch is at the east end rather than the west, so that the dispatcher can reverse such a switch to head a westbound train in to wait on the siding for a meet with an eastbound train which holds the main and passes without stopping. This procedure is planned on the basis of preponderance of tonnage eastbound with one exception, urgency to expedite eastbound trains in preference to westbound.

Contrary to general practice, the power switch is at the west end at Norway, the first siding east of the intermediate terminal at Seneca; and at Antioch and Ellsworth the first two sidings east of the terminal at Alliance. Power switches at the west end of these sidings give the dispatcher a better chance to get eastbound trains out of the respective terminals on short time. This helps to move trains promptly when they are ready to go, and thereby aids in keeping the yard clear for arriving trains. At Alliance the C.T.C. project includes power switches and signals at the east end yard entrance switch, and at the west end of the yard, two crossovers and signals at a junction of two lines; one west to Billings and the other south to Denver.

At each of the power switches at the end of sidings, there is a standard arrangement of signals to direct trains to: (1) continue on main track; (2) enter the siding; (3) leave the siding or; (4) stop. At the spring switch end, there is a dwarf signal to direct a train on the siding to depart. This move is made by trailing out through the spring switch, and therefore, no stop is necessary to permit trainmen to handle the switch.

Signaling Arrangement

As a general rule, trains enter a siding at the power switch end and depart at the spring switch end as discussed above. However, signaling is arranged to direct a train to enter a siding at the spring switch end if the dispatcher decides that train time can be thus saved. The signaling at a spring switch end of a siding is shown in Fig. 2. When the dispatcher decides that an eastbound train is to be directed to enter the siding at Anselmo, he sends out a control code that causes eastward



A spring switch with facing-point lock is located at the leaving end of each siding signal S196.2 to display an aspect of "red over two lunar lights" which are 3 ft. apart in a line at an angle of 45 degrees. Also, the next signal in approach S202.8 displays a yellow aspect. These aspects direct an eastbound train to stop just short of the switch at the west end of Anselmo. Then the head brakeman reverses the switch by the hand-throw stand so that the train then enters the siding. After it is in the clear, the brakeman places the switch normal.

The overall station-to-station block is from one power switch layout to the next, insofar as opposing train moves are concerned. Intermediate signals permit two or more trains of the same direction to follow in the same station-to-station block. Referring to Fig. 2, signal S196.2 was located far enough west to make the block between this signal and eastward signal 104R, equal to 10,571 ft., which is slightly longer than the standard length for an automatic block in three-aspect territory, i.e., equal to train stopping distance plus a considerable margin. Westward intermediate signal N202.9 is about 4.2 miles from westward station entering signal 100L at the east end of Linscott. This leaves 6.6 miles for the intermediate block between signal N196.1 and N202.9. As a general rule intermediate locations are doubles, i.e., with a signal for each direction.

A westbound train entering the junction area west of Alliance depot

The C.T.C. Control Machine

The C.T.C. control machine, in the dispatcher's office, has one center panel 5 ft. 10 in. long, and two wing sections each 6 ft. 2 in. long, thus totaling 18 ft. 2 in. in length. This machine has 27 levers for control of power switches, 18 levers corresponding with spring switches, 50 levers for control of signals, and 17 levers for control of electric locks at hand-throw switches. The track diagram includes lamps which indicate the location and progress of trains on main track.

Above the track diagram is a row of toggle levers, one above the symbol for each siding. When a train enters a siding, the dispatcher throws the corresponding toggle to the east for an eastbound train, or to the west for a westbound train. Throwing the toggle either way causes a lamp to be lighted in the line representing that siding. This is a reminder to the dispatcher of the locations of trains when on sidings.

When the dispatcher sends out a control to clear a signal for a station-to-station train movement, a lamp is lighted above the corresponding section of track diagram to indicate the direction of traffic established. Below each code-starting button is a yellow indication lamp which is lighted when electric locking is in effect so that operating the button would be of no effect. This same light also indicates when commercial a.c. power is off. Time locking is used, based on 30 seconds for each 1,000 ft. of track involved. An automatic pen-type recorder, with 84 pens, located in the top of the desk, makes a record of all train movements on the 238 miles.

Benefits of the C.T.C.

The centralized traffic control is saving train time. Passenger trains No. 42 and No. 43 are scheduled to meet at Gavin about 2:24 a.m., and eastbound time freight No. 80 is usually in that vicinity. Westbound time freight No. 79 is due out of Ravenna at 12:30 a.m. Previously, when authorizing train movements by time-table and train orders, numerous delays were encountered by these four trains in the area between Ravenna and Seneca. In numerous instances, the best solution was to hold westbound freight No. 79 at Ravenna, which meant that this train was often an hour or more late. According to studies made by the division superintendent, the C.T.C. normally saves about 1 hr. for No. 79 and 45 minutes for No. 80, as well as 45 minutes for eastward passenger train No. 44, and 5 to 10 minutes for westbound passenger train No. 43. Also, extra trains save more than an hour.

The chief dispatcher gives a concise explanation of how C.T.C. saves time. Previously, a yardmaster would give the dispatcher a rough estimate on the time a train would be ready to depart from Ravenna, Alliance or Seneca. Based on this estimate, the dispatcher would put out orders to set up meets, an hour or more ahead of time. In the meantime, some circumstance, such as a bad-order car, might postpone departure of the train for 30 minutes or more. When the train actually de-

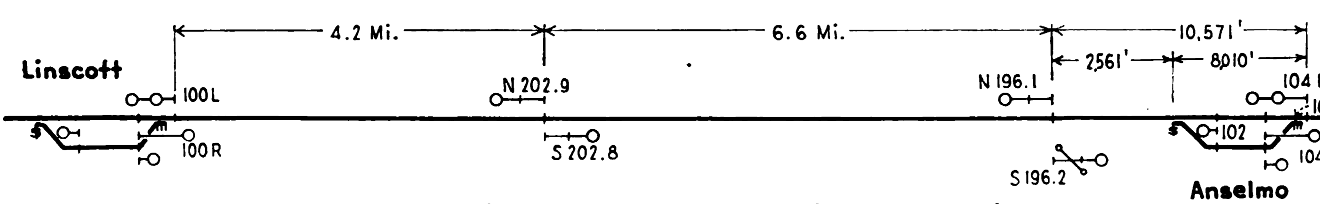
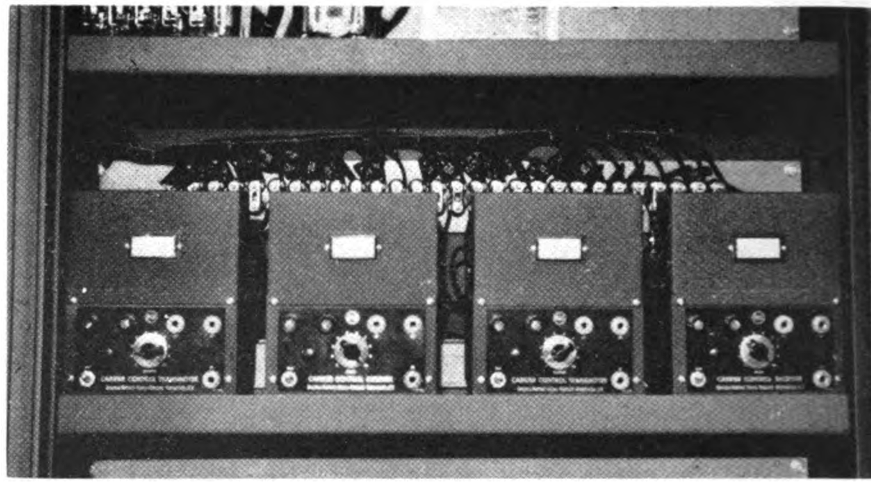


Fig. 2—Typical signaling arrangement of centralized traffic control

parted, not enough time was available for the dispatcher to issue new orders to change meets. The result was that one or more trains might lose 30 minutes to 1 hour or more. In some instances, the dispatcher may have issued orders for two trains to meet at a certain siding, but one train encountered delay. A result was that all trains involved were delayed because there was no way for the dispatcher to change orders in time to make the best of the bad situation.

Now, with the C.T.C, the illuminated track diagram shows the dispatcher the location of and progress being made by trains. Therefore, he can control signals to direct trains to keep moving as required to make meets on close time. For example, on a recent day, with the C.T.C., the dispatcher figured that two trains would meet at Merna. However, the eastbound train had a hotbox and lost time. Seeing the situation on his illuminated diagram, the dispatcher controlled the signals to keep the westbound train moving beyond Merna to Linscott, thus saving at least one hour for that train. Situations such as this occur repeatedly, and all add up to hours of train time saved.



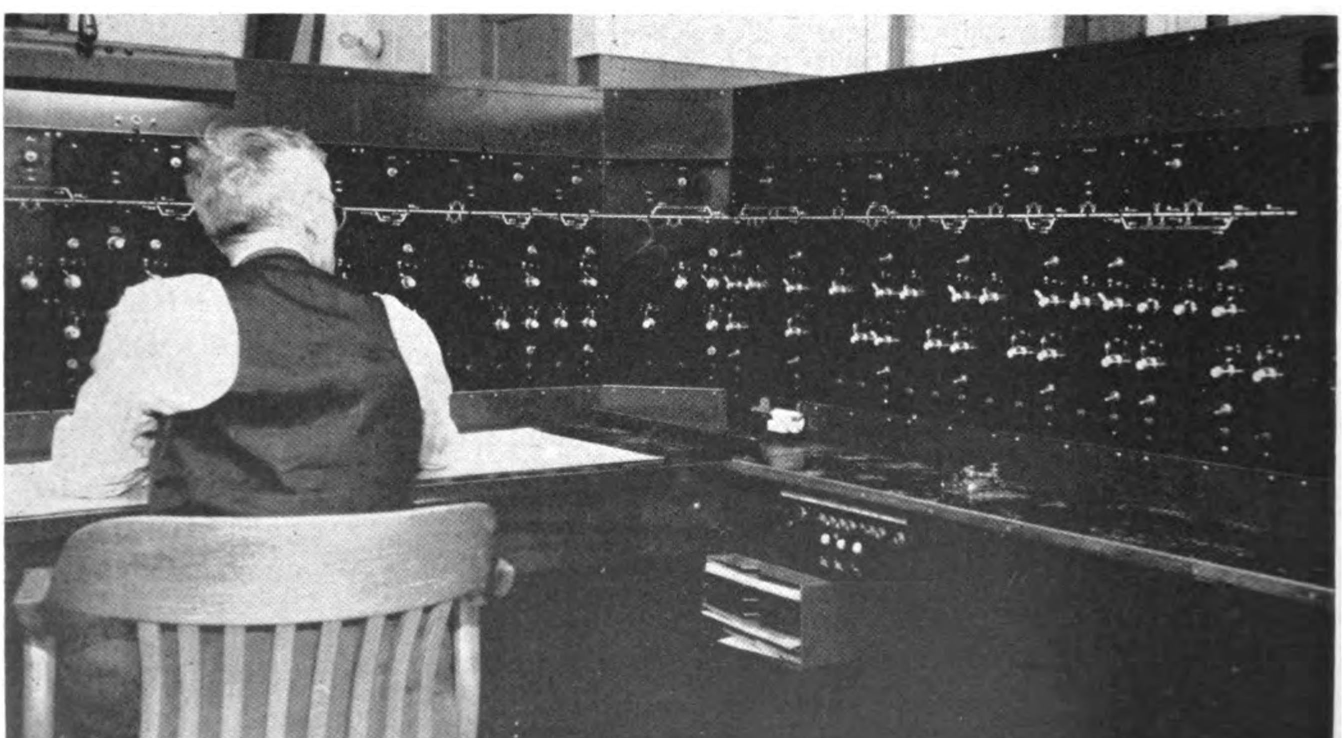
Coded carrier equipment in office at Alliance

Coded Track Circuits With No Local Line Control Circuits

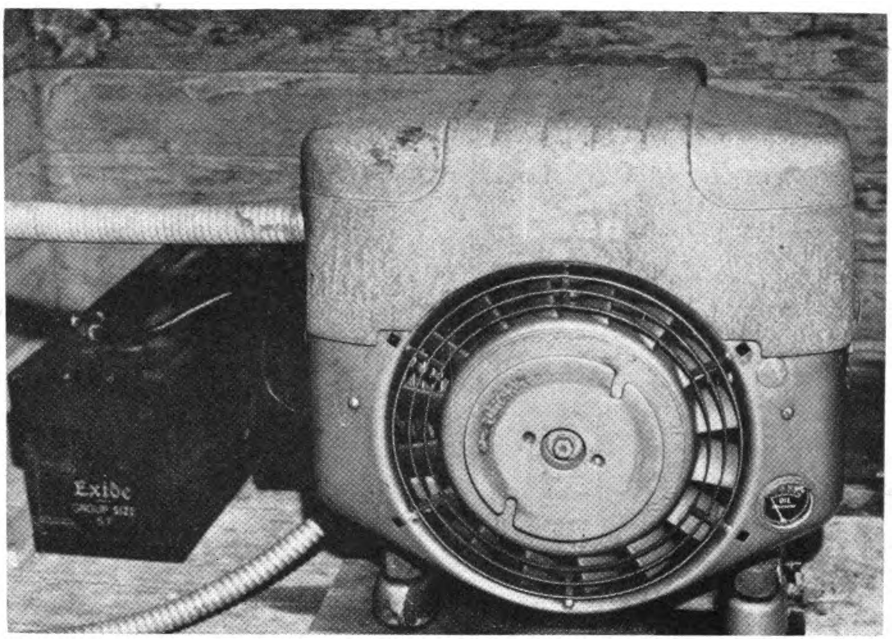
An interesting feature of the project is the use of normally-deenergized reversible coded track circuits in the station-to-station blocks, basic features of this system were explained on page 204 of the March 1946 issue. These are double-end track circuits, i.e., they have not only a relay, but also a battery at both ends. Normally, the track circuits are dormant with no battery feeding. When the dispatcher sends out a coded control to establish a line up from siding to siding, a preliminary operation is to feed the track circuits throughout the station-to-station block in the direction opposite to the train movement. For example, (See Fig. 2) for a westbound move, coded track circuit energy feeds eastward from signal 100 at Linscott to signal 104 at Anselmo. If signal 104L is to be cleared for a move on main track to Linscott, the code received at signal 104 is at the rate of 180 per minute. If signal 196.1 is at Stop because of a preceding westward train in its block, signal 104L can be cleared to the approach aspect by receiving 75 code in the track.

If switch 105 is reversed and signal 104L is to be cleared to red-over-yellow for a train to enter the siding, the track circuits from Linscott to eastward signal 104R do not enter into the control.

If a westbound train on the Anselmo siding is to be directed to depart, the leave-siding dwarf 102, is controlled in part by track circuit code, from signal 100 at Linscott, feeding east to signal 104 at the east end of Anselmo, then reverse code feeds back west on the main track to the west end of the siding to clear the dwarf. If the take siding aspect



This machine controls C.T.C. on the 238 miles between Alliance and Ravenna



At Mullins the 220-volt a.c. power is supplied by this 3,000-watt generator, driven by a gasoline engine with an automatic control

of red over two lunar whites is to be displayed on eastward signal 196.2, as explained previously, the track circuit code at the 120 rate, feeds west from signal 104 to signal 196.2, and 120 code feeds on west to Linscott. Thus, one field station serves both ends of a siding, and the signals are controlled locally without the need for local line circuits, and the only line wires required on this project are the two line wires from Ravenna to Alliance for the C.T.C. code line circuits, except that line wires were used around sections that had conventional normally-energized d.c. track circuits at highway crossing protection installations.

Commercial a.c. power at 220-volts is available at all of the power switch locations except the one at the east end of Mullen. At this location, there is an Onan gasoline-engine driven a.c. generator rated at 3,000 watts output at 220-volts a.c. This machine is started automatically each time a control is received to clear a signal at this field station. The machine then runs until the storage batteries are charged up to a certain voltage, then is shut off automatically.

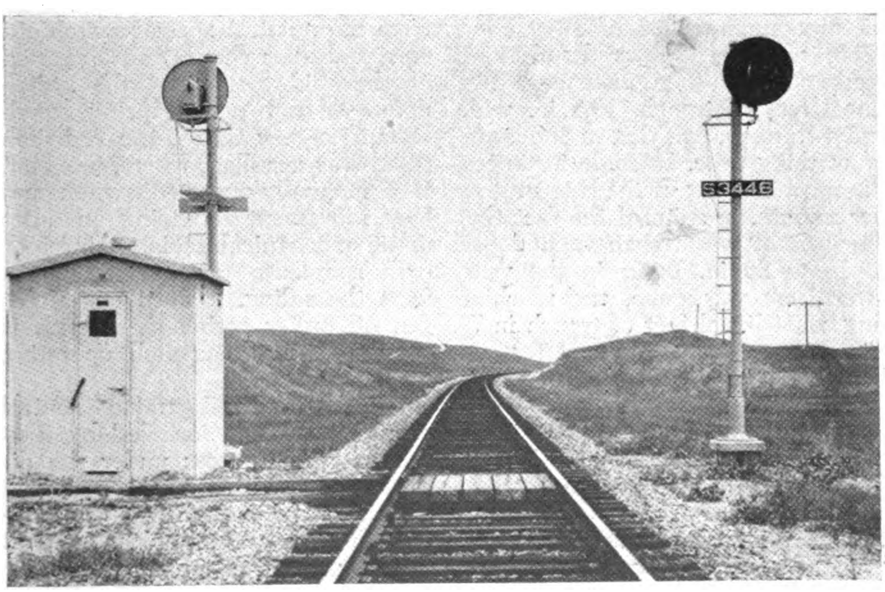
At this location and at all the other power switch locations, there is a set of 12 cells of 80-a.h. lead storage battery which operates the switch motor and feeds the line code equipment. A battery of five cells of the same type feeds local relays and acts as a standby for signal lamps, which are normally on a.c. At these locations, where a.c. is available, each track circuit is fed by one storage cell of the type mentioned above.

At locations between power sidings, no a.c. power is available, and in these sections, primary battery is used. At each intermediate signal, there is a set of 16 cells of 1,000-a.h. primary battery which feeds the signal operating coil and signal lamp which is rated at 5 watts 10 volts. For reasons explained previously, the signal coil and lamp are normally deenergized. At all intermediate locations where no a.c. is available, each track circuit is fed at both ends by a set of 1,000-a.h. primary battery. Each of the long coded track circuits, up to 11,000 ft., is fed by three cells in series. These circuits also are normally deenergized. At electric lock locations, at hand-throw switches, the short release track section is fed by one cell of 1,000-a.h. primary battery, and the local relay and lock circuit by a set of 16 cells of 75-a.h. primary battery.

Carrier on Code Line

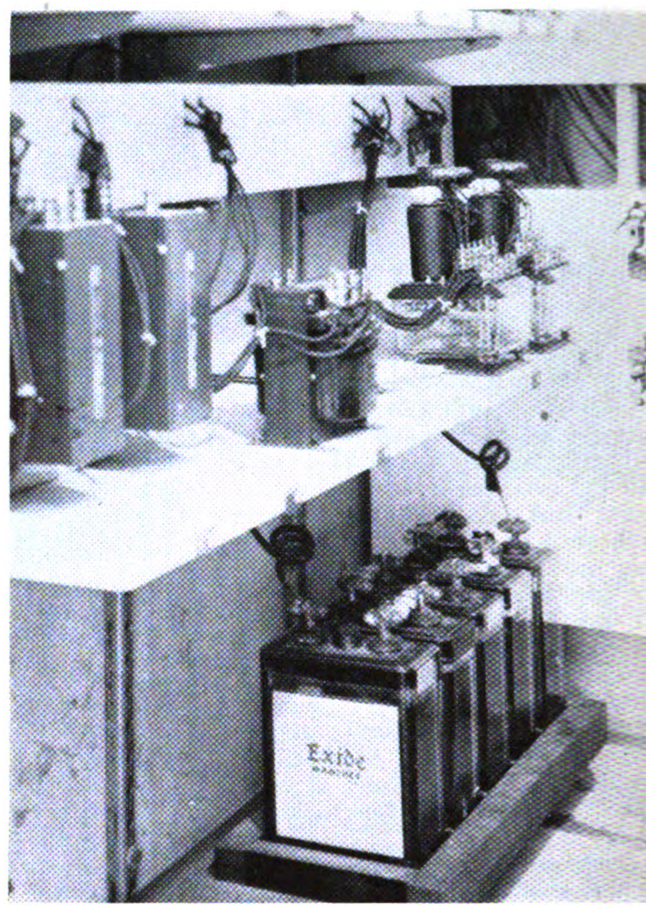
The C.T.C. code line circuit from Alliance to Ravenna, is on two No. 6 Copperweld line wires, 30 per cent conductivity, with 2/64 in. weatherproof covering of Neoprene. These wires are on pins 3 and 4, looking west, on a 10-pin arm, which is the only arm on this pole line. These wires are transposed for 3 kc separation Ravenna to Seneca, and 30 kc separation Seneca to Alliance to make them available for voice frequency operation and to protect against interference in the carrier operated section.

The outgoing control codes and incoming indication codes are handled by G. R. S. Co. Type K, Class M, coded system. Conventional d.c. codes are used for the 107.8 miles between the control office and Seneca. The code line in this section also handles coded carrier at 17.0 kcps outgoing and 13 kcps incoming for the controls and indications for the Seneca to Ravenna territory,



Concrete houses for relays and batteries are used not only at the power switch layouts but also at intermediate signal locations as is shown in this picture

At each intermediate signal there is a set of 16 cells of 1000-a.h. primary cells which feeds coil and lamps



At each power switch there is a set of 12 cells of 80-a.h. lead storage to feed the motor

with carrier repeaters at Hyannis.

At the control office the line code circuit is fed at 145 volts from a set of 65 cells of lead type storage battery. The C.T.C. code equipment at the office is operated from 200-a.h. cells of lead battery. A set of 12 cells feeds the east end of the control machine and two sets of 12 cells in multiple feed the west half of the machine and act as standby for the machine lamps, and feed a reed alternator to supply 110-volt a.c. for the motor on the train graph, if commercial a.c. fails.

Concrete Houses

At each power switch, each spring switch and each intermediate signal location, there is a Massey concrete house for the relays, code equipment and batteries. These houses were wired complete with relays in place, in the signal shop at Aurora, Ill. The relays were strapped down during shipment. Sheet-metal cases are used for relays at intermediate locations and at electric locks. The wire for the battery circuit to switch machines is No. 6 ordinarily, but if the run is more than 500 ft., No. 4 wire is used. The wires to track connections is No. 8 for the short track circuits at switches, and No. 6 for connections for all coded track circuit. The rail throughout the 238 miles is bonded with plug-type railhead bonds, furnished by several different manufacturers including the Ohio Brass, American Steel & Wire Company, and Hanlon-Wilson Company.

Trench Digging Machine

On this project a large percentage of the trenches for buried cable were dug with a Barber-Greene self-propelled power trench digging machine, similar to that shown in a picture on page 803 of December, 1950 issue that shows the digging equipment. In one instance, 3,244 lineal feet of trench, 10.5 in. wide and 4 ft. deep, was dug in 33½ hours of working time. In some instances, the machine dug at the rate of 4 ft. per minute, in spite of the fact that the ground was frozen to a depth of 18 to 20 in. Later in the year, after frost was gone, the machine dug 9,154 lineal feet of trench in 79 hours, averaging 115 lineal feet an hour.

Switch Layouts Well Built

New switch layouts with No. 15 frogs and 30-ft. points were installed at both ends of all the C.T.C. controlled sidings. Racor adjustable rail braces and three Racor vertical pin type rods were installed at these switches, as shown in the pictures herewith. As one of the rods, a G.R.S. roller bearing was installed in each of these switches. The power switch machines are the GRS model 5D with dual control, and with 24-volt d.c. motors. The switch points are 30 ft. long, and, in order to insure that the entire length moves over properly, a helper connection, with cranks and pipe connections, extends from the switch machine to a second operating rod 15 ft. 6 in. from the point. A special switch circuit controller checks the operation of the mid section of the switch point. At each of the spring switch layouts, a new GRS Type A switch stand was installed, which, in effect, is a manually-operated switch and lock movement including an automatic mechanical facing-point lock with a release for trailing moves from the siding. A Pettibone-Mulliken oil buffer spring mechanism is connected in the switch operating rod.

This centralized traffic control was planned and installed by Burlington signal forces under the direction of A. L. Essman, chief signal engineer. The major items of equipment were furnished by the General Railway Signal Company.