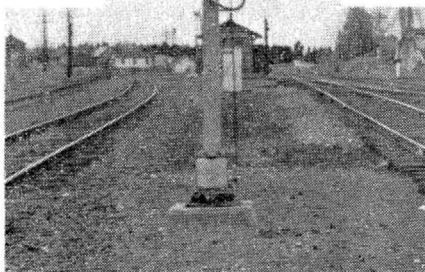


C.T.C. Speeds On the

Ore Traffic D.M. & I.R.

Project including five junctions, as well as 5 miles of double and 6.5 miles of single track, saves many stops for heavy freight trains



Signal 44L at Iron Junction

To SPEED up traffic, provide greater flexibility of operations, and avoid stopping heavy ore trains, the Duluth, Missabe & Iron Range has installed centralized traffic control on 5 miles of double and 6.5 miles of single track, which includes five junctions at Keenan, Iron Junction, Wolf, Spruce and Sparta, all of which are in Minnesota.

The D.M. & I.R. is one of the two railroads which haul ore from the Mesabi and Vermillion iron ranges in Northeastern Minnesota, to ports at Duluth and Two Harbors on Lake

Superior. From these ports, the ore is shipped in lake boats to various points in the vicinity of steel mills at many ports, such as Chicago, on the Great Lakes. The rail haul from the numerous mines to Duluth and to Two Harbors varies from about 70 miles to as much as 120 miles. In 1943, a total of 84 million tons of ore was hauled from this territory, of which the D.M. & I.R. handled 41,000,000 tons. For 1944, the War Production Board has set a tentative

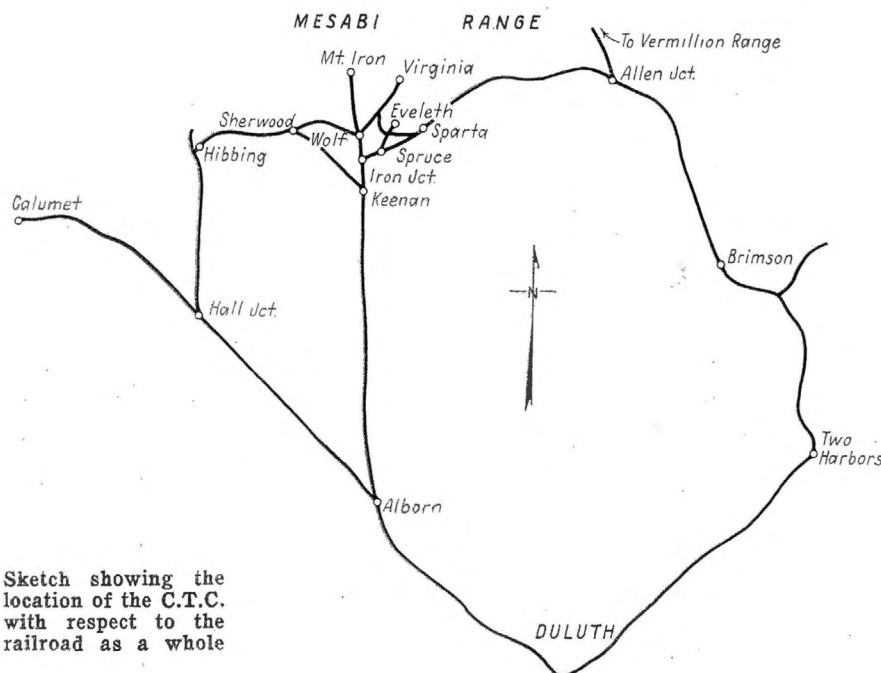
goal of a total of approximately 90 million tons to be hauled from this territory.

Heavy Trains

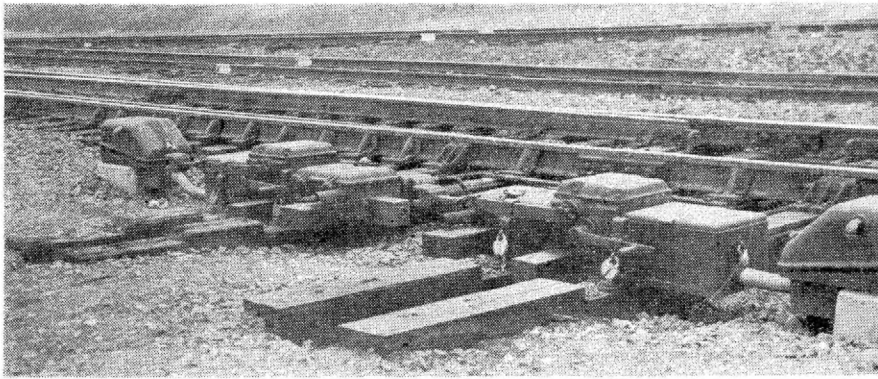
The ore is handled in specially constructed hopper-bottom cars. One type of car, weighing 17 tons empty, will hold 47 gross tons of ore, and a second type, weighing 22.5 tons empty, will hold 67 gross tons of ore. The trains are handled by Mallet-type locomotives which have a tractive effort of 140,000 lb. The lengths of the trains varies from 125 to 180 cars. A train of 180 loaded cars makes a total of about 9,000 gross tons of ore per train. With trains made up of this many cars, it is highly essential that they be kept moving from the time they leave the yards near the mines until they arrive at the yards near Duluth or Two Harbors. Likewise, from the standpoint of tonnage and grades, it is just as essential to minimize the number of stops for trains of empty cars being moved from the docks to the yards near the mines. If stopped where part of the train may be over a little rise or in a sag, the draft gear may be damaged when starting. Furthermore, the time lost in accelerating one of these heavy trains is important, not only with reference to the train itself, but also to other trains being blocked out or delayed on account of the first train stopping.

Routing of Trains

A general practice followed in the years previous to the war was to use the single-track Shaw cut-off exclusively for southbound loaded trains between Sherwood and Keenan, from which point these trains moved on south over the double-track to Duluth. On the other hand, the empty-car trains en route to Sherwood were routed over the double-track north



Sketch showing the location of the C.T.C. with respect to the railroad as a whole



The switch machines are the electric type with dual-control

from Keenan through Wolf and then over the single-track line to Sherwood.

On account of Duluth being farther west, the lake boats save about six hours for each round trip by loading at Two Harbors rather than at Duluth, and this means that a boat can make more trips in a shipping season. Partially for this reason, and partially for mixing purposes, much more ore is being moved to Two Harbors than previously. A result is that, on the D.M. & I.R., more trains are being

movements are made on the C.T.C. territory on an average day, and of this total, about 42 movements are made during the first 8-hour trick, and about 25 during each of the other two tricks.

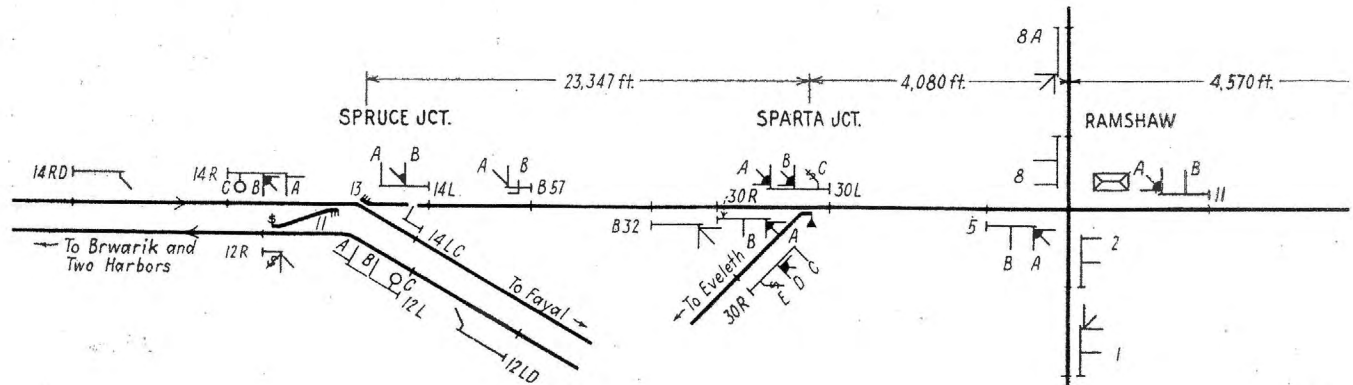
Stops at Hand-Throw Switches

Prior to the installation of centralized traffic control, there was a mechanical interlocking at Keenan, which included a crossover between the two main tracks and a junction

line. When an eastbound train arrived on this single-track line, it was stopped while a trainman swung the gate which caused signals on the double track main line to be set at the Stop aspect. Then the trainman reversed the junction switch and the west switch of the crossover. The east switch was, and still is, equipped with a spring and buffer mechanism so that eastbound trains trail through. After the train had passed, the trainman placed the switches normal. When operating a westward train from the westbound main-track to the single-track, the junction switch and the gate were handled by the trainman.

At Iron Junction and at Wolf, no signals or interlockings were in service, the trains on certain routes being required to stop for trainmen to throw the switches.

The elimination of numerous stops for heavy trains at Wolf, Iron Junction and Sparta, the desire to further the interests of safety in the handling of trains at these three points and increased track capacity between Iron Junction and Sparta (the only single-track on the entire route between Iron



routed over the 5.6 miles of single-track between Iron Junction and Sparta Junction; and also a certain number of loaded trains are being routed from Sherwood eastward via Wolf, Iron Junction and Sparta to Two Harbors.

On double-track on the D.M. & I.R., trains are operated left-hand running.

Volume of Traffic Varies

In the territory equipped with centralized traffic control, one passenger train is operated each direction daily. Also a mixed train each way daily starts at Iron Junction, runs over the Biwabik branch to Spruce and then over the line to Eveleth.

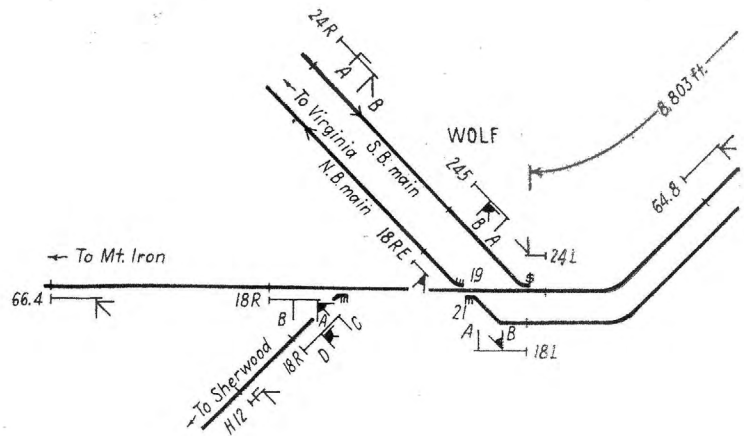
A local freight train is operated each way daily on the main-line via Keenan, Iron Junction, and Wolf. Approximately 90 to 92 train move-

switch leading to the single-track Shaw cut-off to Sherwood.

At Sparta, the junction was protected by a gate across the single-track

Junction and Two Harbors), were the principal objectives for installing the C.T.C.

At Spruce Junction, 2.1 miles east



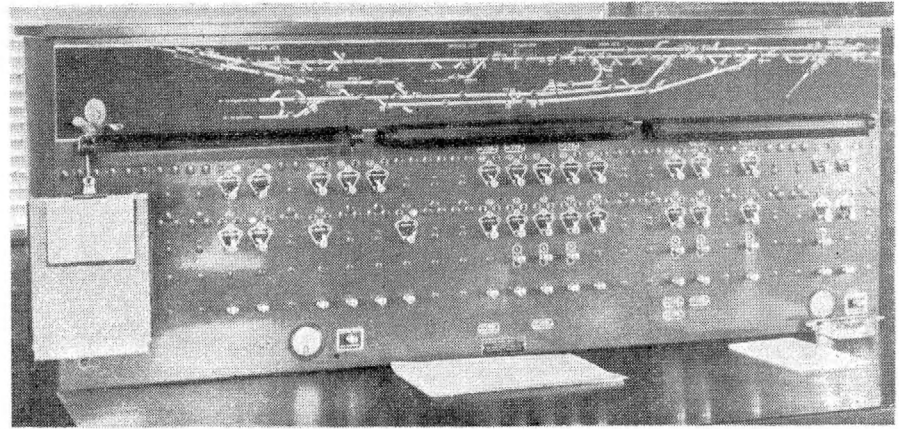
of Iron Junction, a single-track line branches off and extends 2.7 miles to Eveleth, Minn. One mixed train, operated each direction daily over this branch line, also uses the main-track between Spruce Junction and Iron Junction.

C.T.C. To Save Train Stops

Faced with the necessity for doing everything possible to expedite the movement of ore, the D.M. & I.R. made plans for an extensive system of C.T.C., including the five junctions, Keenan, Iron Junction, Wolf, Spruce and Sparta, as well as the intervening main-tracks. The War Production Board, when granting approval of this project, reduced the number of switch machines to be installed from 24 to 16, and reduced the number of electric locks for hand-throw switches to 9.

The C.T.C. as Installed

As finally approved by the W.P.B. and as installed, the project includes: (1) semi-automatic C.T.C. signals at the five junctions for authorizing



The C.T.C. control machine is in a new office building at Iron Junction

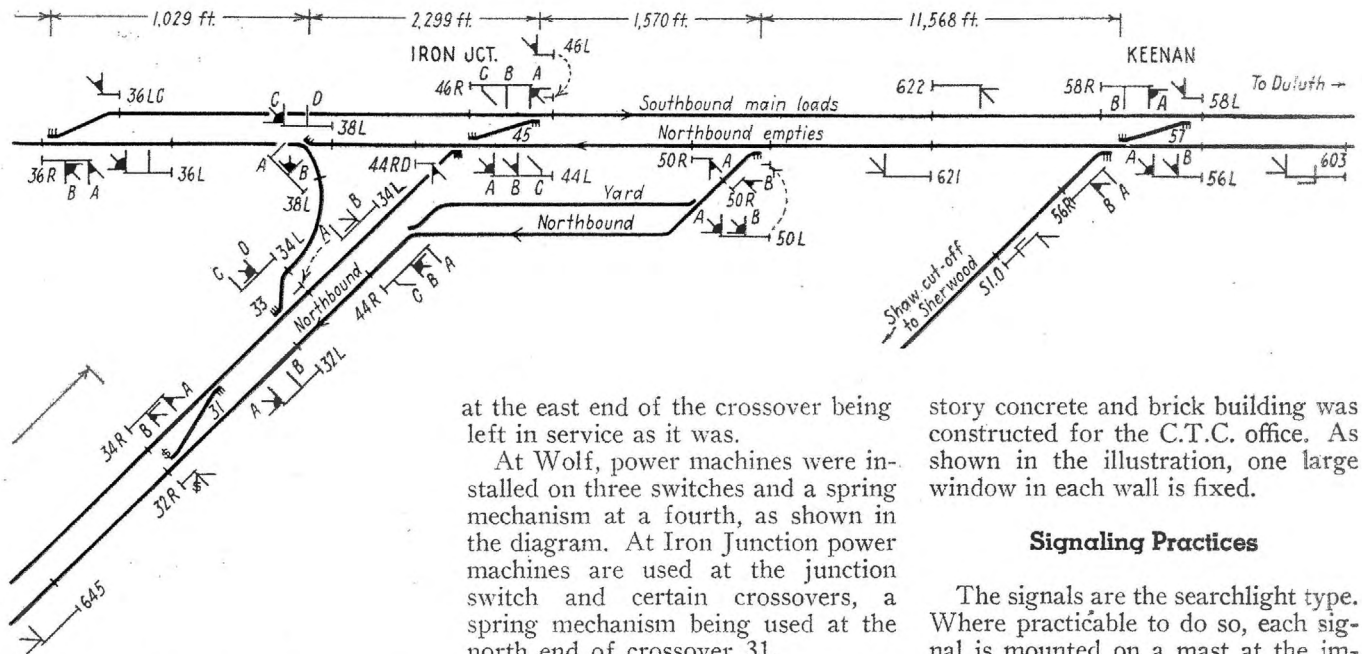
crossovers and junction switches, totaling 16 machines; and (4) electric locks on 9 hand-throw switches.

Track Layouts at Junctions

At Keenan, power switch machines were installed at both ends of the crossover and at the junction switch. At Sparta, power switch machines were installed at the junction switch and the west end of the crossover, the spring mechanism previously in use

is a set of lamps which repeat the positions of switches and the aspects displayed by signals. The illuminated track diagram has lamps which indicate the occupancy of all sections of main tracks. The time coding system using two line wires is used to send controls from the offices to the various field stations to control the signals and switches, as well as to return indications to the office.

On account of fire hazard in the existing frame station, a new one-



Track and signal diagram of C.T.C. territory showing the various junctions

at the east end of the crossover being left in service as it was.

At Wolf, power machines were installed on three switches and a spring mechanism at a fourth, as shown in the diagram. At Iron Junction power machines are used at the junction switch and certain crossovers, a spring mechanism being used at the north end of crossover 31.

story concrete and brick building was constructed for the C.T.C. office. As shown in the illustration, one large window in each wall is fixed.

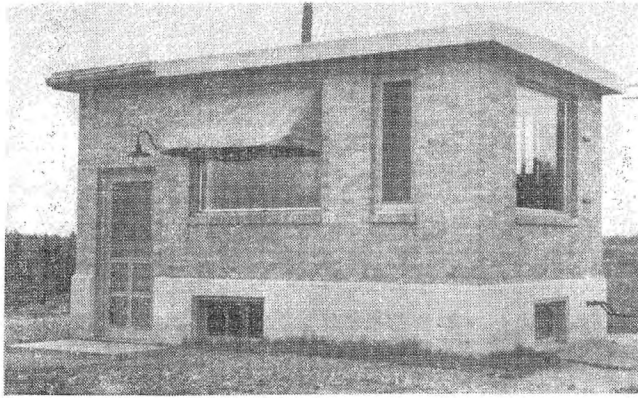
Signaling Practices

The signals are the searchlight type. Where practicable to do so, each signal is mounted on a mast at the immediate right of the track governed. On the double-track, trains are operated left-hand running and, in view of the fact that there is not clearance between tracks for signals, they were placed on masts at the left of the track governed. This practice applies to the six intermediate automatic blocks on the double-track. This practice of placing automatic block searchlight signals at the left of the track governed, on masts of the proper height to bring the lens on a level with

The Control Machine

train movements by signal indication, totaling 29 high signals and 11 dwarfs; (2) automatic block signaling for left-hand running on the double-track and for either direction on the single-track as well as distant signals, totaling 8 signals; (3) dual-control electric switch machines at the

The C.T.C. control machine, which controls all the power switches and signals at the five junctions, is located in an office at Iron Junction. This machine has 14 levers for controlling switches, 14 levers for controlling signals, 5 toggles for controlling electric locks on hand-throw switches and 9 buttons for controlling maintainers' call lamps. Associated with each lever



The new one-story brick building for the C.T.C. office at Iron Junction, Minn.

the engineman in the cab, has been found to meet the approval of engineman better than placing the signals on bridges over the tracks. In the instance on the D.M. & I.R., steel was not available to construct signal bridges, even if they had been wanted, because of restrictions due to the war.

The absolute "Stop" aspect for high home signals on the D.M. & I.R., consists of two red lamps in a vertical row, and, therefore, each semi-automatic C.T.C. controlled high signal has two or more "arms" which in this instance are separate lamp units, either operative searchlight units or fixed red units.

As a general rule, the top searchlight unit governs over the straight track normal speed route, the second unit governs over a diverging medium speed route to a main track beyond. Where no medium speed route exists, the second "arm" is a fixed red marker. Correspondingly if there is a medium speed route but no high-speed route, the top arm is a red marker, while the second arm is operative, as for example signal 34L at Iron Junction.

Special Distant Signals

At Keenan the distant signal S1.0 on the Shaw cut-off is near the top of a grade descending toward Keenan. If an ordinary Approach aspect were used on this signal and a southbound train proceeded, it might not be able to stop on the grade short of the home signal at Keenan. An arrangement could have been provided for trains to stop back of the distant signal until both the home and the distant signal were cleared but this would have caused an extra train stop. For these reasons a special aspect was provided on this distant signal. In addition to the conventional three-aspect searchlight signal unit there is a lower "arm" which is normally extinguished, but when illuminated by C.T.C. it is green.

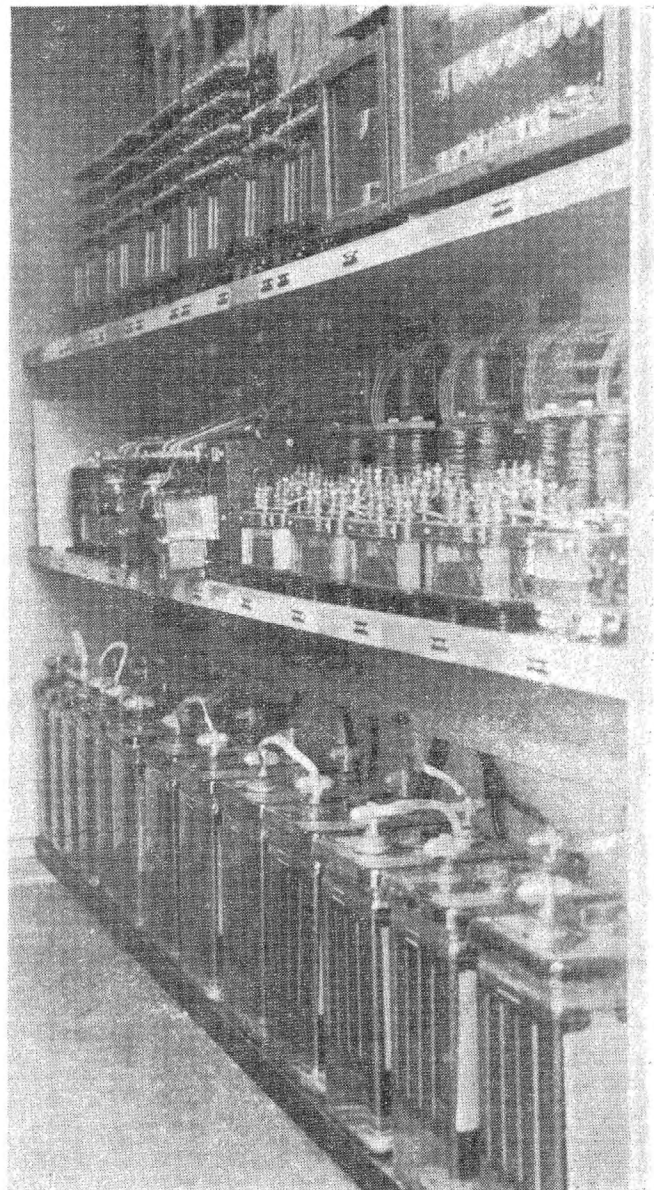
By means of the annunciator bells and track-occupancy lamps on the diagram, the operator in charge

knows the location and progress of all trains on the main tracks. If a train on the main line is passing through Keenan, when a southbound train on the Shaw cut-off "shows up" on the annunciator section, then the operator can tell by his diagram lamps whether the main-line train will clear Keenan by the time the train from the Shaw Cut-off would arrive at Keenan.

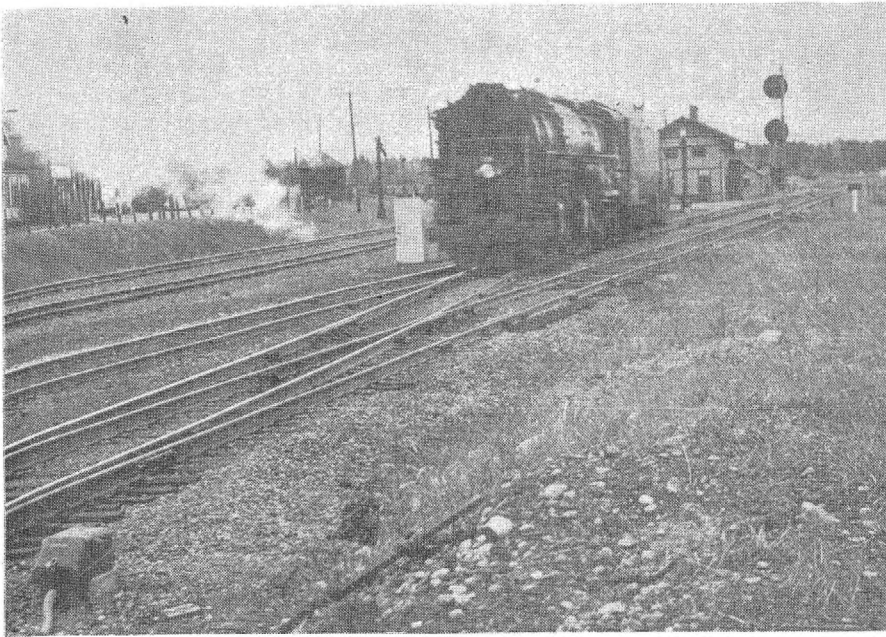
If so, he sends out a special control which illuminates the bottom unit of the distant signal S1.0 so that it displays a special aspect of yellow over green, which indicates to the engineman that the Keenan home signal is not as yet cleared for him but that he can let his train drift down under control toward Keenan, and that by the time he arrives the signal at Keenan will be cleared for him. This same special type of aspect is used on the two distant signals Q10 and H12 east and north of Wolf.

"S" Signal at Spruce Junction

Only one local train each way daily uses the switch at Spruce Junction, and, as this is a light train, no serious delay is occasioned by stopping to operate a hand-throw stand. For this reason no power machine was installed at this switch, but an electric lock, under C.T.C. control, was applied to this switch. Signals were



Inside of a sheet-metal house showing code apparatus, relay and battery



Southbound train on crossover No. 45 at Iron Junction

installed to govern movements from the branch to the main-line or vice-versa. When a train on the branch approaches Spruce Junction, a track-occupancy annunciation appears on the C.T.C. machine. If the operator is ready for the train to occupy the main-track and proceed to Iron Junction, he sends out a control which causes a letter "S" to be displayed in a lamp unit which, in effect, is a third "arm" on the signal 30R. This aspect of red-over-red-over "S," indicates that the electric lock on the switch is unlocked so that the trainman can throw the switch, after which a yellow or a green aspect is displayed in the second arm and the "S" is extinguished. Then the train enters the main-track and the switch is placed normal, before departing.

Similarly, the eastward signal 30L at Spruce Junction has an "S" unit, as the third "arm," to instruct the trainman of an eastward train for the branch, when switch may be thrown. Then the red over yellow aspect is displayed on signal 30L to authorize the train to move to the branch line.

Call-On Aspect

When making switching moves at Iron Junction it is necessary, under certain circumstances, for locomotives

to move back to couple-up with the remainder of the train which is occupying the main-track. Under such conditions, the top arm cannot be cleared; therefore, signals 44L, 44R, and 46R, are equipped with a third "arm" unit which is normally dark and will display a yellow under two reds, by C.T.C. control, which authorizes a locomotive to move past the signal and couple to its train.

Interlocking at Crossing With D.W. & P.

A mechanical interlocking was previously in service at Ramshaw, 1.5 miles east of Iron Junction, a single-track main-line of the Duluth, Winnipeg & Pacific crosses the D.M. & I.R. line between Iron Junction and Sparta. When installing the C.T.C., track circuits were installed through the Ramshaw interlocking, electric locking was provided and the old me-

chanical signals were replaced with searchlight signals.

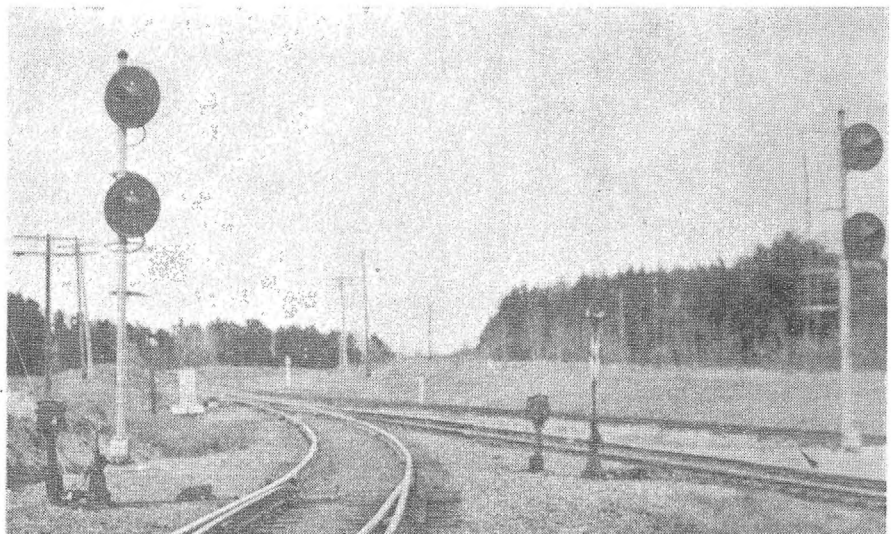
The track circuits are of the conventional d-c. type. Where line circuits are used the track relays are of the neutral type, rated at 2 ohms. On the double-track automatic block and between the home signal and distant signal at Keenan on the Shaw Cut-off, the track relays are the polar type, rated at 1 ohm, and are used to control the corresponding signal to two proceed aspects by polarized track. The maximum track circuit length is 5,000 ft., the rail joints being bonded with Cadweld bonds. Each track circuit is fed by three cells of Edison 500-a.h. primary battery.

Pole Line Work

The local signal line control circuits are on No. 10 Copperweld line wire with double-braid weatherproof covering. Single-phase 60-cycle a-c. power is available at the various stations and is distributed over the territory on a circuit consisting of two No. 8 Copperweld wires.

Storage batteries charged by rectifiers are used for the operation of switch machines, signal control circuits, etc., as well as stand-by for the signal lamps which normally are fed from transformers. Each switch machine or group of such machines is fed by a battery consisting of 13 storage cells including 5 cells of Em-11 and 8 cells of DMGO-9, the 5 cells being used also for the stand-by for the lamps. The storage batteries are of Exide manufacture.

This centralized traffic control project was installed by the railroad forces under the jurisdiction of Leland Clapper, chief engineer, and under the supervision of W. E. Hawley, electrical and signal engineer, the major items of equipment being furnished by the Union Switch & Signal Company.



Wye connection from Wolf to main-line east to Sparta Signal 38L-AB at the left and 38L-CD at the right