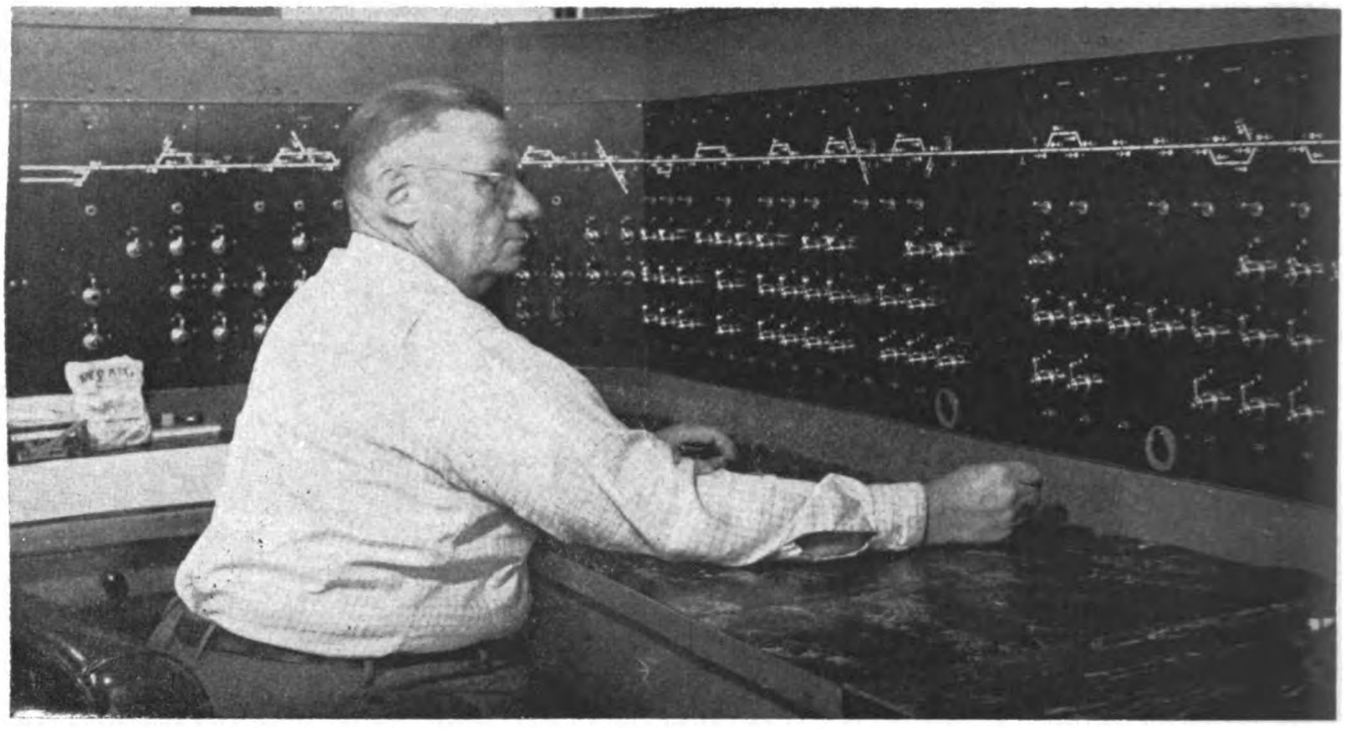


THE DISPATCHER, at this machine in Saginaw, controls the switches and signals on . . .

CTC Saves Time for Freights

On 135 Miles of Single Track

Signal system, planned to meet the needs of train operation, includes two-aspect signals for siding-to-siding blocks

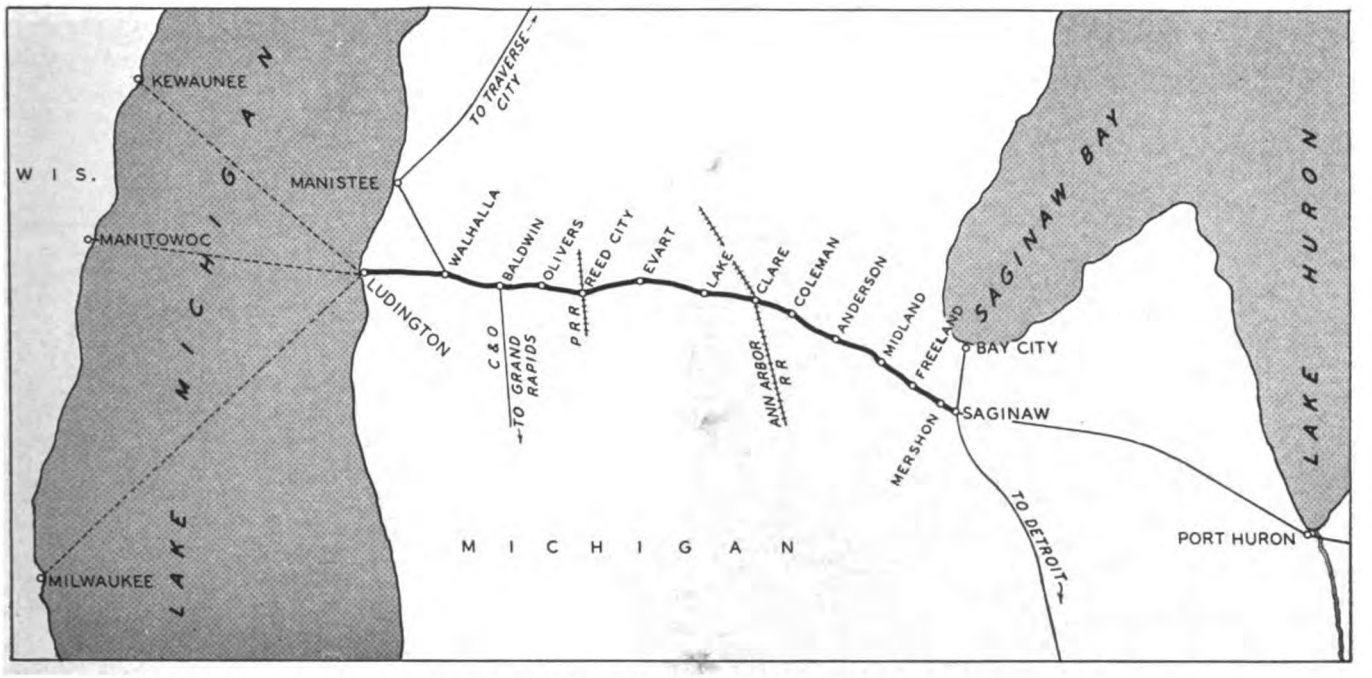
ON 135 MILES OF SINGLE TRACK, used exclusively by freight trains, between Saginaw, Mich. and Ludington, the Chesapeake & Ohio, Northern Region, has installed centralized traffic control. Previously, no signaling was in service on this territory; the switches were hand-thrown, and train movements were authorized by timetable and train orders.

This Saginaw-Ludington section is part of a combined rail-lake ferry route for east-west freight traffic. On Lake Michigan, the C&O operates train ferries. Four ferries operate each way daily between Ludington and Milwaukee; two each way between Ludington and Kewaunee, and two each way between Ludington and Manitowoc. These ferries operate every day, the year around. Much of the through traffic both ways between Saginaw and Ludington is in connection with the train ferries.

From Saginaw, the C&O has lines north to Bay City and south to Detroit and Toledo, as well as east through Port Huron, Mich. and St. Thomas, Ont. to Buffalo, N. Y. From all these lines, westbound traffic is assembled at Saginaw for movement to Ludington to be ferried across the lake. Similarly, eastbound traffic from the ferries is moved eastward to Saginaw to be routed from there on several routes east, north and south. Much of the westbound traffic consists of merchandise and manufactured products. Eastbound traffic includes dairy and agricultural products, meat, lumber and manufactured equipment. Westward traffic is usually at a minimum on Monday and Tuesday, and is at maximum on Wednesday through Saturday and part of Sunday. Schedules include four through trains each way daily, and these trains must be operated on time to coordinate with the ferries. Extra sections are operated as business demands.

Through Trains and Local Freights

Daily, except Sunday, a local freight runs from Ludington to Evart and back to Ludington. Another local runs from Midland to Coleman, then down a 14.7-mile branch to Mt. Pleasant, and back to Midland daily except Sunday. Large chemical manufacturing plants and other industries are located at Midland, Mich., 20 miles from Saginaw. To assist in serving these industries, a switch run operates from Saginaw to Midland and return, daily except Sunday. A local freight starting at Ludington goes 18 miles to Walhalla, then over a secondary line to Manistee, 27 miles, and returns to Ludington. The number of trains daily on some sections ranges from 10 to 14, and between Saginaw and Midland from 18 to 20 trains. No passenger trains are operated on the Saginaw-Ludington territory except that two passenger trains daily except Sunday and two freight trains daily, on the north-south route, use the 13 miles between Baldwin and Walhalla.



THE CENTRALIZED TRAFFIC CONTROL territory of 135 miles between Ludington and Saginaw

Between Saginaw and Clare, 51 miles, the grades and curvature are light. The grades are short and range up to a maximum of about 0.55 per cent. The curves are few and range from 2 to 3 deg. Rougher glacier terrain extends west from Clare, with grades ranging up to 1.07 per cent. Curves are more numerous but do not exceed 3 deg. The ruling grade eastward is about 1.00 per cent for 3.9 miles between Baldwin and Reed City. The ruling grade westward is about 1.00 per cent for 3 miles between Reed City and Baldwin.

The locomotives are the diesel type, each consisting of two units rated at about 1,500 gross tons, either direction. Trains are operated to make connections for all ferries regardless of whether rated tonnage for locomotives is on hand at departure time. The maximum permissible speed for through freight trains is 59 mph. About 3 hr. and 30 min. is the normal running time, either way, for through freight trains on the 135 miles between Saginaw and Ludington.

Automatic Interlockings

Previously a mechanical interlocking was in service at Clare where the Chesapeake & Ohio crosses the Ann Arbor railroad. When installing the CTC, this old mechanical plant was replaced by an automatic interlocking. At this interlocking, all four home signals are normal at Stop. The Ann Arbor signals clear automatically when a train enters the corresponding approach. For a C&O train, the dispatcher uses the CTC system to send out a stored control for the C&O signal which will then clear after the train enters the corresponding approach section. If an Ann Arbor train enters its approach before a C&O train enters its approach, the Ann Arbor signal will clear and lock out the C&O signal.

In any instance, if the home signal does not clear for an approaching train, the train is stopped short of the signal. The conductor goes to a box at the crossing. There is one box for the C&O and one for the AA. In the boxes are: (1) an indication lamp; (2) a clockwork time release; and (3) a telephone. If the lamp is lighted this indicates that no train is within control or approach limits on the other railroad. Then the conductor winds the release. This holds all signals at Stop. When the release runs down, the signal for his train will clear.

Formerly the C&O east-west line between Saginaw and Ludington crossed the C&O north-south Grand Rapids-Petoskey line, at Baldwin. As part of recent track changes, this crossing and several miles of track north of Baldwin were taken up. Trains on the north-south line now use the east-west line on 13 miles between Baldwin and Walhalla. The new power-operated junction switch at Baldwin is within the same signal limits as the east end of the Baldwin siding.

One New Siding; Three Removed

Prior to the installation of the new signaling, one new siding was built at Anderson, and six previous sidings were removed at Branch, Idlewild, Chase, Farwell, Noble and Hersey. The names and car capacities of the power-operated sidings are:

Location	*Car Capacity*
Mershon	100
Freeland	115
Anderson	121
Coleman	97
Clare	117
Lake	95
Evart	96
Reed City	100
Olivers	109
Baldwin	94
Walhalla	155

At each end of these 11 power sidings, new No. 16 turnouts were installed, which are good for diverging train movements at 30 mph. Diverging moves at present, however, are made at restricted speed in accordance with restrictive signal indications.

Coded track circuits, which are in operation constantly at 75 codes per minute, are used on the section from one siding to the next. Conventional d.c. track circuits are used within siding limits; for the switch detector circuits, and on the sidings.

Each siding is equipped with a track circuit which not only controls a track occupancy lamp on the corresponding section of the track diagram, but also enters into the control of the signals governing train move-

POWER SWITCH layouts are well constructed

SIDING THROWN to put signal between main and siding

ments into the siding. Referring to Fig. 1 with the Clare siding unoccupied, when the dispatcher reverses the east switch and sends out a control, signal 7 will display the red-over-yellow aspect, authorizing the train to enter. If the siding is occupied, the signal cannot be cleared.

Siding-to-Siding Signaling

The signaling arrangement used on this project is shown in Fig. 1. Leaving signals are controlled from siding to siding; for example, westward signal 1 displays red for Stop, or green for Clear to authorize a train to go from Coleman to Clare with no provision for a following westward train to pass signal 1 until the rear of the preceding train goes beyond signal 8 at Clare. Signal 1 cannot display yellow, and no intermediate signals are provided for a second train to follow another train into the siding-to-siding block. The decision to use two-aspect leaving signals, for siding-to-siding following train movements, was adopted for this project because: (1) no passenger trains are operated, and all through trains of the same direction are of equal

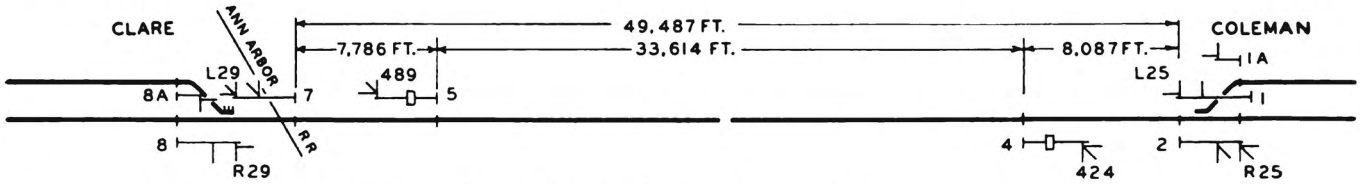


Fig. 1—LEAVING SIGNALS, such as L25 at Coleman, are controlled from siding to siding

class; (2) ordinarily these through scheduled trains of the same direction are spaced several hours apart, and even when extra trains are operated, the spacing between following trains is more than siding to siding.

In this arrangement of two-aspect, siding-to-siding signaling, no intermediate signals, as such, are used. Signal 4 is the approach signal for signal 2, and signal 5 is the approach signal for signal 7. Signal 4 is located more than train-stopping distance from signal 2, and the same applies for signals 5 and 7. This leaves about 6.3 miles between signals such as 4 and 5, where the overall distance between sidings is about 9.3 miles.

On numerous occasions the eastbound local freight train sets out or picks up cars at Hersey, the track on which this is done is connected to the main track by a hand-throw switch equipped with an electric lock. In this layout, a special eastward intermediate signal, No. 836, was installed within range of view from Hersey, so that the eastbound local freight would have "something to run on" when ready to proceed eastward after picking up cars at Hersey. An important advantage is that with the special intermediate automatic signal 836, the local can run at normal speed rather than restricted speed, for the 6.5 miles to Evart.

Hold-Out Signals Save Time

Baldwin is the interchange point between the Saginaw-Ludington east-west line, and the C&O north-south line between Grand Rapids and Petoskey. Therefore, switching on the main line within the limits of Baldwin is required at numerous times. To permit this switching to continue while a westbound train is on its way westward from Olivers, a pair of hold-out signals, No. L57 and No. R57, were installed just east of Baldwin, as shown in Fig. 2. These signals are controlled by a lever on the CTC machine. When switching is to be done for an authorized time on the main track at Baldwin, the dispatcher positions the lever No. 57 to hold signals L57 and R57 at the Stop aspect. This establishes protection for the switching move, and allows the dispatcher to clear signal L55 at Olivers so that a westbound train can proceed toward Baldwin. Before the allotted time has expired, the switch engine clears the main line, and this is shown by a corresponding track-occupancy lamp on the CTC control machine. Then the dispatcher can throw the lever to clear the westward

hold-out signal L57, thereby permitting the westbound through freight to go on through without a stop or delay. Similar arrangements of hold-out signals were installed at Midland and at Dean. All main track hand-throw switches are equipped with electric locks, which are CTC lever-controlled by the dispatcher.

Organized Construction

The construction work on this new signaling was done by railroad forces under the immediate direction of A. J. Detzler, construction supervisor. Each crew included about 6 to 8 men and a foreman. Each crew had its own equipment, including a tool car, supply car and sleeping car including space for chairs and tables.

As a general rule, a crew would concentrate on the pole line work through a section of 30 to 50 miles. Then this crew would go back and work through this territory to lay the buried cable; set the sectional signal foundations; erect the masts; pour the concrete foundations for the sheet-metal houses; erect these houses and install the switch machines.

Two wiremen, working in railroad buildings at crew headquarters, wired the metal racks for the plug-in relays. After these racks were in place in their respective houses at field locations, these wiremen installed terminals, arresters, transformers and rectifiers on the terminal boards on the wall of the house, and connected all the wires going to the racks and to outgoing buried cables. Also these men connected the wires going to signals and switch machines.

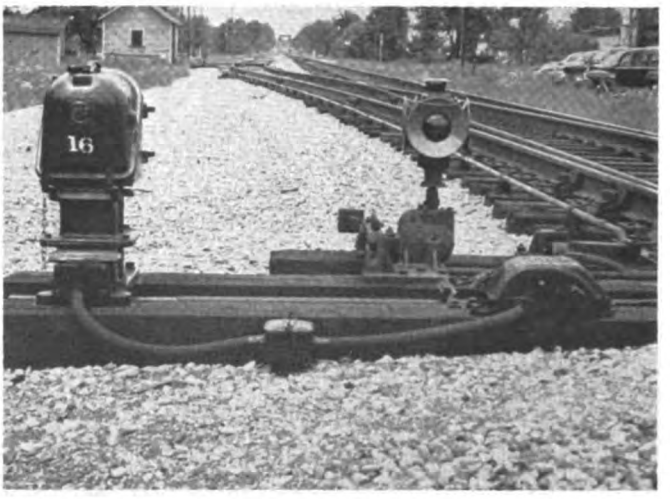
No Work Trains

Construction headquarters were at Saginaw for the first 25 miles and were moved from there to Clare for the 50 miles between Anderson and Evart. The construction headquarters were at Baldwin for the final 60 miles from Evart to Ludington.

Materials for each section were assembled at the headquarters for that section. Then highway trucks were used to haul the materials out to the field locations. The terrain is such that highway trucks could be driven to nearly all of the power switch and signal locations. For the few inaccessible locations, the materials were hauled on motor cars from the nearest road crossing. Thus no work train service was required for this entire project.

Trucks were made available according to the number of crews at work. At the peak, the equipment included three panel trucks, two 2-ton stake trucks, and two pick-up, light-weight trucks, as well as two power machines for digging trenches for buried cable. One of these machines will dig a trench 30 in. deep, approximately 2 ft. per minute.

The pole line, which is used for communication wires and signal wires, is owned and maintained by the C&O. During the past year this pole line was rebuilt, as necessary, to provide clearance for a second crossarm where such an arm was to be added, and to replace defective poles.



HAND-THROW SWITCHES are equipped with electric locks

Only four signal line wires extend for the entire length of the project. Two of these, No. 8 copper with weatherproof covering, are for the CTC code line circuit; and two No. 10 Copperweld with weatherproof covering, are for the local signal line control circuit which is used for either eastward or westward signals in a siding-to-siding block, depending on the direction of line-up being established by the CTC control. Additional line control circuits are used between signals at the two ends of each siding and out as far as the approach signals.

Twelve-conductor No. 14 Kerite aerial cable is used from one end of each siding to the other end. This cable is supported by a Copperweld stranded messenger, using a spiral winding made of copper ribbon $\frac{1}{64}$ in. thick and $\frac{5}{16}$ in. wide. This type of aerial cable was also used on 6 miles through Midland where no space is available for crossarms.

Line wires, No. 10 Copperweld with weatherproofing, are used out to the approach signals. In each section from the end of a siding out to the approach signal, a second crossarm was added to carry the signal wires. In the sections between the approach signals, the two code line wires are on the two pins on the field end of the previously existing 10-pin communication arm, and the two signal line control wires are on pins No. 1 and No. 2. The drop cables from the line poles to instrument houses were made up on the ground, using single-conductor No. 14 wire.

Commercial a.c. power connections are available at

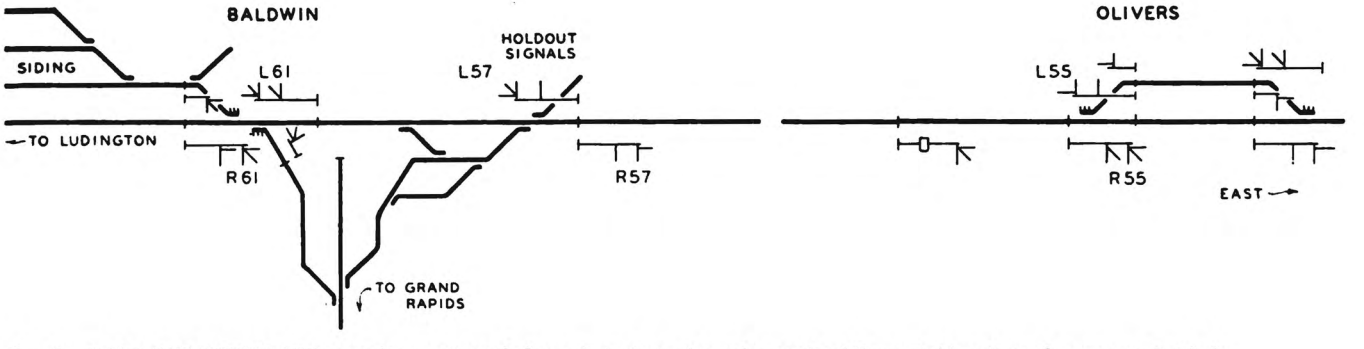
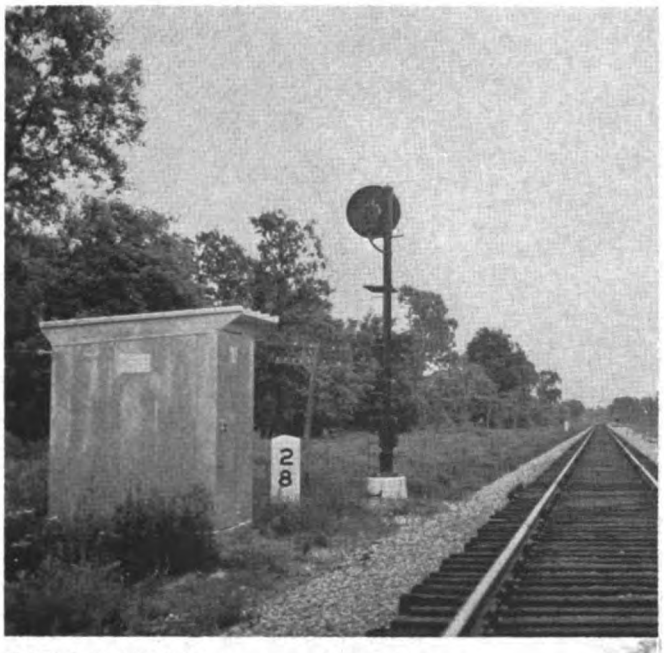
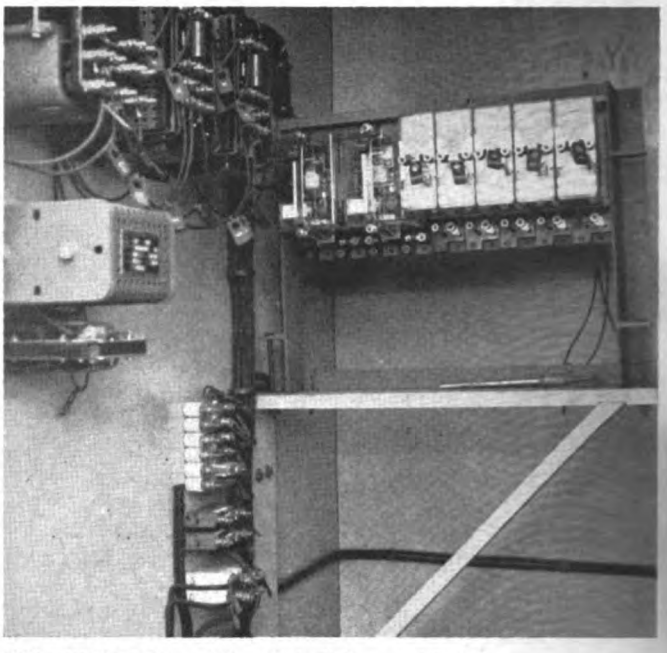


Fig. 2—HOLD OUT SIGNAL L57 permits westward through train to be advanced while switching is underway at Baldwin



SHEET METAL HOUSE at approach signals, too



PLUG-IN RELAYS on hinged shelf in metal house

both ends of the sidings and at nearly all of the approach signals. In the house at the end of each siding there is a set of 12 cells of 80-a.h. lead storage battery which feeds the switch machine motor. This battery also feeds the code equipment. At each approach signal a set of 6 cells of 60-a.h. lead storage battery feeds the line circuit and the searchlight signal coil, as well as the lamp if the a.c. power fails. At some points where a.c. is available, track circuits are fed by one 80-a.h. lead storage cell. All these storage batteries were furnished by the Exide Industrial division of the Electric Storage Battery Co. Where no a.c. is available, each coded track circuit is fed by four 1,000-a.h. Edison primary battery, connected in multiple-series.

The signal lamps are the single-filament type rated at 12-16 volts, 21 candle power, and are burned continuously as an additional aid to men on motor cars to warn them of approaching trains. Also, experience on this railroad indicates that a filament burned continuously will give just as long a life as one that is turned off and on. The lamps are replaced at the end of a service life of approximately 3,000 hr.

Sheet-Metal Houses at All Locations

Sheet-metal houses for the relays and battery were installed not only at the ends of sidings, but also at the approach signals. The reason for using houses, rather than cases, is that the equipment is not exposed to rain or snow when being inspected, and the houses give the maintainers protection in adverse weather.

The houses at the ends of sidings are 8 ft. by 8 ft. and those at approach signals are 5 ft. by 5 ft. Each house is made up of portable sections 16 in. wide, set vertical to form the walls. When assembling such a house, a concrete slab 6 in. thick is poured in place on the ground. A channel iron, which forms the base for the wall, is attached to anchor bolts in the concrete. Then the wall sections are assembled, and the roof sections are placed. The door is also sheet metal.

The inside walls and ceiling are lined with plywood. This plywood is ¼ in. thick, except on one side wall where it is ½ in. thick. On this ½ in. plywood wall are mounted the transformers, rectifiers, arresters and terminals. The arresters were furnished by the Railroad Accessories Corp., and the ground rods are ⅝ in. by 10 ft. Copperweld.

The signal foundations are the sectional pre-cast concrete type. The use of these sectional foundations, made by the Permacrete Products Corp., Columbus, Ohio, contributed to the practicability of distributing materials by highway truck, thus eliminating work-train service.

Each Maintener Has a Truck and a Motor Car

A paved highway, US 70, extends east and west through many of the towns on this 135 miles of railroad, so that a highway truck can be driven to, or within a short distance of, all of the siding switches. On considerable mileage, the highway is within 500 ft. of the track. Where the highway is remote from the track, the distance from a switch to the approach signal was increased in some instances to locate the approach signal near a crossing with a country road.

Thus circumstances were favorable to the planning of this project so that the maintainers could use highway motor trucks as transportation when doing nearly all their work. Accordingly, the railroad purchased and assigned to each maintainer a conventional closed-body panel-type highway truck, which costs about $1,700. This truck body is large enough to carry meters, electrical tools, mechanical tools, line tools, grinders, bonding drills, etc., as well as some supplies, so that the maintainer can complete most any kind of work he encounters.

A one-man type track motor car is also assigned to each maintainer for traveling to points on his territory that are not accessible from the highway. Also the motor car can be used in bad weather when highways are blocked. Individual maintainers are located at Mershon, Midland, Clare, Reed City and Scottville.

This signaling was planned and constructed by signal forces of the Chesapeake & Ohio, Northern Region, under the direction of M. F. Anderson, assistant general superintendent signals and communications, with headquarters at Detroit. The major items of signaling equipment were furnished by the General Railway Signal Company.