AFO Circuits Protect Crossing

The DT&I has installed flashing-light signals controlled by Audio Frequency Overlay track circuits. The use of AFO circuits avoided interference with existing track circuits and simplified one approach, which extends into an interlocking maintained by another railroad

THE DETROIT, TOLEDO & IRONTON recently placed in service the first full-scale highway crossing protection controlled by audio frequency overlay track circuits. Previously, these circuits had been used only for the short, positive island track circuits, and at a mythical crossing on the Sante Fe for testing.

The crossing is located on the Dearborn branch of the DT&I that runs 13 miles from Flat Rock yard to the Ford Motor Co. Rouge Plant. In 1957, CTC was installed and the line single tracked with one passing siding. The CTC machine is located in an interlocking tower near the midpoint. Under normal operation, up to 24 trains per day will move over this line. Maximum permissible speed is 35 mph.

The highway crossing is that of Northline Road. It was, until recently, unimproved and protected only by crossbucks. With the development of the county airport into the Detroit Metropolitan Airport, with runways to serve jet planes, the county decided to improve Northline Road as an airport feeder road. The improvement includes paving the road two lanes wide. Over the crossing, two additional paved lanes are provided, one on each side, because the county believes that at least two lanes must be open when the railroad is doing track maintenance work. The highway crossing is approximately 1,400 ft north of the DT&I crossing with the PRR.

A flasher warning of 20 seconds would require 1,027-ft approach sections. The DT&I's standard, allowing a margin for safety, for this speed is 1,100 ft. This would put the start for northbound trains about midway between the home signal and the PRR crossing. The interlocking detector track circuit extends from home signal to home signal and is 964 ft long. Hence a cut section would be neces-

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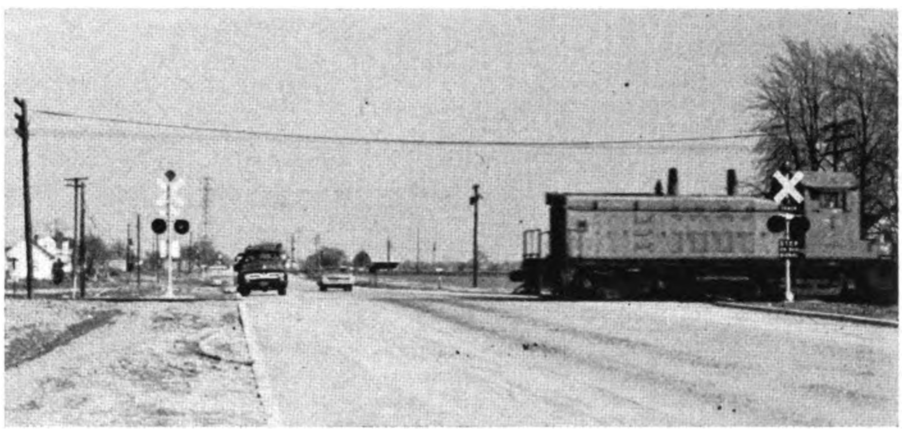
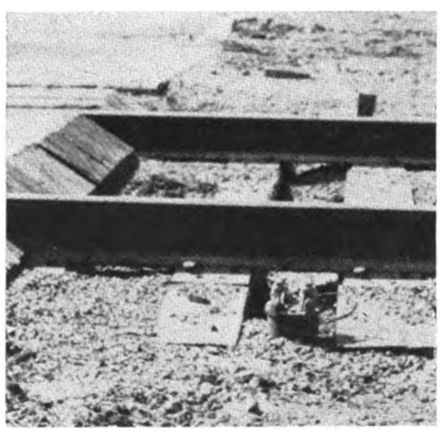
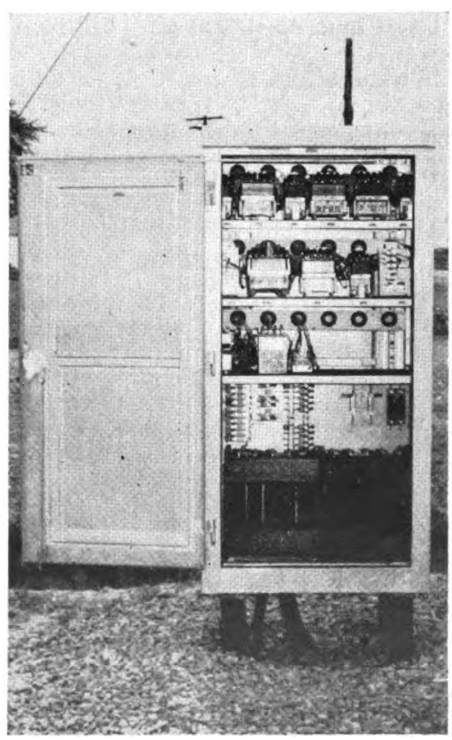


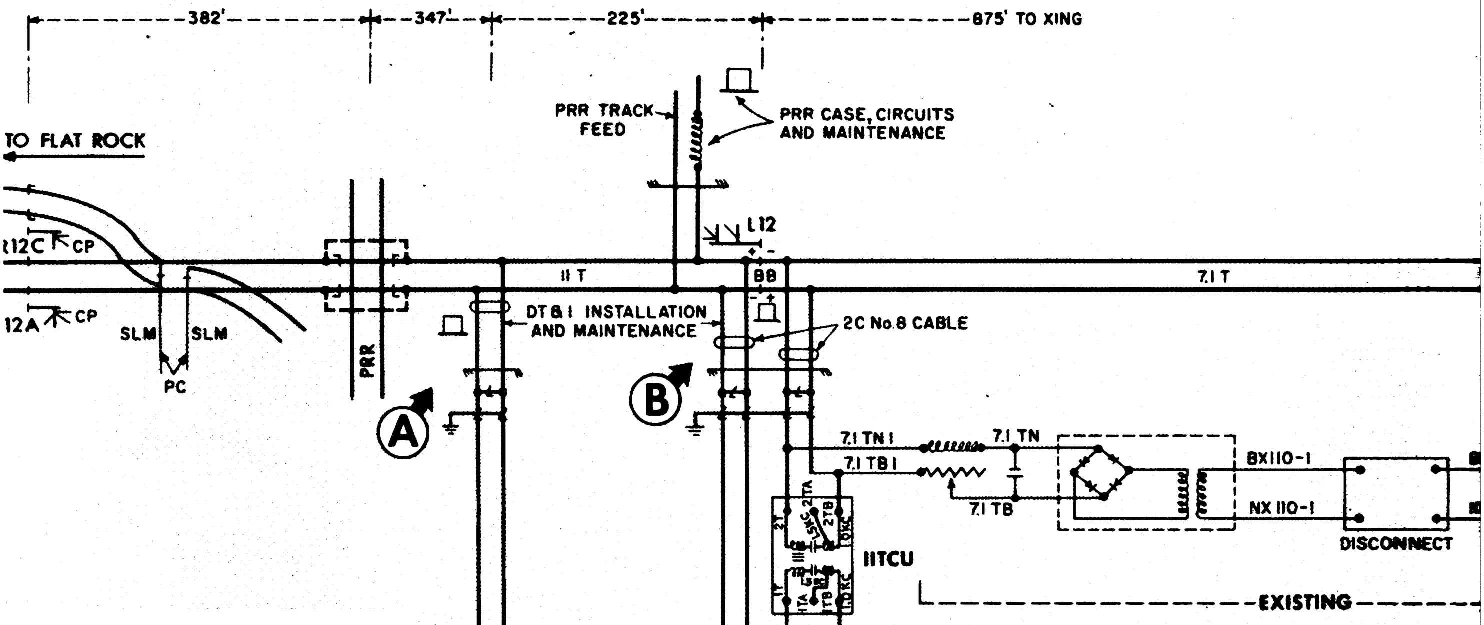
The automatic protection at this crossing is controlled by audio frequency track circuits. The county and the DT&I shared the cost of protecting this airport feeder road.

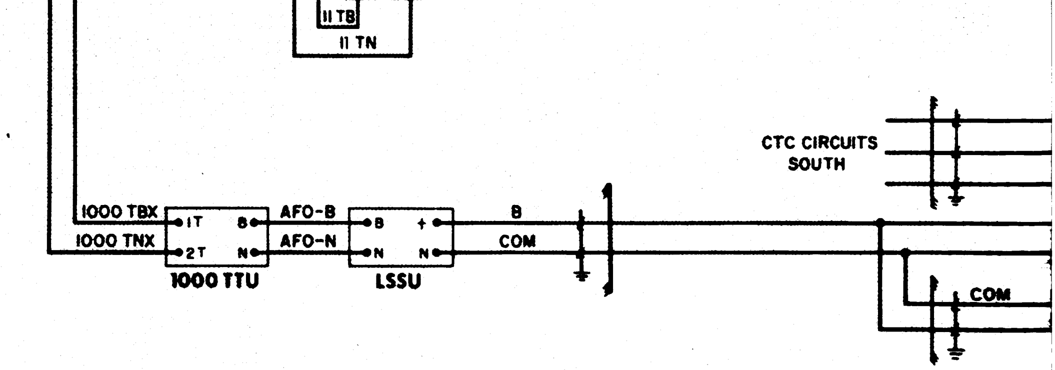


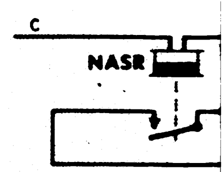
No insulated joints at this crossing. Two conductor track cable was required by audio frequencies used. Track cable was terminated in Raco dual head bootleg.



Stainless steel case houses instruments at the crossing. AFO receivers are at either end of the second shelf. Nife battery provides standby power. Detailed circuits are on next two pages.







Circuit operation for a northbound train is as follows: As the train approaches location "A", the 1.0-kc voltage from transmitter 1000TTU is shunted. The distance that this occurs from the track connections depends upon ballast conditions, being somewhat farther away for dry ballast than for wet, but never any closer to the crossing than the track connections.

Receiver 1000TRU, on the far side of the highway from the transmitter, now receiving no 1.0-kc voltage, allows the relay 1000TR, which it controls, to drop. This opens the XR circuit, causing the flashers to begin operation. It also provides the path from battery, B, through 1000TR down,1500TR up,XPR up, and SASR down, to pick up the northward approach stick relay, NASR. Both the dropping of the XR and the picking up of the NASR open the circuit to XPR. Because of its slow release feature, it remains up long enough to allow the NASR to pick up over the contact of XPR up.

As the train proceeds over the crossing, the 1.5-kc voltage from 1500TTU is shunted and the 1500TR drops. As the rear of the train recedes from the 1000 TRU track connections, the receiver again provides current for 1000TR to pick up.

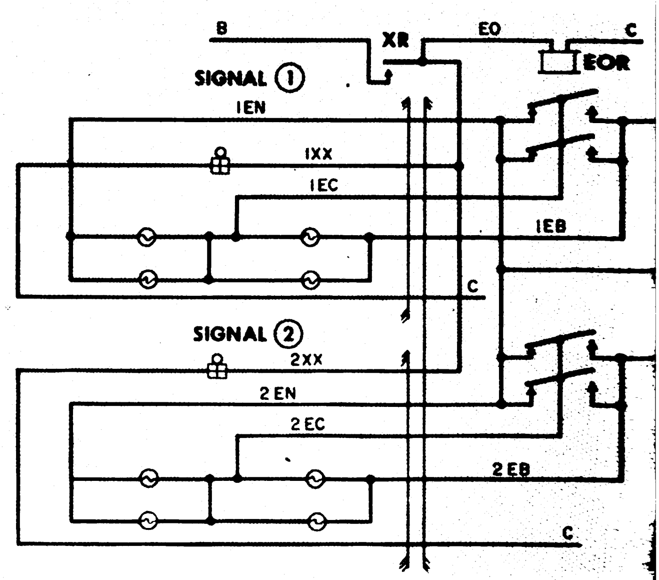
Although 1500TR is down, NASR and 1000TR are up, and the XR picks up, cutting off flasher operation. NASR is stuck up over its front contact and 1500TR down.

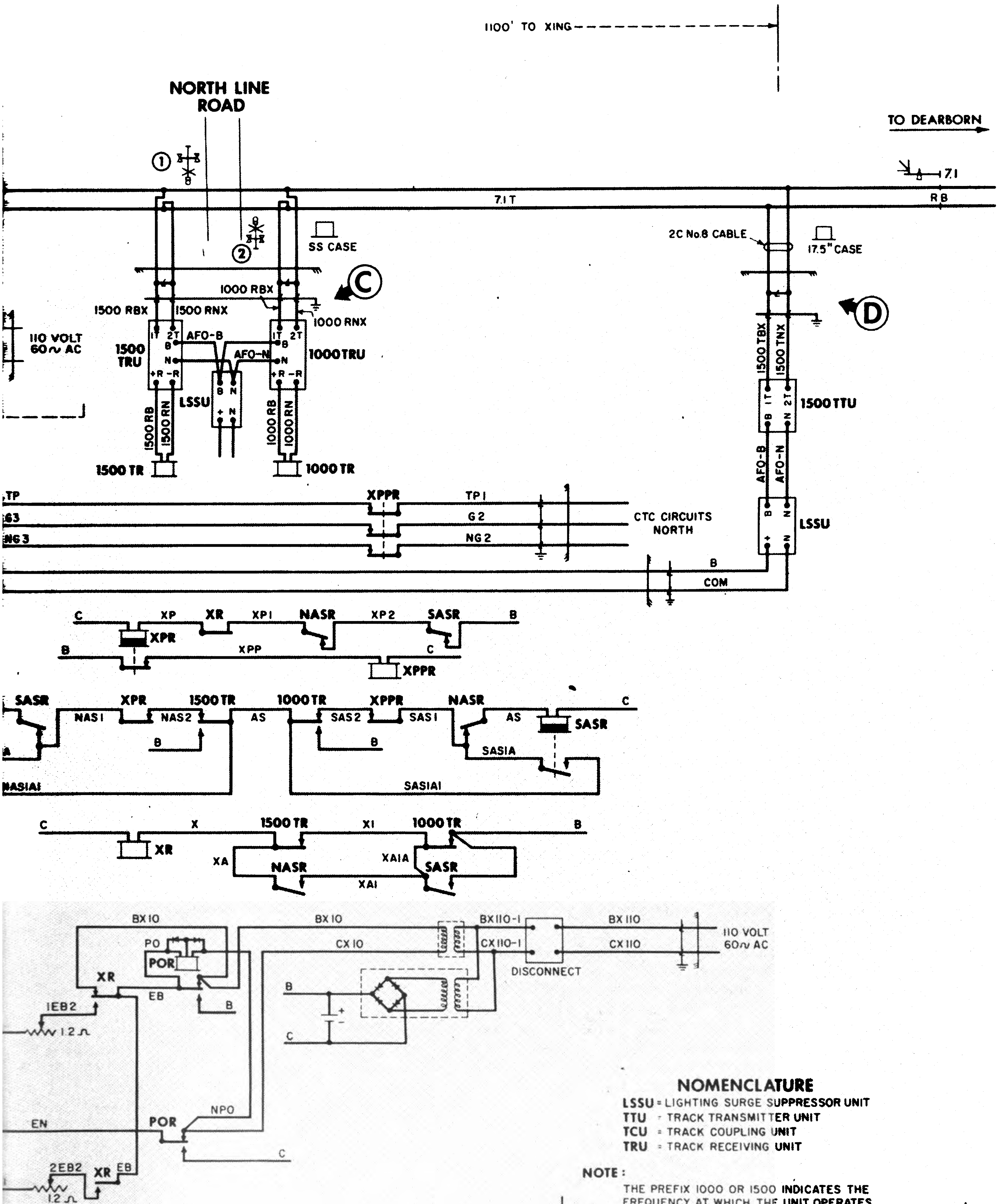
As the train recedes from the track connections at "D", 1500TRU is energized and 1500TR picks up. NASR drops out and allows the XPR (and its repeater, XPPR) to pick up. The circuit is now back to normal.

The function of the XPR circuit in increasing the safety of the operation may best be explained by supposing it were not there, and NAS1-NAS2 and SAS1-SAS2 were each a continuous wire: Taking a northward movement again as an example, assume a circuit failure either in the NASR relay or in the circuit from 1500TR to it. With 1000TR down, the XR would be down and the flashers would work normally, but NASR would not pick up. As the train receded from the crossing with 1500TR down and 1000TR up, the pick circuit to the SASR would be complete and that relay would pick up. The flashers would ring through, of course, but that is a failure in the direction of safety. If a following movement were to enter the approach, 1000TR, before the first train had cleared 1500TR, it would hold SASR energized and allow the XR to pick up and the flashers stop as the train approached the crossing. This, of course, is a failure in the direction of danger, and cannot be allowed.

In these circuits, two safeguards are provided. With the XPR (and its repeater XPPR) in the circuit of both directional stick relays, a failure in the pick circuit of a directional stick relay will allow back-ringing of the flashers, but will not allow the opposite directional stick relay to be picked up under a receding train and held up by a following train. As long as the XR is down, the XPR cannot pick up.

Furthermore, contacts of the XPPR are in the signal control circuit, which will hold signals controlling entrance to the block at stop as long as XPR is down. A reason for adding this feature in this case was the desirability, because of the newness of the circuit, of giving the dispatcher an indication of failure of the AFO circuits. No failure has been experienced so far, and none is expected.





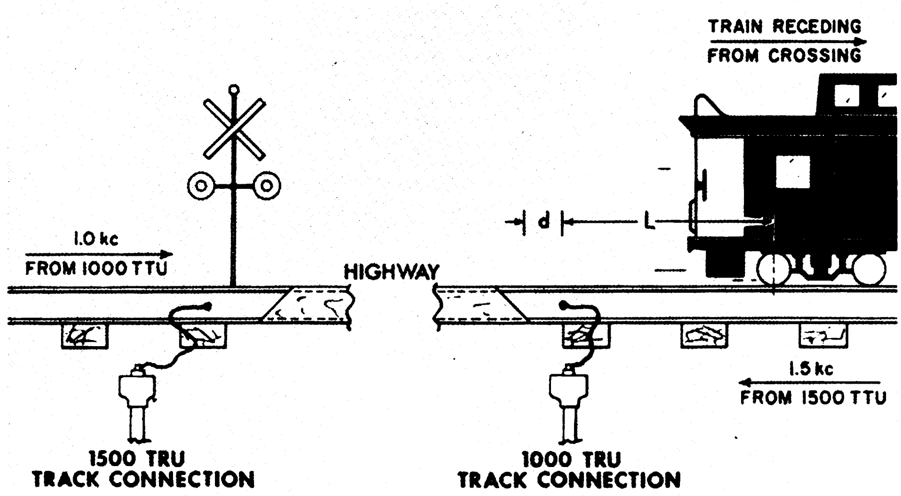
NOMENCLATURE

LSSU = LIGHTING SURGE SUPPRESSOR UNIT
TTU = TRACK TRANSMITTER UNIT
TCU = TRACK COUPLING UNIT
TRU = TRACK RECEIVING UNIT

NOTE:

THE PREFIX 1000 OR 1500 INDICATES THE FREQUENCY AT WHICH THE UNIT OPERATES

DT & I
HIGHWAY CROSSING PROTECTION
NORTHLINE ROAD
AFO CIRCUITS



Distance "d" is about 2 ft. Distance "L", when the flashers stop, is approximately 12 ft.

AFO CIRCUITS *(Continued from page 19)*

sary if proper timing was to be obtained.

Furthermore, this interlocking is maintained by the PRR, so that all construction and circuit work would be under their jurisdiction.

North of the road crossing, the southbound start would lie within the dc track circuit which extends 5,052 ft from the home signal to the approach signal. A cut section would also be necessary here.

Three Methods of Control

There are three methods available for controlling the flashers at this crossing:

1) Standard dc track circuits. Cut sections would be required in existing track circuits and CTC circuits broken through all of them. The northbound start would fall within the PRR interlocking.

2) Standard dc track circuits, but using the whole detector track circuit. A time element relay could be used to time down the approach for a closer approximation to the ideal warning time. This would entail, in addition to the time element relay, additional line wires to the CTC case at the tower. Installing these line wires would present a problem as the existing three crossarms are full, and wires on a fourth crossarm would be below clearance over the PRR tracks.

Considerable over-ringing would be involved whenever a train was stopped at the interlocking or otherwise traveling at reduced speed.

3) The use of audio frequency overlay track circuits (AFO).

The DT&I chose to install the AFO type circuits because it would cost less to install AFO circuits than to use either the full detector circuit with a time element relay and additional line wire, or standard dc track circuits with cut sections. It would be necessary, nevertheless, to involve the interlocking at two locations. Bootleg connections to the rails would have to be made at the start (location "A" on drawing), and a "jumper" placed to carry the AFO around the insulated joints at the home signal (location "B"). In this case, the "jumper" is a band-pass filter, allowing frequencies of 1.0 to 1.5 kc to pass, but blocking both direct current and higher frequencies. Also, a reactor would have to be placed in the dc track circuit feed for the detector circuit.

The filter, or track coupling unit (TCU), was placed in the DT&I's case at the home signal, with an additional set of bootlegs and a cable run to this existing case from the detector track circuit.

The PRR and DT&I agreed that DT&I forces could make the rail connections at the two points. PRR forces installed the reactor in their track feed.

One set of Nife operating battery was installed at the flasher site. Track battery was, of course, unnecessary. Rather than install 10-volt battery and rectifiers at the starts, one line wire was strung 2,200 ft, so that the one set of battery feeds from location "C" both ways, to cases at "A" and "D." The existing common for the CTC circuits was utilized for the return path. The current drawn by the AFO units is very small and it uses little of the reserve capacity of the common wire.

Lightning surge suppressors were required at the receiver and transmitter locations, "A," "C" and "D," to protect the transistors in these units from voltage surges that may be picked up in the open wire lines over which the battery voltage is transmitted. These surges may be due to lightning or from a paralleling power line.

Because of the frequencies at which these AFO units operate, single conductor track cable with a bronze shielding tape, the DT&I's standard, could not be used. Two conductor No. 8 AWG was used for the track cable at all four locations.

Adjustable Cut-off Point

At the suggestion of Union Switch & Signal engineers the track connections at the road crossing "C" were made as close to the edge of the pavement as possible. The point at which the AFO track relay picks up after the passing of a train can be controlled by making an adjustment on the AFO receiver. Further, this will vary somewhat with ballast moisture conditions. Under dry ballast conditions a range from almost zero feet to about 25 ft was noted. The DT&I has set this adjustment for approximately 12 ft.

At future AFO installations the distance "d" from the edge of pavement to the bootleg connections, will be increased to about four feet, as drainage from the pavement may tend to accumulate here.

Total cost of labor and material for the installation was $10,500. The cost was apportioned 50 per cent each for the County of Wayne and the DT&I.

The circuits were designed by DT&I engineers with the cooperation of Union Switch & Signal, and installed by railroad forces under the jurisdiction of W. G. Clinton, Superintendent Signals and Communications. The flasher signals were furnished by Western Railroad Supply Co., instrument cases and lighting transformer by Transcontrol Corp. Relays, AFO units, and other signal equipment were furnished by Union Switch & Signal, Division of Westinghouse Air Brake Co.