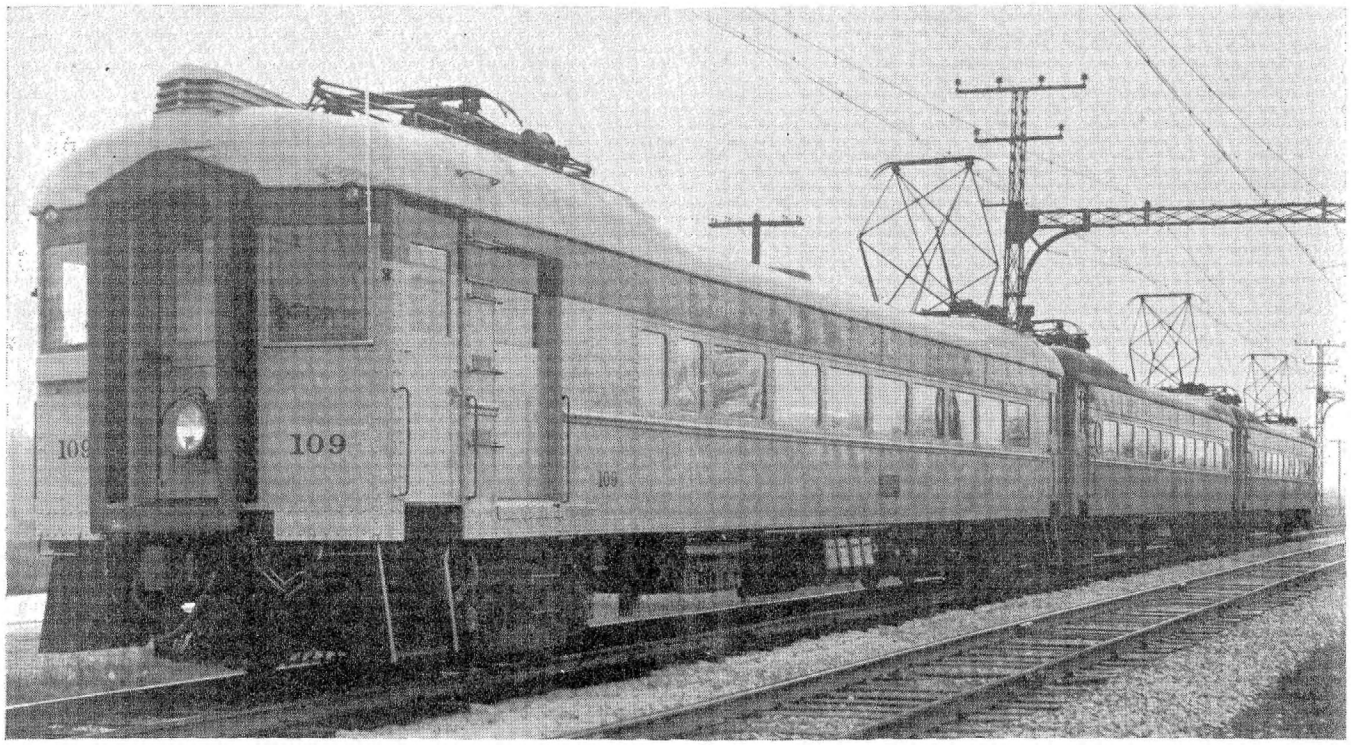


Passenger train Car 109 equipped with 50-watt radio—Note coaxial antenna at nearest corner of car

New Space Radio Relay System

Adopted by South Shore Line

By F. J. Corporon

Assistant Superintendent Way & Structures

Chicago, South Shore & South Bend, Michigan City, Ind.

First of its type to be authorized by the Federal Communications Commission, installation on 77-mi. stretch of electrified road enables two-way communication between dispatcher and freight and passenger trains, maintenance trucks and supervisors' autos

THE Chicago, South Shore & South Bend is an electrified passenger and freight carrier operating from Chicago to South Bend, Ind. From Randolph Street Station, in Chicago, to Kensington, Ill., it operates over the Illinois Central and, from Kensington to South Bend, over its own tracks. The rail distance between South Bend and Kensington is 77 mi. This is a very busy stretch, with 68 passenger trains daily between Chicago and Gary, and 39 between Chicago and South Bend. In addition, a large number of freight trains are operated daily, these trains being hauled by electric locomotives.

Our planning for radio dates back to 1946, when C. H. Jones, vice president and general manager, saw the possible advantages of two-way radio communication in train operation and emergency maintenance. Our first investigation of the practicability of two-way train radio was discouraging, as we encountered many limitations which seemed to preclude a flexible system that would serve our purposes. The most feasible plan in our investigation, however, was arrived at in collaboration with L. G. Sands, sales engineer for the Bendix Radio Division. More than a year elapsed before our unique radio communication system emerged from the preliminary planning to actual experimentation. Now, our system is a reality and is saving time and money, with new ways found everyday to improve our service to passengers and shippers.

Communication Requirements

Communication direct from the dispatcher's office to trains and maintenance vehicles from the dispatcher's office was required, the problem of

getting greater coverage from VHF signals, limited by horizon distances, having been our main problem. The dispatcher's office is located at Michigan City, Ind., approximately half-way between Kensington and South Bend. In order to cover the entire railroad, it would be necessary to use at least three land stations employing VHF radio in the 152 to 162-mc. band. The usual method of operation in such a case would be to tie in these three land stations by means of wayside telephone wires which, in itself, would have been a weakness of a space radio system. Also, we needed to control the equipment from any desired point along this land line. This dependence on land lines for the control of these radio stations would subject the radio communication system to the same hazards in winter as existing telephone communication. Radio would be most useful at times when the overhead catenaries were disabled, and at such times the telephone lines too are usually out of commission. If some sort of a radio-controlled system could be devised, independent of land wires, we felt that it should be utilized in our radio communication system.

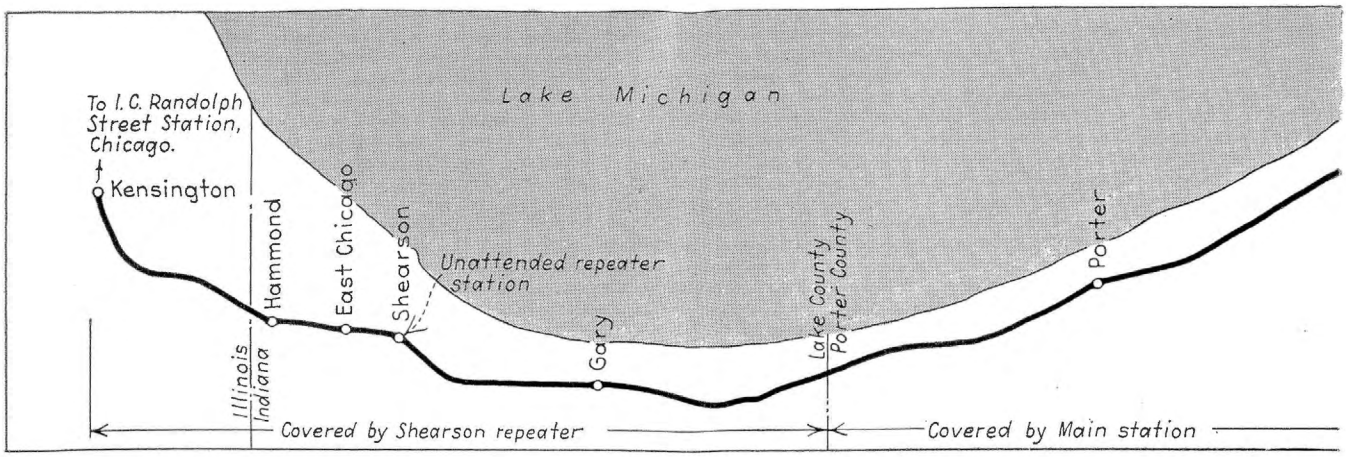
Our engineers, working with Bendix, devised a mobile radio relay system to provide us with the desired communication without depending upon land telephone wires for the control of our radio stations. Thus, we envisioned a true space radio communication system to reach trains anywhere on our lines with none of the faults of previous systems; we could cover our whole railroad with dependable static-free VHF communication. Our answer was to install two automatic radio repeater stations, one to the east of Michigan City and one to the west. Radio communication from the central land station at Michigan City to trains within a 15 to 20-mi. radius of this point would be handled direct without the use of the repeater stations. Communication to mobile units *beyond* this distance, would be through simultaneous retransmission over the two automatic repeater stations. In a like manner, signals from the mobile units to Michigan City would be relayed through the nearest repeater station, if more than 15 to 20 mi. from Michigan City.

Equipment Involved

At Michigan City, two sets of land-station equipments are employed, one for direct contact with mobile units within the direct range of Michigan City, and the other for activating the two automatic repeater stations. Control facilities for both sets of land station equipment are located in the dispatcher's office. One of the refinements of our new system is that only *two* radio channels in the 152 to 162-mc. band are required—158.43 mc. and 161.37 mc. Cross-channel operation is used. The westerly automatic repeater station is located at Shearson, Ind., just east of East Chicago, Ind., and the easterly automatic repeater station at Olive Siding, a few miles east of New Carlisle, Ind. The Shearson repeater station is approximately 30 mi. west of Michigan City and the Olive repeater station approximately 22 mi. west. Both are beyond line-of-sight distance from Michigan City.

Bendix Type MRT-1G communication units are used on trains and at both repeater stations, as well as in the main land station at Michigan City. These communication units consist of an FM transmitter and receiver on the same chassis. The power output of these transmitters when used at our land stations and on our passenger trains is 50 to 60 watts, whereas on freight trains a different type of power supply is used, so that about 25 to 30 watts of power is radiated. Supervisory automobiles and certain maintenance trucks are equipped with 30-watt Motorola mobile units. Under one of the two antennas at each repeater station, a Bendix MRT-1G communication unit is used as a receiver. At the other antenna site, a similar unit is used as a transmitter.

Remote control location in dispatcher's office at Michigan City, chief dispatcher A. H. Kambs using handset controling one land station



A simplified map of the South Shore Line between Kensington and South Bend show-

The units are identical and may be interchanged. The repeater stations receive signals from mobile units or the Michigan City land station on 158.43 mc. and retransmit the receiver intelligence on 161.37 mc.; thus the mobile units receive on the latter frequency.

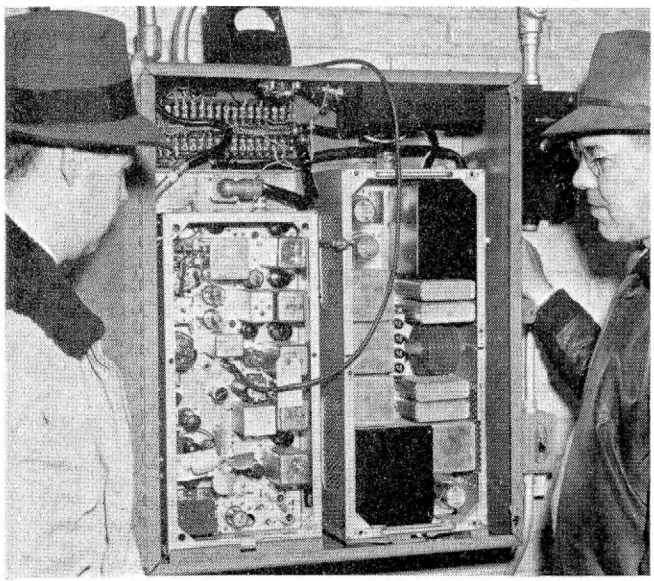
Frequencies and Range

At Michigan City, two Bendix MRT-1G units are employed. One of these units transmits on 158.43 mc. to the automatic repeater stations and receives on 161.37 mc. from the repeater stations. The other communication unit transmits on 161.37 mc. direct to mobile units within the range, and receives on 158.43 mc. from mobile units. When either transmitter at Michigan City is used, a relay circuit disables the other communication unit during the period of transmission. All mobile units transmit on 158.43 mc. and receive on 161.37 mc.

The spacing distance of 1,000 ft. between transmitting and receiving antennas at the relay stations was found by experiment to be ideal, as no interference or quieting is caused to the receiver by the transmitter when relaying signals. Our experience has since shown us, however, that it is not necessary to space these antennas so far apart. Communication between mobile units is possible up to 30 mi. and sometimes ever more through the repeater stations. Signals are received at the repeater stations from one mobile unit and then are automatically and simultaneously retransmitted to the other mobile units. This permits much greater range between mobile units, as the relatively low antenna height on mobile units would normally limit communication between mobile units to much shorter distances.

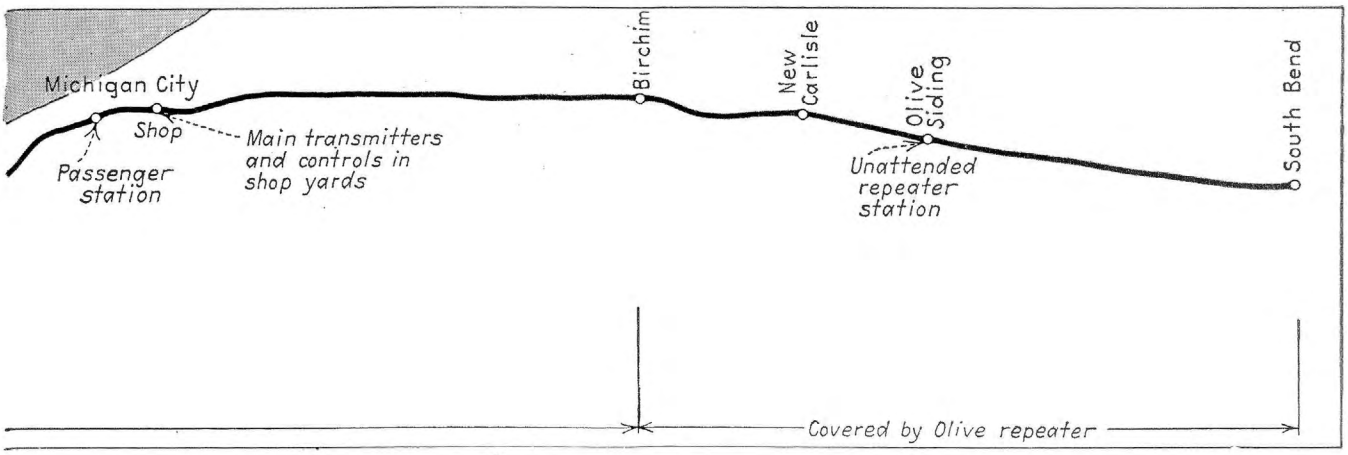
Control of Repeater Stations

At the automatic repeater stations, the transmitters are controlled by radio signals received at the receiving end of the relay station. A radio signal on the proper frequency and of sufficient strength will operate the squelch relay and the receiver. A pair of contacts on the squelch relays turns on the repeater transmitter. Audio output from the receiver is fed through a pair of wires to the speech amplifier input of the transmitter. Whenever the transmitter at either one of the relay stations goes on the air, the dispatcher at



Right—Radio on a line car. The loudspeaker above the window, control at left, transmitter and receiver in case below window, and the dynamotor on the floor

Left — R. B. Hendrickson, assistant engineer and F. A. Zerber, radio man, shown inspecting the land station radio equipment at base of tower at Michigan City



ing locations of main and repeater radio stations and territories served thereby

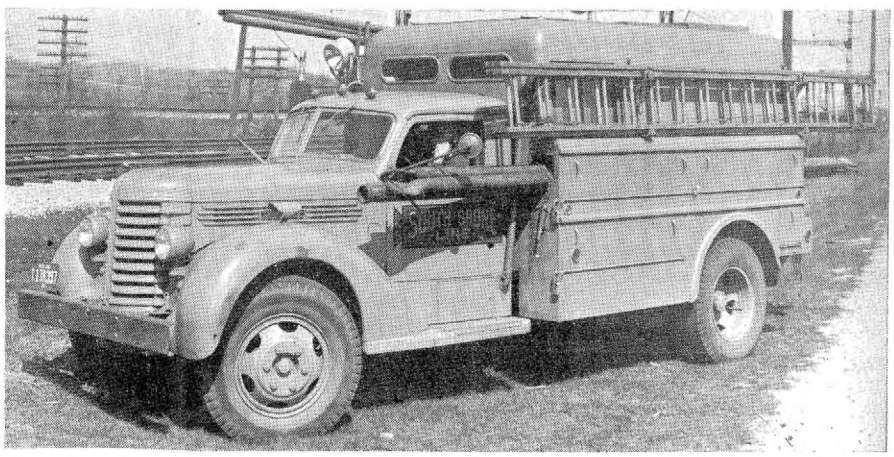
Michigan City will be aware of that fact, as the squelch circuit of his receiver will be operated. The dispatcher's office is equipped with two Bendix Type MS-102A remote control units, each connected to a Bendix Type MT-130A monitoring indicator and a telephone-type handset. The dispatcher may use either of his transmitters by merely selecting the proper handset. The communication units at Michigan City are located in the pump house directly below the standpipe on which two Bendix Type MS-171B lance antennas are mounted 145 ft. above the ground. The communication units are controlled from the dispatcher's office, about 500 ft. away, through underground cable.

Taking a quick look at the entire radio communication system, we can see that the dispatcher may communicate directly or via repeater stations with any of the mobile units on trains or motor vehicles anywhere between Kensington and South Bend. Communication can be maintained with trains as far as the 53rd Street Station on the Illinois Central, although communication is not needed beyond the junction where our trains enter upon the tracks of the Illinois Central. In addition, crews at any of our mobile units can communicate with the crews at any other mobile unit when within the service range of either of the two repeater stations. When mobile units are too close to Michigan City and are out of the operating range of either of the two repeater stations or if one mobile unit is in the service area of one repeater station and another is in the service area of the other repeater station, communication between these two mobile units may be manually relayed by the dispatcher at Michigan City.

Radio Proving Invaluable

Since our space radio communication system has been in operation, we have found that we have, for all practical purposes, 100 per cent coverage of our railroad. In many instances already, radio communication has proved invaluable. Our line car is equipped with two-way radio and, in case of trouble, we have been able to reach the crew of the line car while enroute, to send them directly to the trouble spot; this eliminates even a moment's delay and we are often able to catch up with trouble before it happens. Our supervisors, traveling in automobiles and our maintenance crews traveling in trucks, can be reached by the dispatcher along any part of our railroad. This added system flexibility gives us a new dimension of operational efficiency. Our line car, several motor vehicles, two passenger trains and two freight locomotives have already been equipped with radio. It is expected that the remainder of our freight locomotives will soon be equipped with radio and that radio will be expanded to cover all of our through passenger trains.

W. J. Mallon, superintendent of way and structures, is in charge of our system planning, assisted by the writer and R. B. Hendrickson, assistant engineer way and structures. The system was installed and is being maintained by F. A. Zerber, contract radio communication engineer. This is the first radio communications system of its type to be authorized by the Federal Communications Commission, and it is our feeling that similar systems might be of value on other short-line railroads and on sections of the larger railroads. The major items of radio equipment for the installation were furnished by the Bendix Radio Division of the Bendix Aviation Corporation.



Line maintenance truck equipped with radio so that the dispatcher can communicate with the crew foreman anywhere