Train Telephone Communication

System employed by the Pennsylvania provides continuous communication between trains, between front and rear of trains, and between trains and wayside towers

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Engineman using the train telephone to talk with a block operator miles away

A LONG felt need for a means of communication between trains, whether moving or standing, and between trains and wayside stations is believed to have been met in the train telephone system being given trials on the Belvidere branch of the New York Division of the Pennsylvania Railroad. This telephone system is the result of joint development by the Pennsylvania and other railroads* with the Union Switch & Signal Company over a period of several years. Since the earliest days of experimentation with radio, the railroads and manufacturers of electrical equipment have been attempting to solve the problem of providing reliable communication on and between railroad trains and wayside stations.

This innovation is the latest of a long list of improvements developed by the Pennsylvania and other railroads in co-operation with various electrical manufacturers to expedite train movements and afford better service for the public. Discoveries and developments in the field of electronics have been utilized by the railroads in numerous ways, and constant research is under way to find means of further increasing the efficiency of railroad operations. Among more recent contributions in the field of electrical and electronic developments are centralized traffic control, dragging equipment detectors, cab signals, radio-telephone tugboat dispatching, telephone announcing systems in yards and stations, yard engine telephone systems, magnaflux method of examination of axles for cracks, Sperry apparatus for detecting flaws in rails, and the like.

*Editor's Note—For detailed explanation of circuits and apparatus, see page 665 of *Railway Signaling* for December, 1943. For explanation of installation of this communication system on Bessemer & Lake Erie, see page 387 of July, 1940.

Cab Signaling Leads to Communication System

Among these, an outstanding contribution to train operation is the cab signal, by means of which a signal is displayed in the cab of an engine reproducing wayside signal indications and keeping the engineman constantly advised of the conditions on the track ahead of his train. In the development of this cab signal system, it was found that a further extension of the application of electronics to railroad operation was possible to provide a means of communication between moving trains, and between moving trains and wayside stations.

The train telephone in use on the Pennsylvania Railroad today, is a result of these studies. Actually, it is neither radio nor telephone. It incorporates certain features of both types of equipment and eliminates other features of both systems. So far as radio is concerned, it must be remembered that, essentially, communications by radio are broadcast to all suitably tuned receiving sets within transmission distances through ground and atmosphere; i.e., through transmission paths universally provided by nature. Radio would possibly fulfill the requirements of communication between moving trains and between moving trains and wayside stations if it were not necessary to share with others the privilege of the air and conform to Federal rules and regulations so essential to the maintenance of order under crowded and competitive conditions. On the other hand, wire telephony does not fulfill all of the requirements of communication between moving trains and wayside stations for the reason it is confined to definite wire transmission paths from the transmitter to the receiver.

The train telephone system in use by the Pennsylvania on the Belvidere branch combines certain features of radio and wire telephony, utilizing the constant contact with moving vehicles possible by radio

and at the same time restricting the transmission paths to railroad property. Railroad vehicles invariably use track rails which extend to all areas requiring communication with moving equipment. Thus the rails offer a most desirable communication transmission path. The rails,

The block operator uses train telephone to call the crew of a freight train miles away

A freight train conductor calls his engine crew on the telephone

together with adjacent communication pole lines, are utilized for the transmisison paths and the electronic equipment, electron tubes, condensers, coils, and the like, on engines, cabin cars and wayside stations provide the means of utilizing radio principles in maintaining the constant communication contact so essential to the success of the scheme.

Tests Started in 1941

Experimental installation of the Union Train Communication System on the Belvidere branch was authorized in September, 1941, and in June, 1942, an engine and cabin car had been equipped, wayside appliances installed and placed in service. To date, 10 engines, 10 cabin cars and 1 block station have been equipped, and an additional block station will soon be in service.

It is a carrier telephone system using the upper side band of a 5,700-cycle carrier for transmitting calling signals and voice. The carrier current is fed conductively into the rails, picked up inductively from the rails and induced in the wires of the communication line adjacent to the track. It is carried through the rails and line wires between front and rear ends of trains, from one train to another train and to wayside stations by direct-wire connections in the vicinity of the station.

At the sending telephone on the engine and cabin car, a circuit is provided by a loop from an insulated truck to adjacent track via the rails, and a current at carrier frequency is sent out along the rails and adjacent line wires with the return path through the ground. The impedance drop in the rails between the insulated truck and adjacent truck causes the transmitting rail voltage. Receivers pick up the energy which is transmitted through induction coils in proximity of the rails and is amplified and demodulated for reception in the loud speakers and handset telephones.

A the station, the output or transmitting connections from the set, when talking or signaling, are made to a simplex leg of a block line and to the rail system, the circuit being completed by the capacity coupling between the block line and the rails the length of the branch. The receiving connections at the station are made to the track rails at points about 150 ft. apart, the impedance drop of which provides the energy which is amplified and demodulated for reception. There is no interference in operation between this system and radio, telephone or signaling systems.

Train Equipment

The engine and cabin car equipment consists of a weather-proof instrument shelter containing electron tubes, condensers, coils, dynamotor, fuses, etc.; a source of power supply; an output transformer; two receiving coils; a loudspeaker; a control box; necessary wiring and conduit.

The equipment box or instrument shelter on the engine is located on the running board near the front end, the output transformer is in front of and below the smokebox, the receiving coils are about 4 in. above top of each rail and located between the engine truck and front drivers, the loud-speaker is in roof of cab above engineman, the control box with calling button, indication lamps, volume control and handset is in cab above and in front of engineman.

The equipment box and storage battery in the cabin car are under one of the seats; the output transformer is under the cabin car about midway between the trucks; the receiving coils are about 4 in. above top of each rail between the trucks; loud-speaker is in the cupola; control box with calling button, indication lamps, volume control and handset are on a partition of the car. The removable equipment trays in the equipment boxes on the engine and cabin car are interchangeable. The electron tubes are the same as those used for telephone, radio and other purposes.

Block Station Equipment

The block station equipment consists of a metal cabinet which houses the electron tubes, coils, condensers, rectifier, transformers, etc., for calling, transmission and reception; a desk stand microphone, with calling button and lamp indicator in the base and a head band receiver; foot switch for transmission; loud-speaker with volume control for reception of calling signals and conversation. When head band receiver is being

The bar of metal shown below the cylinder is an end of receiving coil

used, the loud-speaker is cut out. The set is normally in receiving condition when turned on.

Power Supply

The power required is about 150 watts for receiving and a maximum of about 550 watts for calling and talking. It is furnished on the engine by the headlight generator, on the cabin car by storage batteries, and at the block station from commercial 110-volt 60-cycle supply.

It was found desirable, for the most satisfactory operation, to provide one bonded rail of the main track, and to install resistance shunts around all insulated joints.

Truck Insulation

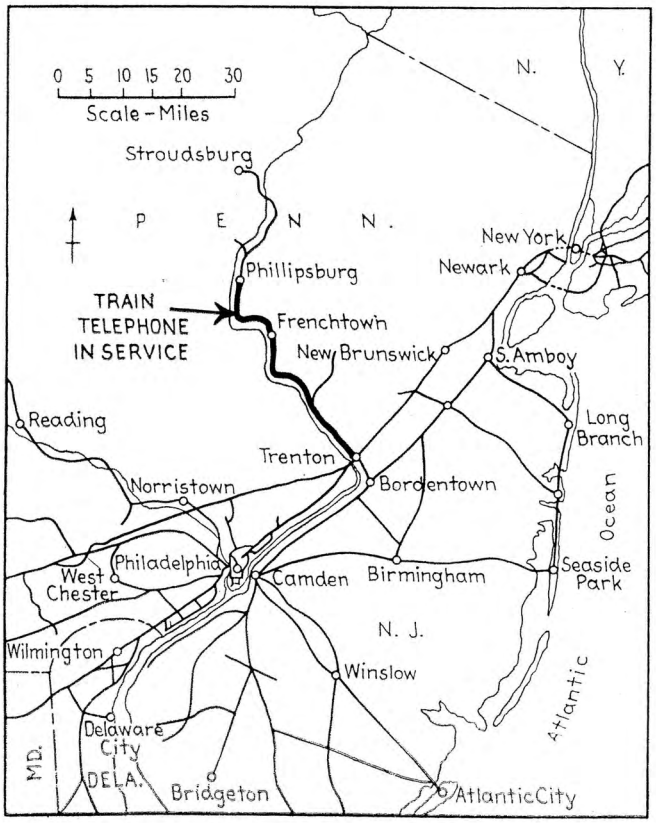
Insulation of cabin car tracks, essential for operation of the telephone system on cabin cars, was found to present little difficulty. A design was developed employing ⅛-in. hard fibre to withstand moisture, so placed that no wearing or rubbing surfaces are in contact with the fibre, and effectively separating all metal parts through which current could pass from the frame of the cabin car to the wheels to which the transmitting circuit was connected. Insulation of wheels of engines was found to present varying problems for different types of engines; on the mikado type used on the Belvidere branch, the front engine truck was found to be most adaptable for insulation as has been the case with other types of freight engines studied.

The map shows the portion of the Belvidere branch on which the train telephone is regularly used, namely Trenton to Phillipsburg, a distance of about 50 miles. Equipped engines and cabin cars entering the territory at Phillipsburg and at Trenton are tested by the engineman and conductor in conversation with each other and with the operator at Frenchtown. The telephone equipment on engines and cabin cars is kept turned on continuously between these two points. When the telephone is to be used, a calling signal is first sent out by means of a push button on the control panel which causes an audible signal to sound in loud-speakers of receiving sets at the wayside station and on engines and cabin cars within the radius of operation. The person calling, then broadcasts the name of the station or the number of the engine of the train and whether engine or cabin car is being called, until response is received and telephone communication established.

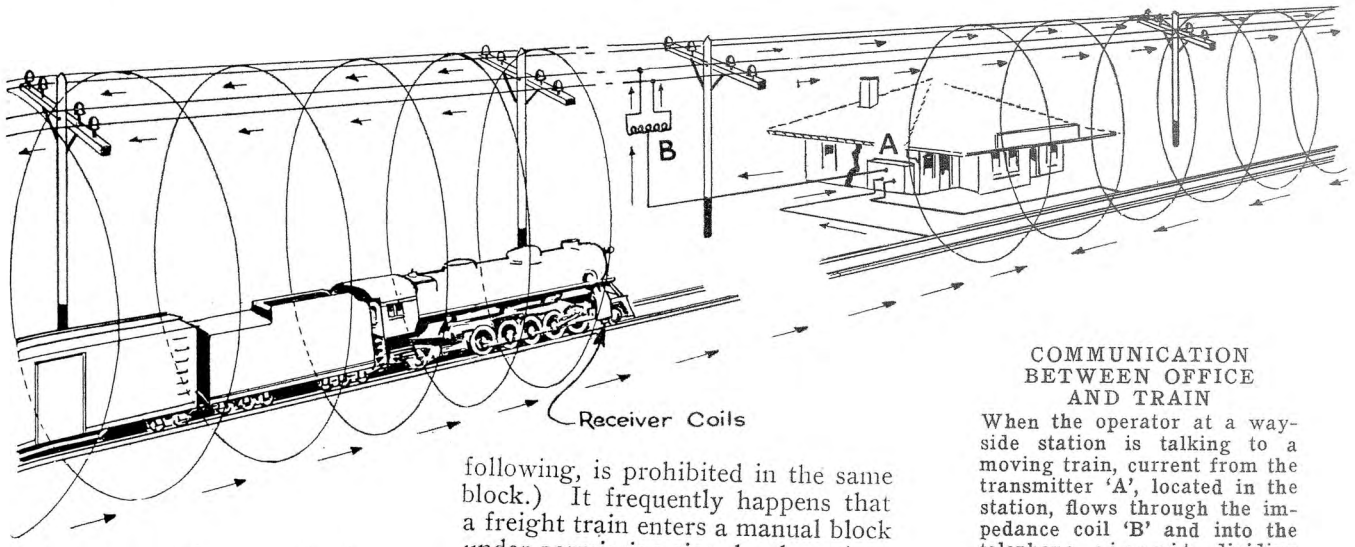
Benefits of the System

Experience with the daily use of the system on the Belvidere branch has shown numerous advantages, in movements of trains, by reason of the close contact which is constantly available between the train employees on the front and rear of trains and between them and the operator at Frenchtown.

The operator finds out by telephone from the engineman and conductor just what is occurring in their movements, keeps the train dispatcher fully advised and thus permits accurate planning of all train movements affected. When anything unusual happens, all persons interested are promptly advised and ad-



Map showing the section equipped with the train telephone communication system



COMMUNICATION BETWEEN OFFICE AND TRAIN

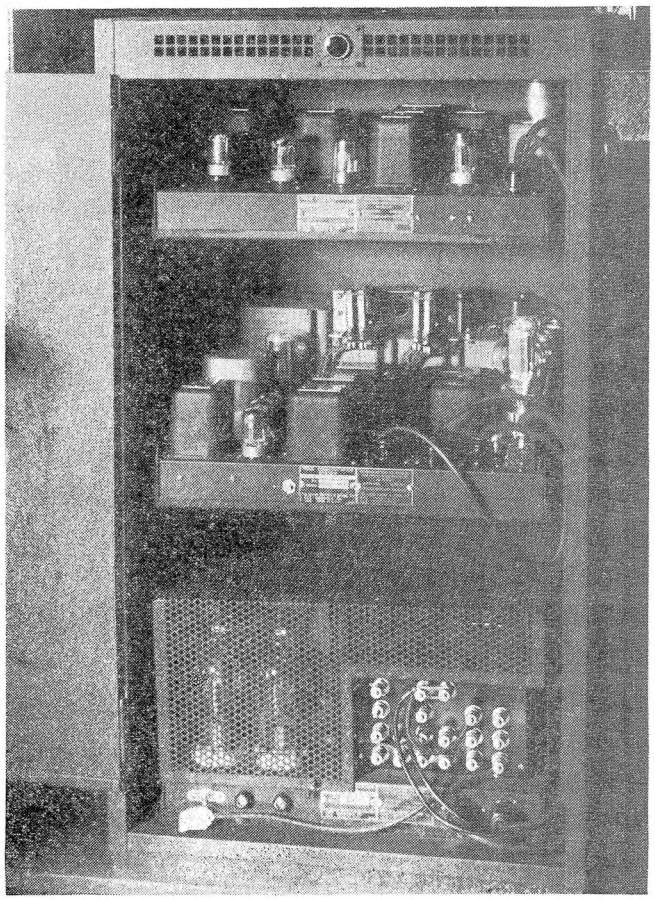
When the operator at a wayside station is talking to a moving train, current from the transmitter 'A', located in the station, flows through the impedance coil 'B' and into the telephone circuit, dividing equally between the two lines and returns by capacity coupling through the ground. When the operator is talking, a current is continuously induced in the running rails of the track. This induced current is picked up from the rails by the receiver coils mounted on the locomotive and on the cabin car. This current is then amplified and translated into voice reception. When a member of the train crew is talking to the office, he applies local current to the track which induces current in the line wire over which it is transmitted to the station.

vantages are taken on the instant, reducing delays which otherwise would occur if wayside telephones had to be used for reporting the circumstances.

Communication between the engineman and conductor incidental to the movements of their train has been found to improve operations and reduce delays; starting and stopping, switching, setting off and picking up cars, testing air brakes, taking water and coal, handling equipment becoming defective en route and many other matters affecting the prompt movement of trains are subjects of telephone conversations carried on daily by the train telephone system.

With traffic density of 10 to 12 through freight trains and 4 passenger trains daily, the installation of automatic block signals has not been found necessary on this line. Since the early days of railroading, trains on the Belvidere branch have always been carefully protected by the particularly restrictive form of manual block system standard on the Pennsylvania. With the inauguration of the train telephone, great benefit has been derived in safely handling trains under this manual block system as would be true under any signal system. In fact, the constant contact between trains and the block operator at Frenchtown permits of movements complying with all the restrictions of the manual block system to be made almost as advantageously as though automatic block signals were in use. Conductors on trains entering sidings or clearing a block previously occupied use the train telephone to advise the operator; operators use the train telephone to tell the engineman the train may enter main track from siding or enter a block and whether the block is occupied by another freight train. (Opposing trains or a passenger and a freight train, either opposing or following, is prohibited in the same block.) It frequently happens that a freight train enters a manual block under permissive signal only a short time before a train ahead clears the block at the other end; with the train telephone, the operator is able to call the engineman of the following train and tell him the block is then clear, thus permitting the train to proceed safely at increased speed.

It has been said a railroad signal system is merely a means of communication; the train telephone gives promise of becoming a valuable aid generally in efficiently controlling train movements under all signal systems, as well as providing the many other advantages inherent in this new form of communication.



Train telephone wayside equipment cabinet at Frenchtown