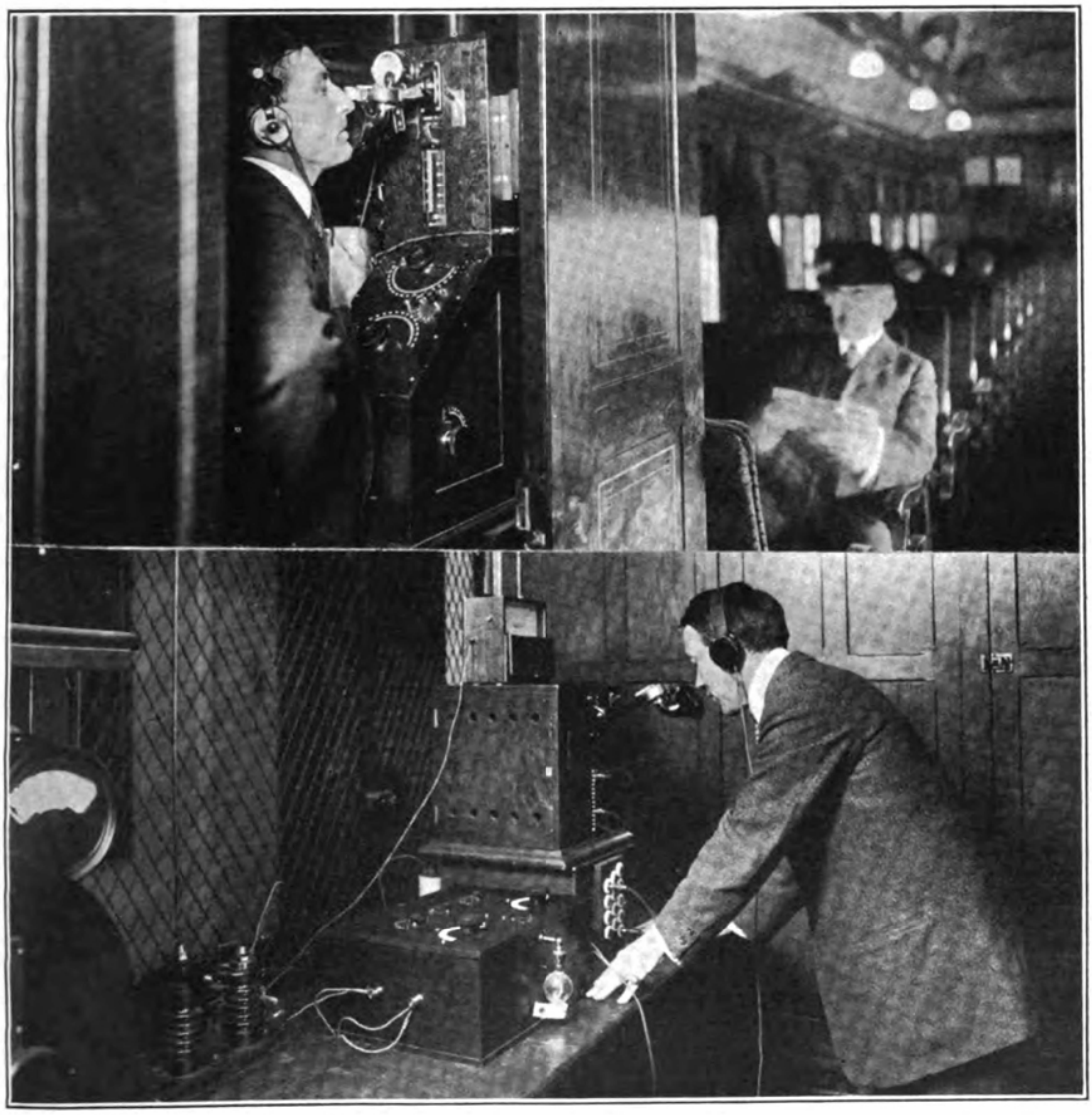
Wireless Telephoning From Moving Trains

By L. B. Foley, Superintendent, Telephone, Telegraph and Wireless, Delaware, Lackawanna and Western Railroad.

LAST year the Lackawanna Railroad Company, after successful experiments in telegraphing without wires to and from one of their Limited trains, decided to attempt to substitute wireless telephony for the telegraph if that should prove feasible. The purpose of this was to obviate the necessity for adding a Morse telegraphist to the regular train crew. The superintendent of telegraphs of the Lackawanna, Mr. L. B. Foley, who has been for years an ardent advocate of the commercial application of wireless to railroad work figured that the saving thus represented in one operator's salary represented the interest at six per cent on a $1,500 investment, and that therefore his road could well afford to go to the additional expense of equipping two of the



Upper Picture Shows Telephone Transmitter and Telephone Operator in the Compartment of a Moving Train. Lower Picture Shows the Transmitter and Operator at the Fixed Station at Scranton.

Limited trains on the New York-Buffalo run with radio telephone apparatus in place of the wireless telegraph, and also to install similar apparatus first at Scranton; to be followed ultimately by other track-side telephone installations at other division headquarters.

The problem of telephoning to and from fast express trains was by Mr. Foley put up to Dr. Lee deForest, America's pioneer in the radio telephone field. This expert lost no time in designing and building a special type of wireless telephone which was first installed last spring at the wireless station at Scranton.

During these first trials no attempt was made to telephone from the train, but in the receiving instrument on the eastbound train out of Scranton, the voice of the speaker at the transmitter was clearly understood on the train as far east as Strausberg, over 52 miles, when traveling over 50 miles an hour.

Confirmed in their confidence of success by Forest decided upon a permanent train installation as well.

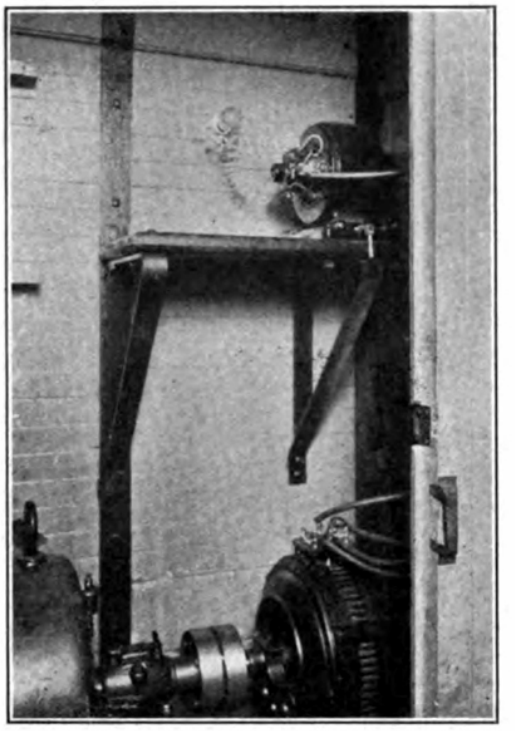
This apparatus has recently been completely installed on the Lackawanna Limited Train No. 3, which leaves Hoboken for Buffalo daily at 10.15 A. M. A description of this installation and of the very satisfactory results already obtained follows.

The "antenna" system of radiating on receiving wires consists of two No. 10 stranded phosphor bronze wires on each side of the roof of four cars comprising the first four in the train, supported on large petticoat porcelain insulators on iron stanchions of each corner of the car roof. These wires are 18 inches above the metal roof of the coaches. When the train is made up the antenna wires of all four coaches are connected in series by means of flexible connectors, so that the entire system is some 300 feet in length.

The power plant for the wireless telephone generator is located in a closet in the front end of and baggage coach. It consists of a five-horsepower Terry steam turbine direct coupled to a special high-frequency alternator designed and built by the deForest Radio Telegraph and Telephone Company, of New York. Steam is supplied directly from the locomotive at a normal pressure of 125 pounds. This pressure is controlled by a reducing valve in the steam heating pipe beneath the car. The turbine exhausts directly downward on to the track bed.

The operating speed of the turbine-generator unit is 2,500 r.p.m., and this is maintained within close limits by means of a special governor under the specially several conditions obtaining here where the full generator load is thrown on and off as the radio telephone apparatus is frequently and suddenly switched from transmitting to receiving.

The special conductor type alternator is excited from a quarter kilowatt 110 volt exciter supported on a shelf directly above the alternator, and belted to a pulley on its shaft extension.



STEAM TURBINE AND GENERATOR LOCATED IN BAGGAGE CAR.

Alternating current having a frequency of 6,000 cycles is led through two separated leads in wooden conduits to a pair of Gibbs train connectors at the rear end of the baggage coach, and thence to the radio telephone booth in the rear end of the smoking car next adjoining. A pair of leads from the alternator field and exciter are also led into this compartment to enable the telephone operator to easily regulate the voltage and power input.

The illustration shows the form of radio telephone transmitting and receiving apparatus installed on this train. It follows in general design the lines of the familiar wall telephone set, though of course somewhat larger.

The radio transmitter is in the upper part of the instrument, the receiving tuning instruments in the lower part, set at an incline, so as to give the operator ease in tuning his receiver to any transmitted wave length.

The deForest Audion Detector, indispensable in wireless telephone work, is used. This instrument is shown on the little cabinet fastened to the door of the transmitter case. The usual pair of sensitive high-resistance double telephone receivers are shown connected to the Audion detector.

The entire telephone apparatus is thus of exceptionally neat and compact design, well suited to complete ease of manipulation, and could scarcely be improved upon from the standpoint of simplicity of operation.

This new deForest radio telephone transmitter, a patent on which has just been issued, marks a great advance over all old forms of the direct current arc transmitters or generators of high-frequency currents.

The arc apparatus, from its very nature, could not be made reliable and free from frequent adjustment and skilled regulation. The new type, however, is really "fool-proof." As bearing out this statement may be cited the fact that once the quench spark gap here employed is properly adjusted it is locked up so as to make it impossible for the operator to touch it or alter its adjustment.

The transmitter circuit here employed is peculiar to this type of apparatus and does not comprise the tuned coupled circuits usually employed in wireless transmitters.

This novel circuit arrangement greatly simplifies the tuning of the transmitter. Moreover, the antenna system is not tuned to the primary, nor even "substantially in tune" with it, but the wave length of the transmitted radiation may be varied through generous limits by merely shifting the contact switch shown on the front of the transmitter case. Once this is set to the desired wave length no further attention on the part of the speaker is required except to push down the little "listening switch" for talking, and to lift same for listening.

This little switch also controls the filament-lighting current of the Audion bulb, which thus becomes a visual signal to guide the speaker. He can not telephone when this light is lit, nor can he receive when the lamp is not lighted.

It is not necessary to speak into the transmitter louder than in ordinary long-distance wire telephoning. In fact, the articulation suffers and the range is diminished if one attempts to shout into the transmitter mouthpiece.

The preliminary trial trips of the Lackawanna Limited carrying the deForest telephone were made during the week of February 7th last. Contrary to expectations it was then found that, after preliminary adjustments, regulation of the steam turbine, etc., had been perfected, the voice from the rapidly-moving train was received at the Binghamton wireless station of the railroad over almost as great distances as from the fixed station to the train. This is, of course, partly due to the fact that the train noises interfered with the faintest sounds received. These train noises would, in fact, reduce the range of reception on the train to ten miles were it not for the extraordinary efficiency of the deForest Audion amplifier, or telephone relay. On the train a two-step Audion amplifier is employed, very similar to that now used in transcontinental telephone service by the American Telegraph and Telephone Company (who recently purchased the wire telephone rights to all the deForest Audion patents). By this amplifier the voice-currents as received are amplified as much as 60 times their original intensity, without the slightest distortion, and are thus raised so far above the train noises that the voice of the Scranton operator, for example, can be distinctly heard when the train is 30 to 40 miles distant.

Thus it appears that the little Audion, first as detector and then as amplifier, is as essential a feature in his epoch-marking introduction of radio telephony to railroading as is the new transmitter system itself.

The following brief report on the first official trial trip was sent to President Truesdale of the road by Mr. Foley:

"Five wireless telephone messages were received at Binghamton passenger station, from train number six on February 7th, passing the following stations:

	Distance.
Loundsberry	26 miles.
Apalachin	14 "
Vestal	8 "
Hallstead	14 "
Alford	27 "

Railroads throughout the country generally are already evidencing keen interest in this pioneer work of the Lackawanna road, especially for freight train service they see where a great economy can be effected even by the simplest one-way radio telephone service from signal towers to the caboose of through freight trains. Each unnecessary stop that a long heavy train is now compelled to make represents a loss to the road of from $20 to $30. It frequently happens that scheduled wayside stops of a "manifest" freight train could be avoided were it possible to telephone the latest new orders to that train crew, while under full speed.

By a series of small radio telephone stations located at certain signal towers along the right of way it will now be possible to convey these orders verbally to the train conductors or to the engineers direct.

Dr. deForest has recently brought out a very small radio telephone transmitter which can be profitably installed complete for less than $400, capable of telephoning to a caboose over a range of two or three miles. He estimated that a railroad line of 500 miles can be fully equipped for such freight signaling service for an initial outlay of $30,000. The monthly interest on this sum at five per cent is $125. Operating expenses of these small radio telephone transmitters plus that of the caboose receiving stations, would not exceed $1,000 per annum all told, including power consumption, deterioration, etc.

Railroad men state that on such a road a daily loss of $200, due to "unnecessary" stops of the manifest freights, is a conservative estimate. The probable saving which can thus be effected by such radio telephone service is therefore receiving, just at present, their most careful consideration.