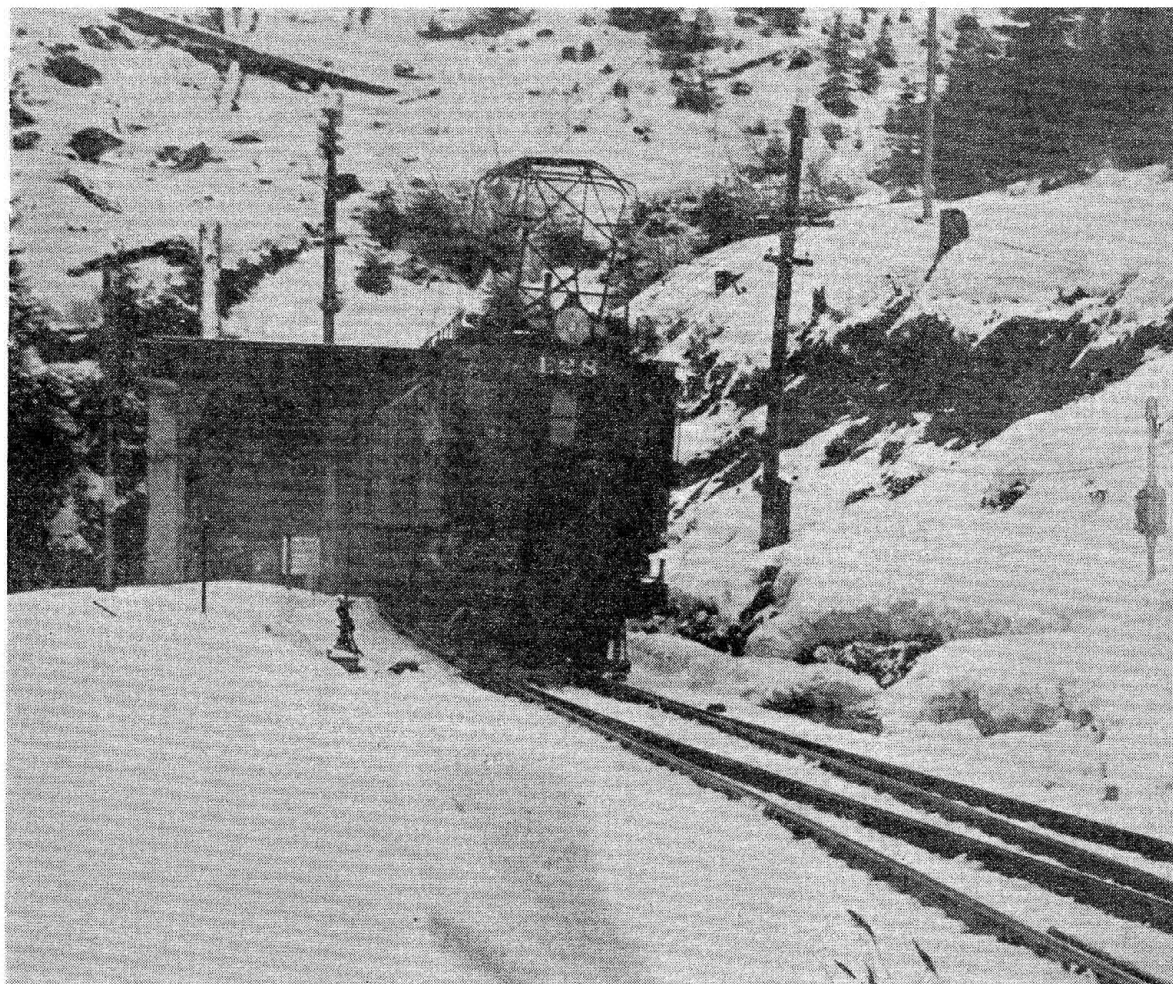


Electric locomotive emerging from the Snoqualmie tunnel during train communication tests on the road



Milwaukee Tests Train Communication

Inductive system gives good results on electrified territory through deep canyons and long tunnel in the Cascades

THE Chicago, Milwaukee, St. Paul & Pacific has recently conducted extensive tests of inductive train communication equipment on electrified territory, 440 miles between Harlowton, Mont., and Avery, Idaho, and 216 miles between Othello, Wash., and Seattle-Tacoma. The first item was to determine whether the train communication would operate satisfactorily under the overhead catenary energized at 3,000 volts d-c. and with a wayside power circuit at 100,000 volts a-c. Also it was quite possible that the traction motors on the loco-

motive, when pulling or when being used in regenerative braking, might cause interference with the train communication. In brief, it may be said here that no such interference was encountered on these tests.

A second item was to be assured that the train communication would operate properly when the locomotive and/or the caboose were running through the numerous tunnels including the Snoqualmie tunnel through the Cascade mountains which is 11,890 ft. long and 1,500 ft. below the surface of the ground at the deepest point. Numerous tests proved that the communication operated satisfactorily when the train was in tunnels, in deep gorges or alongside rivers.

Location of Apparatus

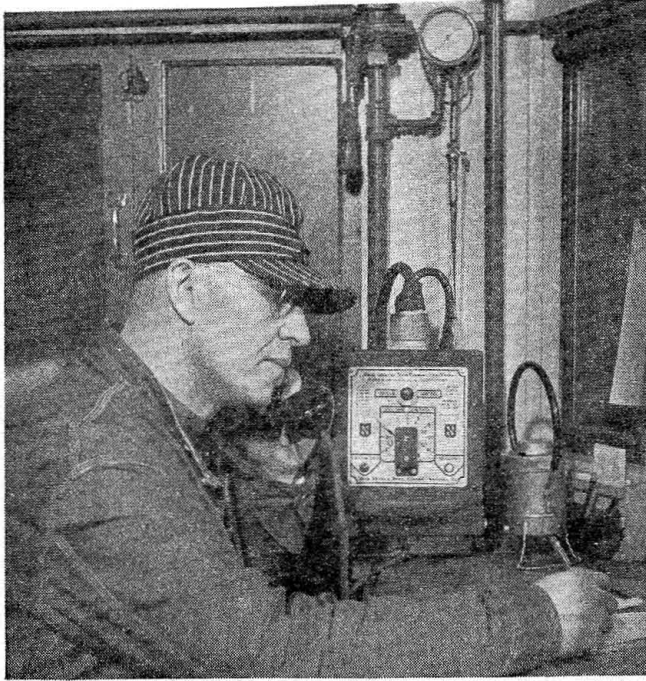
The equipment in the locomotive used by the engineer is the same as that in the caboose used by the con-

ductor. Also a similar set was in service at Hyak, Wash., a wayside station just east of the Snoqualmie tunnel.

Normally the handset, including the transmitter and receiver, is hung on a hanger at the left side of the cab, as shown in one of the accompanying views. On the face of this case there is a dial for adjusting the volume of the loud-speaker which is mounted on the wall of the cab. During the various test runs two-way telephone communication was maintained between the locomotive and caboose at all times as well as between the train and the wayside stations at Hyak and Cedar Falls.

How It Is Used

Normally the equipment in the locomotive and in the caboose is in service to receive incoming calls which are reproduced by the loud-speaker.



Conductor in caboose using the train communication apparatus to talk to engineman

For example, if the conductor wishes to talk to the locomotive, he removes the hand set from the hook, holds it to his head and, when speaking, he presses a button on the handle of the hand set. The conductor would say—"Caboose number 11 calling engine E28, over." The word "over" indicates the end of the call or statement so the engineman will know when to come in with his answer. The engineman, when hearing the call, takes his hand set and answers—"Engine E28 answering caboose 11. What do you want? Over." When the conversation is finished, both hand sets are returned to the hangers.

To the left of the dial there is a small lamp which is lighted to indicate that the equipment is energized ready to receive messages. A lamp to the right of the dial is lighted when a message is being sent, and a lamp, marked "speech control," above the dial, flashes intermittently when the person talking is using the correct volume of voice. This is an aid to a man learning to use the communication system.

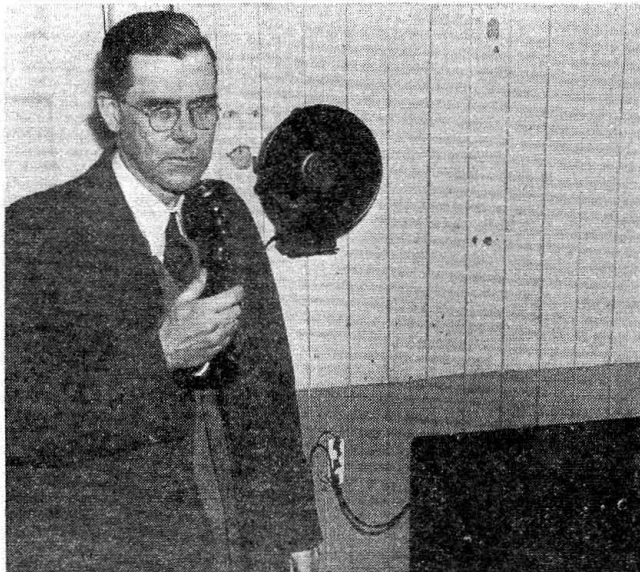
Details of Inductive Communications

The equipment used in these tests is the Union Switch & Signal Company's inductive system of train communication, in which the transmission between the head end and rear of the train as well as between the train and the wayside station in this particular set is accomplished by means of 88 kc. frequency modulated carrier impressed inductively on the rails and the wires on the pole line, so that the

energy is not broadcast over an extended area as in conventional radio, but rather is confined to the railroad right-of-way and immediate vicinity thereof.

Low Power Limit

This installation of inductive train communication is adjusted to operate within the low power limits of the Federal Communications Commission



L. F. Donald, general manager, Milwaukee Road, Lines West, using the wayside equipment at Hyak to talk with the men on the train

and, therefore, is not in the same class as radio broadcasting, and, for this reason, no assignment of frequencies is necessary. When transmitting from the caboose, for example, the message could be picked up by an efficient radio receiving set tuned to 88 kc. located any distance up to about 2,000 ft. from the track, provided the atmospheric conditions are good for

radio reception. No commercial F-M radio receiving sets are tunable in this range.

Transmitting from a caboose, for example, is accomplished by a single wire loop, one end of which is connected to a bearing on a truck at one end of the car, then the wire extends through the electronic sending apparatus, then up to the roof for the full length of the car and down to connect with a bearing on the truck at the other end of the car, so that the sections of rail which are at various times between the two trucks are included in the one-turn loop. The wire in this loop is No. 4 copper. The installation does not require that either truck be insulated from the car.

The voice currents delivered from the microphone circuit modulate the carrier frequency delivered by an oscillator. The modulation is a frequency modulation and is accomplished by means of a reactance tube which varies the frequency of the oscillator over a predetermined range at a rate which depends on the frequencies of the voice currents. The output of the modulator is amplified in the driver and again in the power amplifier consisting of four 6L6 tubes. The modulated carrier current goes to the output transformer which supplies the energy to the transmitting loop.

The supply to the electronic transmitting equipment requires about 0.5

amp. at 400 volts d-c. The transmitting loop, when sending, carries about 10 amp. and about 60 watts.

Receiving Apparatus

The receiving coil, which consists of 100 turns of wire about 10 in. in diameter, is mounted on the roof of the caboose, this being preferable to

a location under the car over a rail because, when so mounted, noise was introduced when passing over insulated rail joints.

The energy picked up by receiving coils is amplified in its received form in two stages of a carrier current amplifier. It is then heterodyned with the output of an oscillator to produce an intermediate frequency which is chosen higher than the carrier frequency. The intermediate frequency which carries the initial modulation is then amplified through three stages, the last of which serves as a limiter. After this amplification, it goes through a discriminator which is the frequency modulation term for a de-modulator. Here the voice frequency is separated out from the intermediate frequency. The voice frequency is then further amplified and delivered to the loudspeaker or telephone receiver. The band of frequencies used in this system is about 6,000 cycles wide, that is 3,000 cycles on either side of the nominal carrier frequency. This makes available a voice band from approximately 200 to 2,750 cycles which is capable of giving a satisfactory reproduction of voice.

Part Played by Rails and Line Wires

In this system when adjusted to operate at 88 kc., transmission by rails only between vehicles is limited to about 2,000 ft., and for greater distances the use of line wires and/or overhead trolley is essential.

Power Supply for Communication

The electronic equipment of this train communication system operates on a supply of 400 volts d-c. which is produced by a small dynamotor rated at 500 m.a. output at 400 volts. On the caboose, the dynamotor is fed from a set of 16 cells of 450-a.h. storage battery. For these tests, an express car is being used ahead of the caboose, and this set of battery is included in the regular car-lighting system on this car. When in condition to receive messages, the discharge from the battery to the dynamotor is about 6 amp. at 32 volts, and, when sending, the discharge is about 12 amp. On the locomotive the train communication equipment is fed from the 32-volt sources of d-c.

The electronic equipment for either the caboose or locomotive is all contained in a sheet metal case 16 in. high, 16 in. deep, and 48 in. long. The equipment is in three separate units, a sending set, a receiving set and a power unit, each of which is plug connected and can be removed or replaced independently.

General Gray Writes to American Railroaders About the 716th Ry. Op. Bn.

Brigadier General Carl R. Gray, Jr., director general of the Military Railway Service, has addressed the following open letter to all American railroad men:

To: The Railroad Men, Their Families and Friends.

American railroad men who are charged with the safe and on-time delivery of millions of tons of freight each year are fundamentally honest and devoted in their attention to duty. It is their job to see that the receiver of the freight gets it in perfect condition and on time.

I cannot understand how, with their background, members of the 716th Railway Operating Battalion could have strayed so far from the principles which they have always stood for, unless perchance, the accused were in reality men without railroad experience or background, but simply a cross-section of American citizenship drawn into the Army by induction, a proportionate number of which were assigned to the Military Railway Service units. I just cannot feel a group of railroad men had gone wrong to the extent that the reports from the trials and convictions seemed to indicate.

The railroads of America actually crippled themselves to give us experienced officers and a great many experienced enlisted men. In order to have the necessary railroad experience, most of these officers and men really had to be above Army age. Many of them served in the last war. Now with particular reference to the 716th Railway Operating Battalion, this Battalion is composed of 887 officers and enlisted men; only 349 of these were even questioned and 160 brought to trial, of whom almost one-half had had no railroad background. Those with railroad background who were brought to trial represented only three-tenths of one per cent of the total strength of the Military Railway Service in this theater. Of the twenty-two men tried and acquitted, seventeen had railroad background.

One of the men convicted and sentenced to a long term was from my home town, St. Paul, and reports from St. Paul indicate that this man was not a railroad man and that he had a police record before he went in the Army. I have not had a chance to check up on the previous record of some of the others, but I do know that it was most unfortunate, and, to me, definitely misleading that the 716th Railway Operating Battalion's name seemed to be used each time there was a conviction in connection with these black market operations, even though the man sentenced did not belong to the 716th Railway Operating Battalion.

I have no brief for a thief, but I have lived among railroad men all my life and know them to be fundamentally honest. The thing that I want the American public to understand is that neither this Battalion nor any of the American railroad men in the 67 units, and over 30,000 men, are thieves. They are conscientious rail transportation men who are as much interested in getting the supplies to the soldiers in the front lines, their consum-

ers, safely and on time, as they ever were back on a commercial railroad in the United States, where their bread and butter depended upon a continuation of that kind of service.

I have talked to too many of them and they look upon their responsibilities here and to their Big Shippers—the Services of the Army—and their consumers—the Soldiers in the front line trenches—with a higher degree of service standards than they have on the most competitive commercial railroads back home. In the United States their jobs depended upon successful, safe and on-time rail transportation. Over here, they know that their future, the future of their families, the future of their country, in fact, the future of the world, requires the same dependable rail transportation service for the Armies that they have always given the shipping public of the United States. They have given that unstintingly.

They know no 16-hour laws over here. An Engineer will work on a track if necessary, and a Conductor will help build bridges, while the "Gandy-Dancer" will try to run a locomotive if there is no Engineer available. They are not thieves and they are not criminals, but they are American citizens with a pride and a love of their industry and their work, a mature realization of their responsibilities, and a devotion to duty that has been superb. They are pushing forward tens of thousands of tons of freight a day to their comrades in arms, the men of the Armies they are supporting, and I just cannot stand idly by and let an impression go unchallenged that they have so completely forgotten their American railroad standards and principles, as well as their American ideals, as to be guilty in other than a very small degree of the whole black market operations, which fortunately have been nipped in the bud in time.

To the everlasting credit of the 716th Railway Operating Battalion and to the other Battalions and units of the Military Railway Service in this theater, all of these men have gone steadily forward in doing their job of railroading for the Armies. Their morale is excellent and the 716th Railway Operating Battalion has just passed a rigid inspection with an excellent rating. The 716th's Bulletin of March 24th states, "The end of March is nearly here and still no venereal disease in the 716th." This indicates to me that they are good, solid American railroad men, that they still have confidence and faith in themselves, in their unit, in their railroad industry and in America, and will not permit exaggerated and false accusations about them in any way to lessen their attention and adherence to duty, nor "slow them down" in doing their share of moving the freight forward to the Armies.

With kindest regards,

Sincerely yours,

CARL R. GRAY, JR.
Brigadier General, USA
Director General.