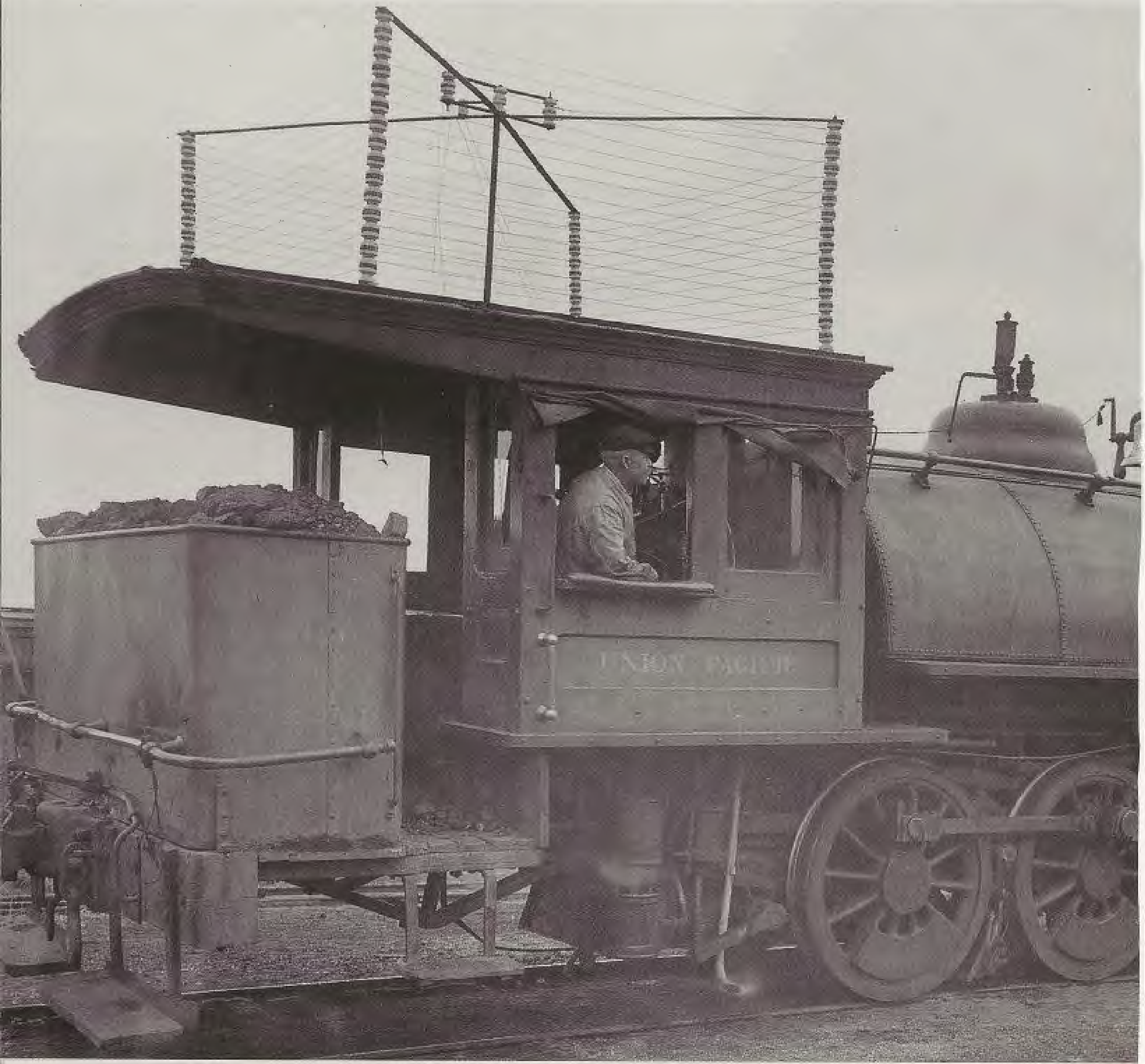
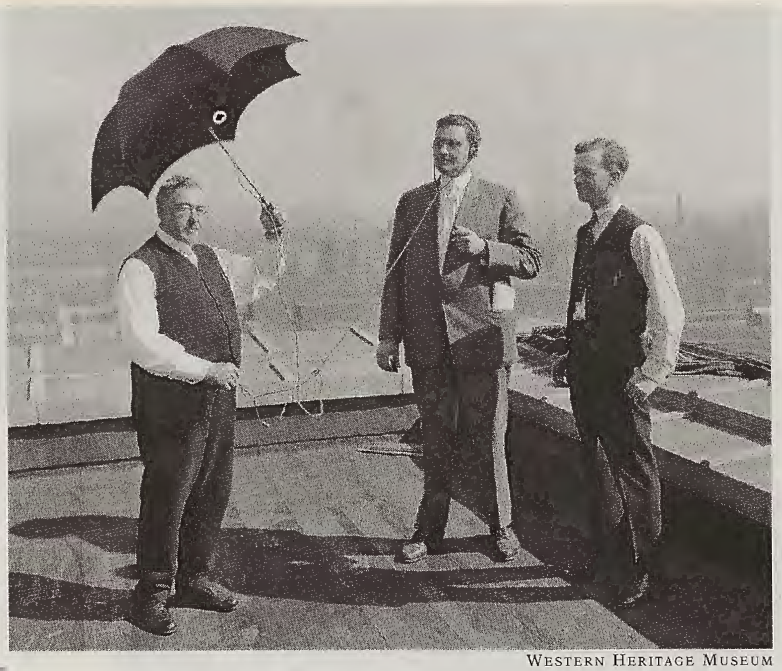
Voices on the



rails

The coming of radio to America's railroads

BY JAMES ALEXANDER JR.



WESTERN HERITAGE MUSEUM

LUMBERTON, N.C., DECEMBER 16, 1943—"Between 60 and 100 persons were killed and more than 100 others were injured when two crack, streamlined trains of the Atlantic Coast Line Railroad were wrecked at 1:15 o'clock this morning in a shallow cut two miles north of Buie. More than half of the dead and injured in the accident, which seemed likely tonight to have proved more costly in human life than the wreck of the 'Advance Congressional Limited' in Philadelphia on Labor Day ... , were soldiers who were homeward bound on holiday leaves."—*New York Times*

America was at war, and the front page of the December 17, 1943, *New York Times* also recounted the bombing of Berlin by British air forces and fierce battles in the Pacific. But the report on the unexpected loss of servicemen's lives on a hard-pressed American railroad would be a catalyst for action on the homefront.

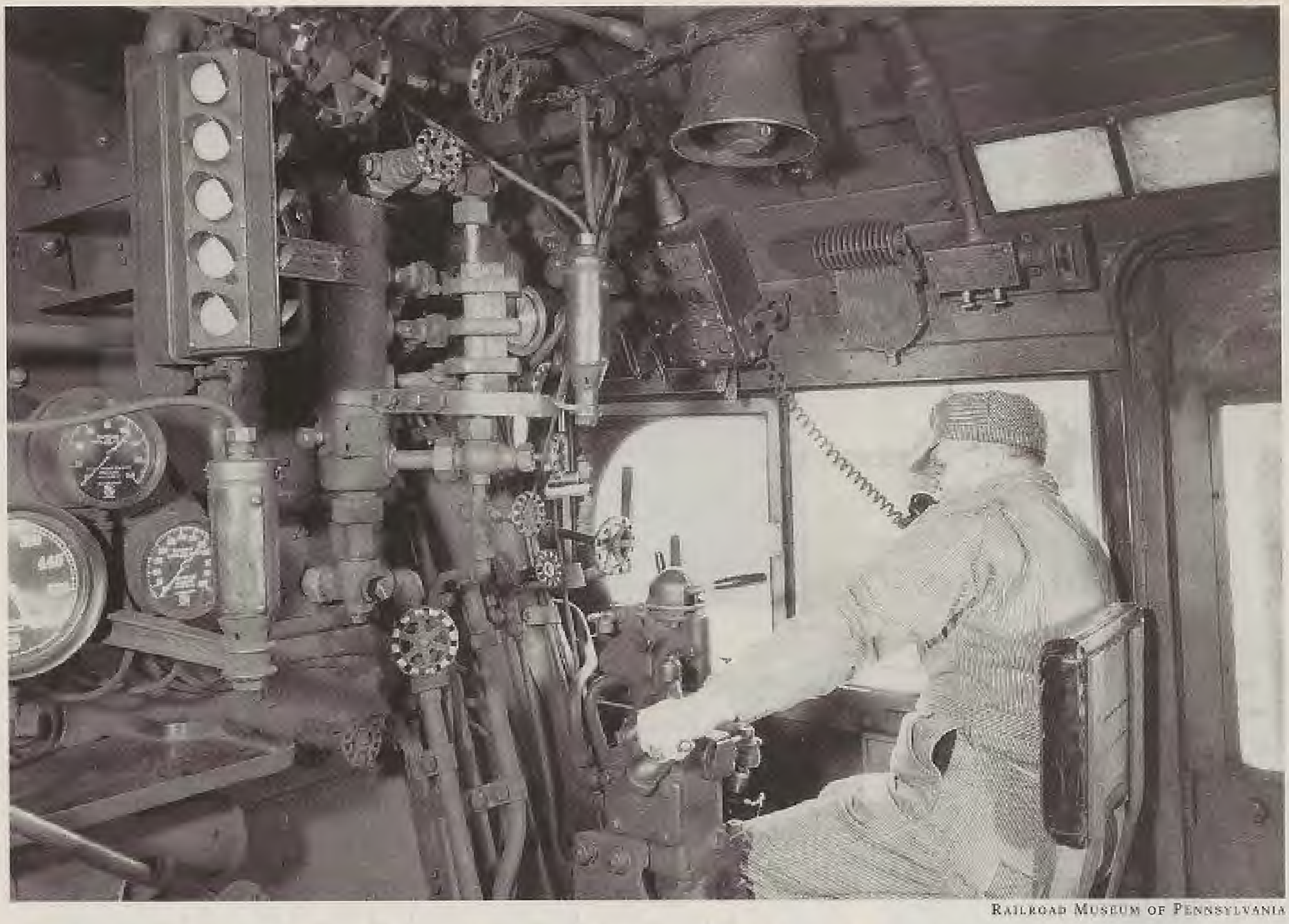
The ACL wreck galvanized public opinion. Columnist Drew Pearson led the public outcry in his radio broadcasts and newspaper columns, demanding to know why the railroads did not employ "radio-telephones" that he claimed would have allowed both wrecks to have been avoided. Letters to the editor picked up the cry. Politicians and federal bureaucrats got into the act. Overlooked was the progress that railroads had made in improving safety rules and signaling systems. Little credence was given to the fact that the railroads had been deprived of resources and access to technology that was diverted to the war effort.

The Association of American Railroads responded by asking the Radio Technical Planning Board in Washington to examine the safety benefits and feasibility of placing radio telephones on moving trains. The AAR asserted that wartime shortage of radio equipment and restrictions on radio frequencies had hampered them.

Within the railroad industry, indignation reigned, and the charges were labeled as "unmerited calumny." In February 1944, an assistant to the president of the AAR proclaimed that contrary to the assumption that the wreck showed there was "something backward about railroading," the accident "could have been prevented by the use of a 5-cent fusee, whereas a million dollars worth of radio equipment could not have done the job," to quote *Railway Age* of February 26, 1944.

WESTERN HERITAGE MUSEUM

In one of the first photographed experiments with railroad radio, circa 1910, Dr. Frederick H. Milliner (top) holds an umbrella/antenna atop a Union Pacific building in Omaha to send orders to an 0-6-0T working the nearby UP yards (left).



RAILROAD MUSEUM OF PENNSYLVANIA

Engineer of PRR T1 No. 5530 uses trainphone in 1946; overhead speaker, which was an open party line, could be cut out by lifting handset.

That assistant would be amazed by the split-second communications of today's railroad industry. But he was right in a sense—railroads had already begun to explore wireless communication. Despite American railroads' pioneering interest in radio communications, however, it took a tragic train wreck in North Carolina—and decades of experiments—to bring this now-common technology to the industry.

Classic errors led to crash

Prompt investigation of the ACL wreck by the Interstate Commerce Commission supported AAR's complaint that a relatively simple mistake had been made. A broken rail had derailed the rear three cars of the *West Coast Champion*, traveling southbound at 85 mph. Separated from the rest of the train, the cars remained upright, fouling the northbound track, while the rest of the train—three diesels and 15 passenger cars—came to an emergency stop a half-mile down the track.

The rear of the train was promptly protected by a brakeman who positioned himself to halt following traffic. Near the head of the train, the conductor, hampered by blinding snow, was unaware that the last cars had separated. Lantern signals were obscured and misinterpreted. He believed that a broken coupler seen near the front of the train had caused the emergency braking, when actually the damage to the knuckle and the broken air line were secondary consequences of the rear-end derailment he could not see.

Knowing that the northbound *East Coast Champion* was due, the engineer followed standard procedure and instructed his fireman to walk south to protect the northbound track, even though he, too, was unaware of the problem at the rear. The fireman carried lanterns and one fusee, but in the excitement he forgot to take additional fusees or any torpedoes from the locomotive's supply.

When he saw the headlight of the northbound, the fireman attempted to light his one fusee, slipped on the icy ballast, and broke it. His efforts to use his flickering lanterns to halt the train, hurtling at 85 mph in compliance with the last automatic signal which displayed "proceed," were to no avail. The northbound plowed by, hit the protruding cars, and calamity ensued.

The ICC report addressed the question of whether radio or other technology could have avoided the wreck, and concluded that it was caused by human failure to fully inspect the southbound train when it stopped, and to provide proper flag protection at the front end. Even if the train had carried a radio, neither the conductor nor the engineer knew all the facts. The report did not consider the likelihood that radio contact between the head end and the crew at the rear would have been helpful. Ironically, it was a radio call from a single state police cruiser that summoned help to the desolate location.

The ICC report was not enough to relieve the railroads of the sting of the charge of backward technology. The chairman of the Senate's Interstate Commerce Committee publicly pressured the FCC, whose chairman saw opportunities for railroad radio, and began meeting with the ICC to establish jurisdiction. Public pressure was still on. In its January 6, 1945, issue, *Railway Age* noted that "after being practically dormant since 1930, intense interest in train communication burst forth in February 1944, and has continued at white heat since that time."

Pennsy introduces the trainphone

Previous events caused major responsibility for the industry's response to fall on the Pennsylvania Railroad, which was still smarting from the public reaction to a wreck of the *Congressional Limited* just several months before. Ironically, the day before the North Carolina wreck,the Pennsy had run a major ad in the *New York Times*, showing a smiling soldier alighting from a Pennsy passenger car to greet his family, under the caption "Christmas Reunions Mean So Much to Our Boys This Year!"

The course of technical progress also put the Pennsy in the limelight. The federal government earlier had restricted radio frequencies for railroad use, and although several railroads were experimenting with radio, results were inconclusive. If meaningful radio applications were not at hand, something rather similar was, and Pennsy played its own success story for all it was worth. The Pennsy called it a train telephone system—later using the term "trainphone"—which was an induction carrier system rather than true radio.

Thus in February 1944 the PRR announced that it had successfully tested the system on the single-track, 50-mile Belvidere-Delaware ("Bel-Del") branch, from Trenton to Phillipsburg, N.J. Communication was now possible between front and rear ends of freight trains, and with the block operator at Frenchtown, midway on the line.

Public relations was coordinated by the AAR. Testifying before a Senate committee several months later, an industry spokesman decried the "definite note of unfriendliness and skepticism toward the railroads ... In brief, the railroads are charged with negligence for not using a method of communication which has not yet been developed to the point of practical usability, and the helpfulness of which in the two selected cases almost certainly would have been nil."

The AAR continued to monitor columnist Pearson's criticisms, and sought to persuade him that he had been given erroneous information. The PRR then announced that the new trainphone system would be installed on the 245 route-miles of four-track line between Harrisburg and Pittsburgh; the system was in full operation by 1947. By 1950, 1613 miles of the PRR network had trainphone service.

Officials of the Atlantic Coast Line visited the Bel-Del installation, and within a year of the wreck had ordered the same induction system from Union Switch & Signal for 234 miles of track; the Chicago, Milwaukee, St. Paul & Pacific also started testing it. The Pennsy continued to extol the advantages of the system in industry publications as well as advertising, into the early 1950's. Modified versions of trainphone were used at several of the Pennsy's yards as well, and a bulky hand-held version for brakemen was also produced.

A simple technology

The induction trainphone system was a logical outgrowth of developments leading to cab signals and related use of rails to carry electrical currents. It was neither telephone nor radio, but parts of both. A typical installation had 31 vacuum tubes and operated off of the 32-volt locomotive generator. To transmit, the engineer would first throw a switch to send a calling tone, then speak into a telephone handset, causing the tube electronics typically housed in the side of the tender to energize a transmission loop on the tender, creating an electromagnetic field that included the rails.

The field, with a carrier current modulated on one of two FM frequencies (88 kilocycles was generally the lower one, the higher one 120 or 144 kilocycles—today, the term would be "kilohertz"), was inductively picked up by trackside phone and telegraph wires. The wires carried this carrier current greater distances than the rails could; the signal was induced back and forth repeatedly between the rails and wires. At the block operator's location, the signals were pulled off the wires via an induction coupler, and amplified into a loudspeaker and phone set.

The tender had a single transmitting loop. Two receiving coils were mounted above the tender's upper deck, one for each incoming frequency. Topside, the transmitting antenna looked like and could function as an insulated handrail. Similar equipment on the caboose allowed for the same functions.

In the Bel-Del trials, the block station's equipment had been coupled to the rails as well as the wayside wires, and the carrier signal was 5.7 kilocycles AM. The locomotive's receiving coil was a bar located just above the rails, similar to the cab signal receiver, and heavier reliance was placed on the rails to carry signals, which required among other things that all rails be bonded. These characteristics were changed when the system was expanded.

All equipment in a given section was constantly tuned in to the loudspeaker to await incoming call tones and to monitor other discussions. This "party

In a 1948 scene, conductor W.H. Beck sends a calling tone, transmitted from antenna atop a caboose such as N5B 477767. Rooftop disks are induction coils for receiving on two frequencies.

Two photos: Railroad Museum of Pennsylvania

KANSAS CITY SOUTHERN

COLLECTION OF HAROLD K. VOLLRATH

Similar to PRR cab units, KCS Fairbanks-Morse "Erie-built" diesels carried a rooftop "radiophone" antenna. Peering from the cab of KCS 2-10-2 No. 203, engineer Troy Shirk calls the caboose while leaving Kansas City in May 1946.

line" enabled communication from head to rear end, between nearby trains, and with block operators. As initially used, trainphone supplemented the formal train-control rules, and did not replace them. Rulebooks included detailed procedures for trainphone use.

The Pennsy's system was devised by Union Switch & Signal Co. Other companies such as General Railway Signal Co., Aireon Manufacturing Corp., and Aviation Accessories Corp. devised similar systems. Applications could soon be found on a number of lines including New York Central at its Sharonville Yard near Cincinnati; Louisville & Nashville at its neighboring DeCoursey (Ky.) yard; Norfolk & Western at Roanoke, Va.; Chicago, Burlington & Quincy between Galesburg, Ill., and Lincoln, Nebr.; Kansas City Southern on its entire main line between Kansas City and Port Arthur, Texas; Duluth, Missabe & Iron Range on both its Missabe and Iron Range Divisions; Jersey Central at Allentown, Pa.; Bessemer & Lake Erie between Pittsburgh and Albion, Pa.; and ACL between Rocky Mount, N.C., and Pee Dee, S.C. But the Pennsy was the major user of induction communications on the road, and stuck with it after other railroads lost interest.

Rugged, inexpensive, and private

The major initial advantage of the induction communication system was that its electromagnetic fields did not carry very far in the air, thus avoiding the need for FCC approval. The system assured privacy (neither the casual radio listener nor saboteurs could pick up those signals). Also, it could be used without having to wait for postwar release of military radio technology.

The system also worked well in tunnels and near steel structures, where regular radio signals often failed. Trainphone (or the Union Inductive Train Communication System, as US&S called it), required existing trackside wires to be reasonably close, no more than 100 feet away from the tracks; where this was not the case, as in a tunnel, a single wire would be placed closer to the track. The system was also ruggedly built. Its technology was similar to that already in use for cab signals and other purposes; component assemblies were somewhat modular, making maintenance easy.

Although early studies expected the system to work in electrified regions by having the catenary carry the signal, heavy hums from the 25-cycle power source, interference from electric traction motors, and the fact that regular trackside wires were usually buried quickly caused PRR to abandon any idea of using trainphone on the electrified New York-Washington main line or west to Harrisburg.

The initial reaction of train crews to trainphone, as to radio, was positive. The unions worried about protecting their memberships' job duties, but in general they were supportive; it made life easier and safer. Veteran PRR engineer H. Lee Coleman recalls that on occasion a hogger who got tired of the speaker's squawking would turn it off and proclaim, "must be in a dead spot!" But they quickly came to appreciate the value of a warning of a problem ahead.

KCS gets in on the act

Kansas City Southern was the second-heaviest user of systemwide induction communications, having initially tested the equipment in 1944 on one locomotive and one caboose and five fixed locations between its Kansas City East Yard and Pittsburg, Kans. Its early equipment was designed by Aircraft Accessories Corp.

By 1946, KCS announced that all new freight and passenger locomotives would have "radiophones" manufactured by Aireon Manufacturing Corp. The system relied primarily on trackside telegraph wires to carry the induction signals, with little reliance on the rails such as with the PRR's US&S system. The carrier current operated at 170 kc FM. Some other technical aspects differed, but the basic principle was the same.

KCS found the system to be especially useful in boosting capacity of its extended single-track system, although it was initially seen as a supplement to existing signals and movement rules, not as a replacement. As on the Pennsy, the system was operated by the telegraph department. Economic analysis had convinced KCS that the cost of the equipment would be more than offset by operating savings.

Veteran railroader Harold K. Vollrath, who had observed inconclusive induction communication testing on the Texas & New Orleans (Southern Pacific's lines in Texas and Louisiana) around 1946, was pleasantly surprised to find that KCS subsidiary Louisiana & Arkansas had a fully operating system when he landed a dispatcher's job with the company in 1949. The line's new *Southern Belle* passenger train was advertised as having radio available on the entire line to assure its safety.

Handling all of the 989-mile territory by himself on the midnight shift for a nearly 20-year career, Vollrath made good use of the system through lineside operators. He says the system was a great help in dispatching trains in what was otherwise "dark" (unsignaled) territory. In some cases, if only the base operator nearest the train could engage in verbal communication with the crew, the operator would then pass on Morse code reports to Vollrath by wire.

KCS's use of the induction system lasted until around 1960. By 1965, microwave was in full operation and train orders were issued directly to trains by regular radio. Several years later, all line wires were out of service.

Early radio developments

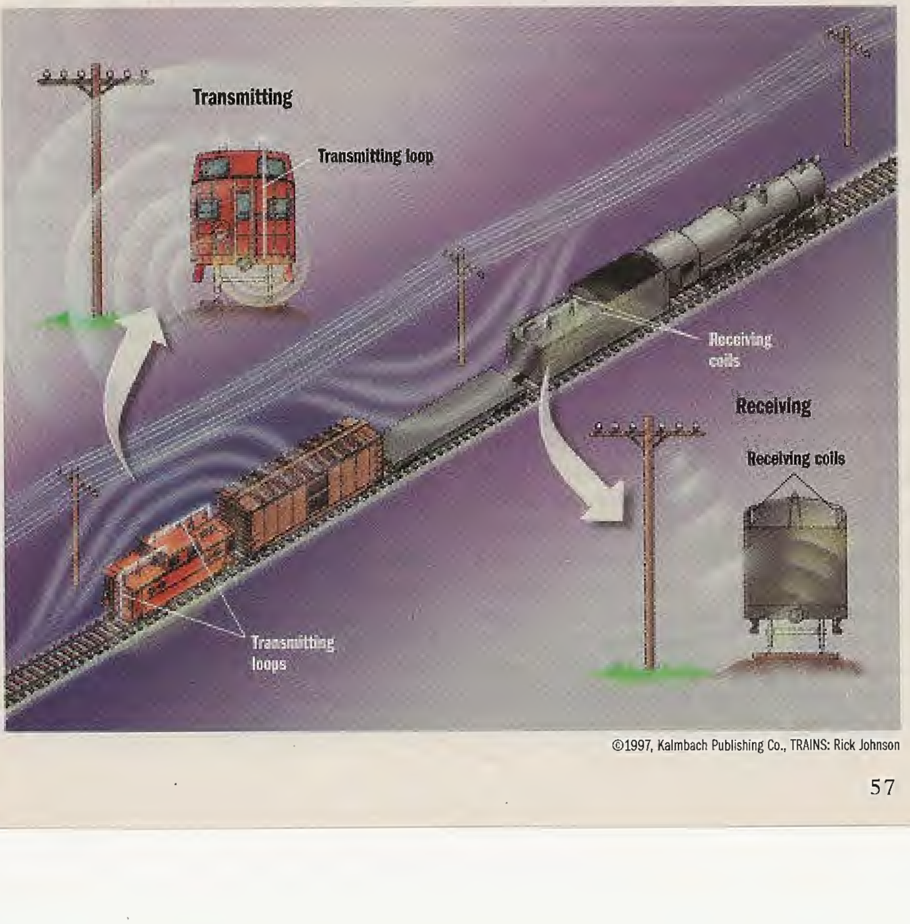
Notwithstanding the charges by Pearson and others that railroads had neglected technology, they were engaged in a wide variety of experiments from the earliest days of radio. Even before Marconi first sent a long-wave signal over a mile through the air in 1895, one W.W. Smith had obtained a patent in 1881 for a "car telegraph." This system relied on the metal roof of a passenger car to receive signals by induction from trackside telegraph wires. Its principle was similar to US&S's later induction system. The Lehigh Valley Railroad experimented with this induction telegraphy in the late 1880's, but as was to be the case for several decades, technology was not sufficiently advanced for it to be pursued. Chicago & Alton tinkered with some form of wireless telegraphy in 1905.

Around 1910, Frederick H. Milliner set up a radio transmitter on the roof of Union Pacific headquarters in Omaha and sent instructions to a switcher equipped with a receiver. In 1914 radio voices were carried between a San Pedro, Los Angeles & Salt Lake (later part of UP) train and the Los Angeles station some half-dozen miles away. The UP continued to experiment with radio transmissions at least through 1916. Over the years, yard communications often preceded road communication installation on many lines.

Public recognition of the value of radio for the railroad industry was established by the Delaware, Lackawanna & Western, which as early as 1903 had installed a "Marconi Coherer" on its Hoboken Pier 2 to transmit to the nearby Telephone Repair Shop. In 1913, in what was claimed to be the "first wireless equipped train in the world," according to the *New York Times* of November 22, 1913, the Lackawanna established successful two-way radio communications between moving trains and transmitters in New York City, Scranton, Pa., and Binghamton N.Y., first with telegraph and subsequently with voice. DL&W had engaged the Marconi Company, which had assigned young David Sarnoff, later of RCA fame, as the project engineer.

Soon, messages reporting ill passengers and success in coping with storm disruptions were reported. The initially skeptical Marconi was convinced that wireless was not "God's gift to the mariner" alone.

Discussion at the Association of Railway Superintendents in 1916 reflected initial belief that wireless was mainly useful as a backup in case lines were down, a major concern of the Lackawanna, which operated in the "sleet belt." Tests on the DL&W showed that semaphore signals could be set by



radio also. Interference with radio transmissions of the U.S. Navy, which used the same frequencies in New York harbor, and subsequently the effects of World War I, led to a halt of these pioneering efforts.

The year 1920 brought major developments in railroad radio. With assistance from a retired U.S. Signal Corps officer and the DeForest Wireless Company, New York Central began experiments with a "wired-wireless" system that used carrier currents in both rails and wayside wires. The same year, the PRR began experimenting with radio communications with its tugs in New York harbor, and the Milwaukee Road began testing the use of trolley wire in electrified sections to carry communications. The American Railway Association's Telegraph and Telephone Section established a Committee on Radio and Wired Wireless to deal with developments.

Through the 1920's, a number of railroads experimented with various uses of radio and induction communication, in cooperation with AT&T, RCA, GE, Westinghouse, Zenith, and a host of other inventors.

In 1928, the PRR ran a special train between Altoona and Pittsburgh to demonstrate radio communication between the head and rear end of freight trains. On board to observe the Westinghouse equipment were officials of PRR, NYC, Chesapeake & Ohio, N&W, New Haven, Bessemer & Lake Erie, Lehigh Valley, B&O, and a host of experts. Within a year, Canadian National had installed telephones for passengers on moving trains to communicate by radio with the Canadian Bell system. Union Pacific and others installed commercial radio receivers in lounge cars to entertain passengers. It appeared that radio was about to take center stage in railroad operations.

Picking up interference

Then in 1930, the Federal Radio Commission abruptly withdrew authorization for the wave bands with which the railroads had been experimenting. Efforts were shifted to testing on limited frequencies under special experimental licenses. While some experiments continued, the major thrust into radio had been blunted, as railroads were deprived of assured frequency allocations and feared loss of investments in new equipment. Railroads continued to be concerned that radio equipment was too fragile and unreliable for the rough and tumble of daily operation.

In 1936, PRR began experiments with GE and US&S of induction carrier voice communications. A year later, B&LE installed the US&S's system in successful regular service between Albion and North Bessemer Yard (Pittsburgh). Improved traffic movements, better monitoring of on-the-road problems, and other efficiencies that today we take for granted were enthusiastically reported.

In 1941, the Pennsylvania authorized a major test of the US&S system on its busy Bel-Del Branch. Going into operation the following year, by the time of the *Champion* wreck in late 1943, Pennsy's major installation was to be the basis for the railroad industry's public relations efforts to show critics its progressive use of technology.

As World War II ended, both resources and previously secret military technologies were released. Observers were enthusiastic. Speculation on the value of radar, microwaves, and portable communications abounded.

> "In the prewar years, railroads continued to fear that radio equipment was too fragile and unreliable for the rough and tumble of daily operation."

In May 1945 the FCC assigned 60 clear channels for railroad use, each channel 60 kilocycles wide, between 152 and 162 megacycles. (The number of channels and their width subsequently changed as a result of technological refinements and other needs.) Other railroads that had not made the initial commitment to the induction carrier system began putting radios in their equipment. In 1949, the Chicago South Shore & South Bend announced that it had installed America's first systemwide radio communication. Transmitters at East Chicago, Michigan City, and Olive Siding, Ind., allowed the interurban's train crews and trackside facilities to be in constant communication on the busy 77 miles between Kensington (Chicago) and South Bend. In 1952, the first transistorized radio equipment on a railroad was installed on the B&O, which also began testing television in its Chicago yard that year.

The end of trainphone

Pennsy's interest in radio lagged. In the early 1950's, American railroads were installing more than 2300 radios a year, but PRR only installed limited radio yard communications (such as at its Sunnyside yard) later in the decade. For some years the Pennsy continued to show its trainphones in advertising, and they did serve a major purpose. By 1952, 1268 trainphones were installed.

Studies of Pennsy's trainphone concluded that the system was becoming outdated. By 1966, radios were being rapidly installed in locomotives, cabooses, and at block stations across the system. By the end of that year, a radio had been installed at Frenchtown, site of the Pennsy's first wayside trainphone location. General Order No. 2220, effective April 30, 1967, put all trainphones out of service, and a useful but outdated technology came to an end.

Trainphone had been part of a commitment by railroads to greater efficiency and safety. Visitors to the Railroad Museum of Pennsylvania can view the trainphone antenna, receiving coils, and control box high atop M1b 4-8-2 No. 6755. The main electronic locker, installed in the side of its tender, shows the housing and connection points, but only two tarnished radio tubes remain of the electronics that once carried voices on the rails. A fitting epitaph to the admittedly brief success of trainphone appeared in a headline in the February 17, 1948, Philadelphia *Evening Bulletin*, just four years after the *Champion* wreck: "Radio Phones on Train Prevent Pennsy Wreck."

Even with the end of trainphone on PRR, the promise of radio itself was not yet fulfilled. Radios became smaller and more versatile. End-of-train devices sending coded messages and hotbox detectors transmitting synthesized voices were still to come. And eventually overhead satellites would bring not only more reliable communications, but safer protection of train movements. Computers, too, were to use electronics to bring unimagined efficiency to railroad operations. I

JAMES ALEXANDER is on the staff of the Railroad Museum of Pennsylvania. This is his third TRAINS *byline. This article is an outgrowth of a research program he conducted for the museum. Readers may direct questions to him at the Museum, P.O. Box 125, Strasburg, PA 17579.*