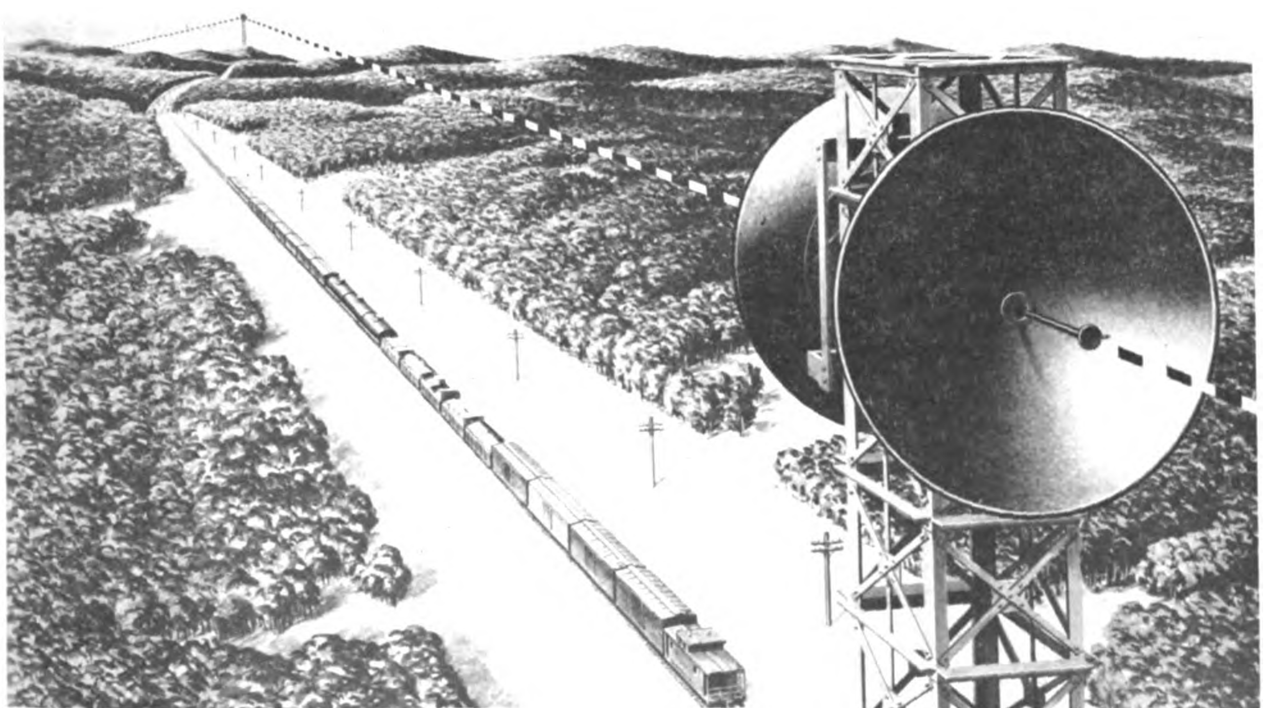
Railroad Communications . . .

FROM MORSE . . . . .

Telegraph Office Rochester, N.Y., 1868

Photo courtesy Western Electric

TO MICROWAVE

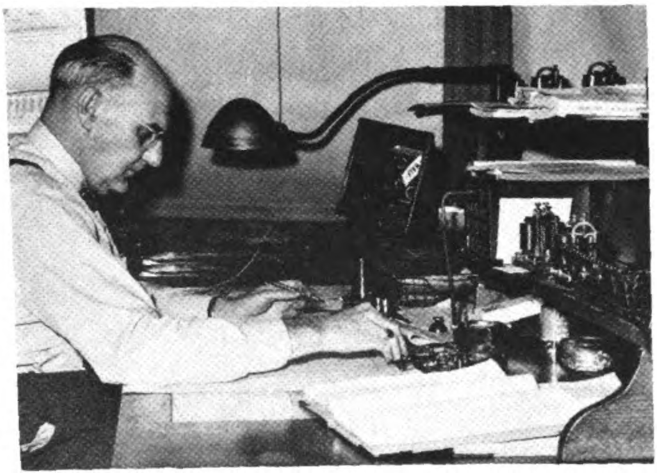


Pictorial sketch of railroad microwave 1968

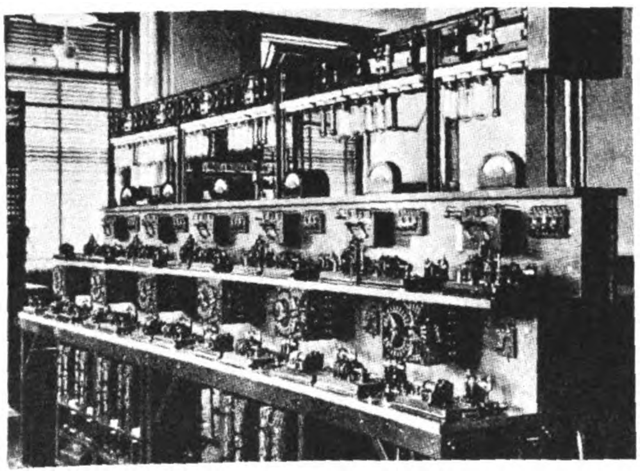
This illustration courtesy Inter. Tel. & Tel.

Communications

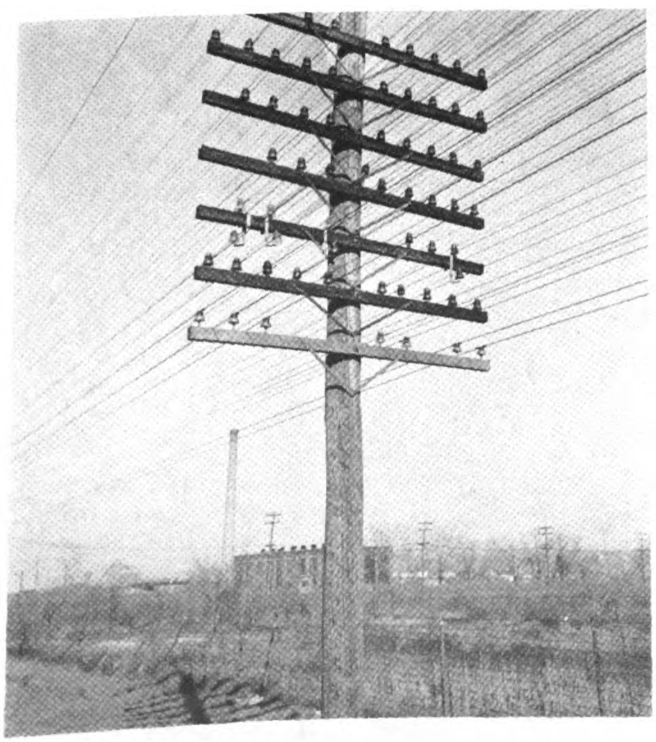
From Morse to Microwave



Morse telegraph invented in 1837, was principal means of wire communications on railroads for many years



About 1923 telegraph office equipment, repeaters, duplex and quadruplex apparatus were mounted on large oak tables



On many railroads, the pole lines were owned jointly by a commercial telegraph company and the railroad

The Morse dot-dash code telegraph was invented by Samuel F. B. Morse about 1837, the first message being sent in 1844 over lines on the Baltimore & Ohio right-of-way between Baltimore and Washington. Several early railroads, including the Baltimore & Ohio and the United New Jersey Railroad & Canal Company (now PRR), adopted the Morse telegraph for communication between offices. The practice of using train orders, and of transmitting such orders by telegraph, was developed on the Erie in 1851.

Railroad message traffic grew by leaps and bounds. By 1923, the Santa Fe was handling a total of 2,270,000 messages through 21 relay offices in a typical month. This heavy traffic on the Santa Fe, as well as on numerous other railroads, was handled primarily by Morse. Equipment in main offices and repeater stations included telegraph repeaters, duplex and quadruplex apparatus, mounted on massive stair-step oak tables. Condensers, coils and resistors were mounted on overhead racks or under the tables.

Joint Ownership of Pole Lines

Commercial telegraph companies developed along with the early railroads, 1835-1850. A logical practice was to build jointly-owned pole lines on railroad rights-of-way, with some wires used by the railroad and other wires by the commercial company. The Baltimore & Ohio constructed and operated telegraph facilities and services, not only on its own railroad, but also beyond its rails as far as Boston, New Orleans, Galveston and St. Louis, these operations extending on approximately 50,000 miles of pole line. The Baltimore & Ohio Telegraph Company was absorbed into the Western Union Telegraph Company in 1887.

As years rolled by, nearly all railroads in the United States had joint contracts with commercial telegraph companies for construction, maintenance and ownership of pole lines and much of the telegraph equipment in offices. In most instances the railroad superintendent of telegraph was a joint employee of the railroad and a commercial telegraph company. Also, in each outlying town the railroad agent was also the agent for the commercial telegraph company.

A single Morse circuit can be used to transmit only one message, either one way or the other. Duplex telegraph, to transmit both ways simultaneously, was invented in 1868, and quadruplex came in 1872.

Using methods known as "simplex," "phantom" and "composite," interconnections between existing line wires were used to derive additional line circuits. By means of coils connected to a pair of telephone line wires, equal current flows in each wire in the same direction. Such an arrangement can be utilized as a telegraph circuit without interfering with the telephone service. This is called a "simplex." Where two pairs of telephone wires are adjacent and have identical electrical characteristics, coils, condensers and transpositions can be used to obtain an additional telephone circuit. One of the pairs is comparable to a single wire. This is called "phantom."

The term "composite" applies to at least three arrangements as follows:

Two wires of a telephone line circuit can, by means of coils and condensers, be used to derive two telegraph circuits without interfering with one another. Two adjacent pairs of line wires with no intermediate stations, used with a phantom superimposed thereon, can be arranged with coils and condensers to derive four telegraph circuits, one on each of the four wires, without interfering one with another or with the three telephone circuits on these four wires. Two pairs of adjacent wires with practically the same electrical characteristics and with a phantom superimposed thereon and which have intermediate stations can, by the use of suitable coils and condensers, be utilized to obtain two telegraph circuits, one on each of the pairs without interfering one with the other or with the telephone circuits. The two wires of one pair may be considered in effect the same as one of the wires of a single pair, and the other pair of wires the same as the second wire of the single pair.

Having applied these methods such as simplex, phantom and composite, the only other way to get more line circuits in those days was to add more line wires.

This "joint" situation—more line wires and pole lines, as well as more telegraph office equipment to handle more telegraph message traffic—had continued to grow for nearly a century. Then, "Boom!" lots of things happened. Practicable printing telegraph equipment; multi-channel carrier; radio; facsimile; microwave; television; and electronic computers came along fast, within a relatively few years. The impact of each of these new types of equipment on railroad communications will be discussed under separate headings.

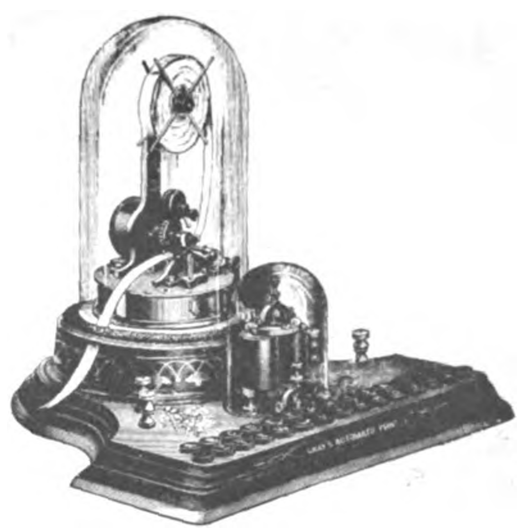
Morse invented a form of printing telegraph before he developed the "dot-dash" Morse code which came into general use in preference to early printers, ticker tape, etc. The Gray automatic printer was developed in 1872. Practical telegraph printing equipment adapted for use on railroads—some made by Morkrum and others made by Kleinschmidt—came on the market about 1910 to 1915. In 1910, the Burlington installed Morkrum telegraph printers between Chicago and Galesburg. By 1920-1922 several roads were using printing telegraph to a limited extent, for example the Southern Pacific had two-channel automatic tape printing telegraph between San Francisco and Ogden, and between San Francisco and Los Angeles.

Since about 1935 a great many railroads have changed over from Morse telegraph to printing telegraph for practically all long-haul message traffic, as well as short-haul between yards and principal offices. However, some roads still use Morse on branch lines as well as for emergency stand-by on some main lines. Switching networks for printing telegraph as used on the Pennsylvania are explained in the July 1946 issue, p 473.

The "torn-tape" method of printing telegraph switching, including "gang" type transmitters as used on the B&O, are explained in the issue for September 1948, p. 550.

Carrier Revolutionizes Pole Lines

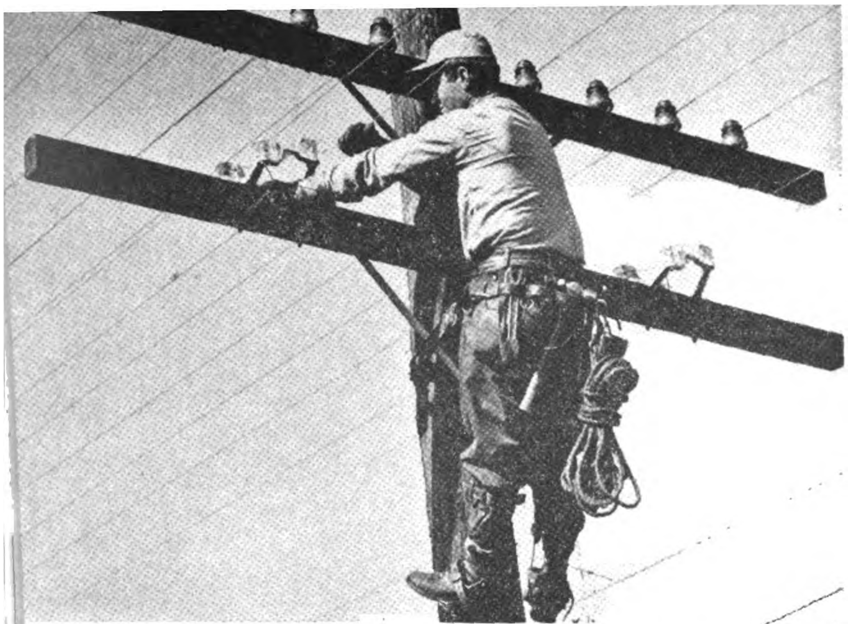
Soon after radio broadcasting came into vogue in the early 1920's, someone said, why not apply various frequencies onto one pair of line wires, and thus have any reasonable number of circuits on one pair. The scheme was a success, and is known as "carrier." All that is required is the necessary electronic equipment at the terminal offices and repeater stations. In recent years railroads have been installing lots of this carrier —in 1957, about 1,895 carrier terminals and 176 back-



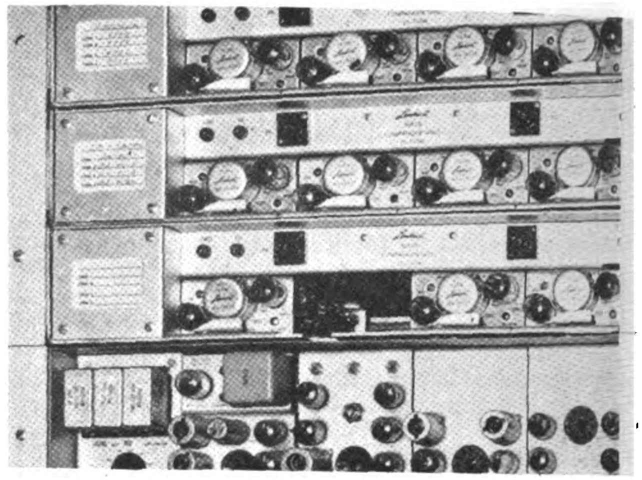
The Gray automatic tape printer, invented in 1872, was used by commercial telegraph companies and some railroads

In 1910, the Chicago, Burlington & Quincy installed Morkrum printing telegraph from Chicago to Galesburg

In 1914 L&N used Kleinschmidt teletypewriters and 1920 saw keyboard punch, automatic transmitter and page printers



By using 30 kc transpositions and carrier, N&W put all communications circuits on eight wires on the signal pole line



High frequency carrier (30-150 kc) provides long-distance dialing circuits for SP (12 channels in this carrier bay)

to-back repeaters were installed on the railroads. Carrier equipment is available to handle a range of from one channel up to more than 24. Each voice channel can handle up to 18 telegraph circuits.

By thus applying carrier, railroads reduce the number of line wires on their pole lines. In a mountainous area, one road installed two new high-strength wires, and used carrier on these wires for all important circuits. The high-strength wires have withstood storms without break for several years.

To eliminate outages caused to pole lines by storms, the Seaboard Air Line in 1948 installed a buried cable on 248 miles. This is a two-conductor No. 10 cable, buried in the burm about 5 ft from the nearest rail. Four carrier channels on this cable are for telephone circuits and two are for outgoing and incoming codes for centralized traffic control. September 1948, p 545.

In 1954 the Quebec North Shore & Labrador built a railroad 363 miles long. Communications on one wire pair include the dispatcher's phone on the physical and 11 channels of carrier for telephone, printing telegraph, and line codes for centralized traffic control. Furthermore, equipment used in an emergency will switch all these communication and signal circuits over onto the two-wire, 23,000-volt a.c. power distribution line circuit, which is on the same poles. December 1954, p 29.

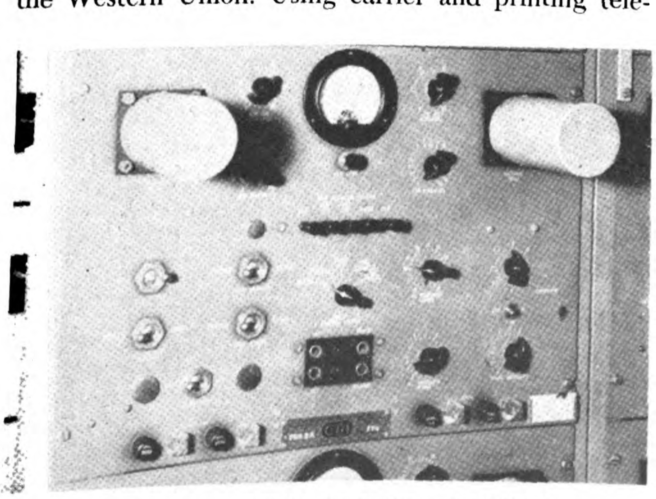
In 1956 the Norfolk & Western removed 1,723 miles of pole line formerly owned jointly by the N&W and the Western Union. Using carrier and printing telegraph, the communications line circuits were reduced to a maximum of four pairs, which were placed on an arm added to the existing N&W signal pole line. May 1956, p 29.

These and other applications, of carrier on railroads, suggest that the railroad pole line of the future will consist of a few high-strength line wires, and therefore will be economical to construct and maintain. What more can you ask for in a pole line, now or in the future?

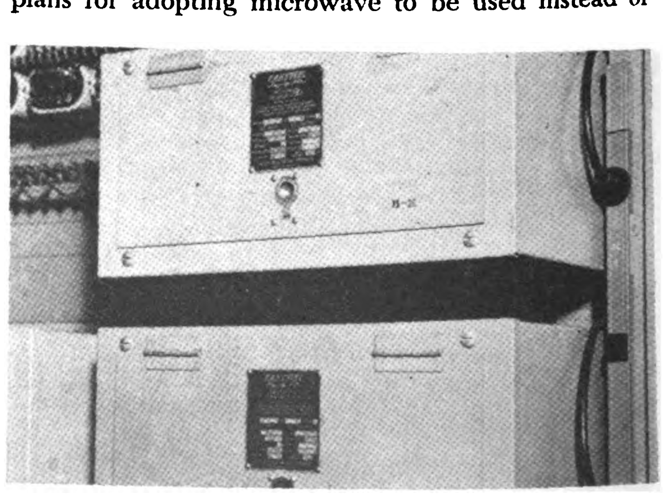
Microwave Comes to the Railroads

During World War II, super-high frequency radio relay systems were developed for use in military services. In this system, energy in the 890 mc and above range is transmitted by antenna "dishes" in a straight line from place to place, rather than being sent in all directions, as in radio broadcasting. Repeater stations are about 30 to 40 miles apart, depending on local terrain. This system is now known as microwave. Equipment is available to use as many as 120 channels simultaneously in one microwave "beam." Any voice channel can be used for 18 printing telegraph channels. Obviously such a system is a "gold mine" for handling large volumes of telegraph message traffic or long-haul telephone conversations.

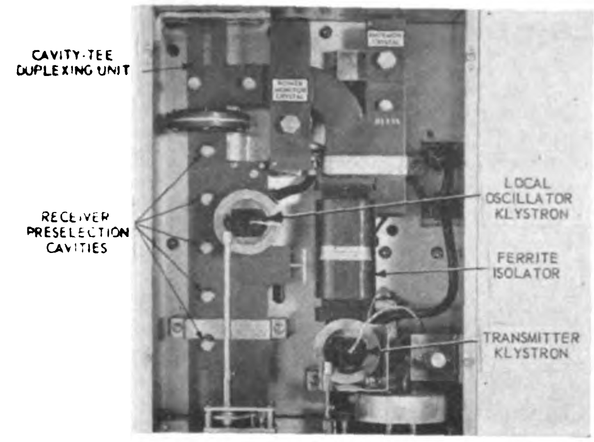
This was a "natural" for the Western Union Telegraph Company, which, in October 1945, announced plans for adopting microwave to be used instead of



Duplex equipment on speech-plus basis or half-duplex can be used for party-line printing telegraph circuits



Selenium rectifiers provide 120 or 130 volts direct current for party-line or through printing telegraph circuits



"Heart" of each station of the SP's Dunsmuir-Black Butte, Calif. microwave system is this frequency-diversity RF box

line wires on pole lines, and announced that contracts covering ownership or joint ownership of pole lines on railroads would be terminated as soon as practicable. For details of this announcement see p 776 and p 778 of the November 1945 issue. See March 1958 issue for report of Western Union microwave system up to now and as proposed for the future.

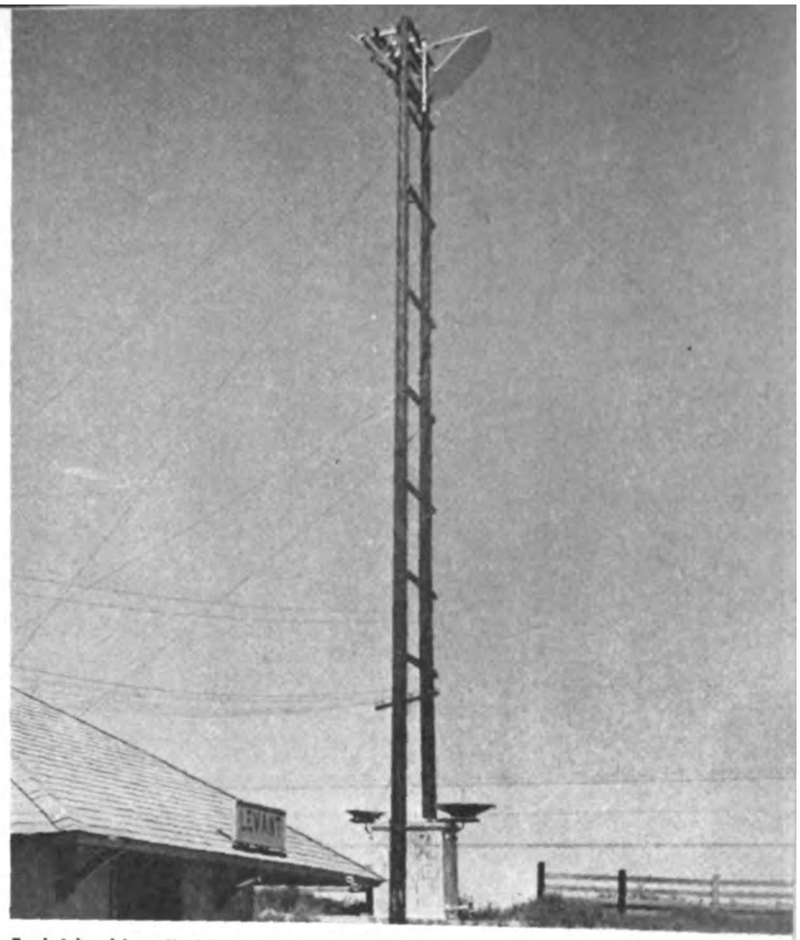
This announcement and subsequent termination of these contracts on numerous roads was the turning point in the history of communications on railroads. Now they can adapt pole lines to their own requirements, and they are unfettered to use radio, microwave, television and facsimile as meets their needs.

Realizing the advantages of microwave, installations have been made by several railroads, including the Rock Island, Santa Fe, Southern and Southern Pacific. The Pacific Great Eastern, which has little or no pole line as such, has recently completed an installation of microwave on its entire route of 640 miles between Clinton, B.C., near Vancouver, and Fort St. Johns, B.C. The Santa Fe is now working on its third microwave project, which is on 60 miles between Topeka, Kan., and Kansas City, Mo. This may be one link in a microwave system extending from Chicago to Los Angeles. The Rock Island is planning its second project on 380 miles between Herington, Kan., and Des Moines, Iowa. Extensive microwave installations have been made by electric power companies, pipe line companies and government agencies, such as TVA.

Agreements in effect for many years with the American Telephone & Telegraph Company allowed the railroads to use Bell telephones in railroad offices to route calls between railroad offices via railroad owned line wires. However, when some railroads made their early microwave installations, the AT&T refused to allow the railroads to route their telephone calls on the microwave. The reason stated was that the agreement called for circuits on railroad rights-of-way, whereas the microwave beam cuts across areas outside the right-of-way limit.

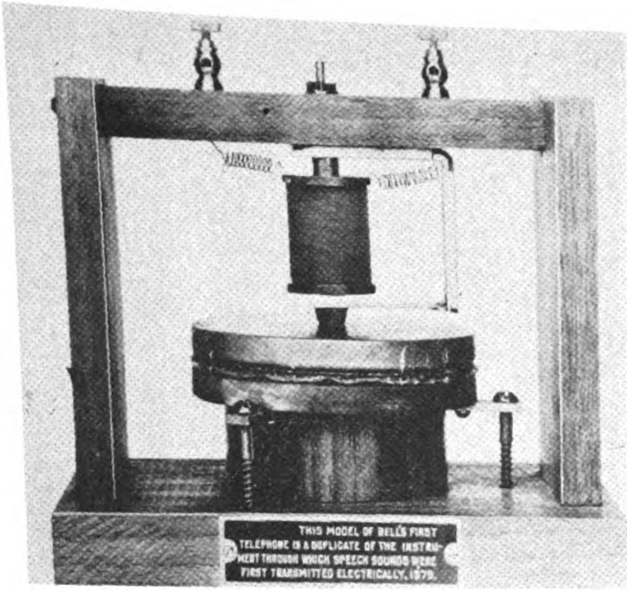
Perhaps AT&T has decided to cease this evasive policy, as is evidenced by their testimony before the recent microwave hearing before the FCC, as reported in the August and September 1957 issues. At this hearing the representative of AT&T was agreeable that the commission assign microwave frequencies to the railroads. However, the representative of the Western Union Telegraph Company gave testimony opposing the assignment of microwave to the railroads. The commission has issued no decision as yet, but quite likely the railroads will be assigned adequate frequencies for using microwave. Thus the future for railroad use of microwave is bright.

For articles concerning microwave projects see Railway Signaling and Communications: Rock Island, November 1950, p 707; Santa Fe, January 1953, p 48; Southern, May 1956, p 74; Southern Pacific, January 1957, p 20; Santa Fe, November 1957, p 38.

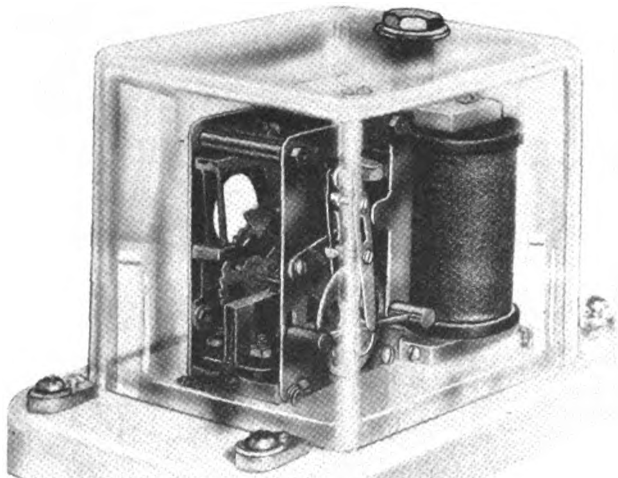


Rock Island installed first railroad microwave system in severe sleet-storm area of Norton-Goodland, Kan. (106 mi)

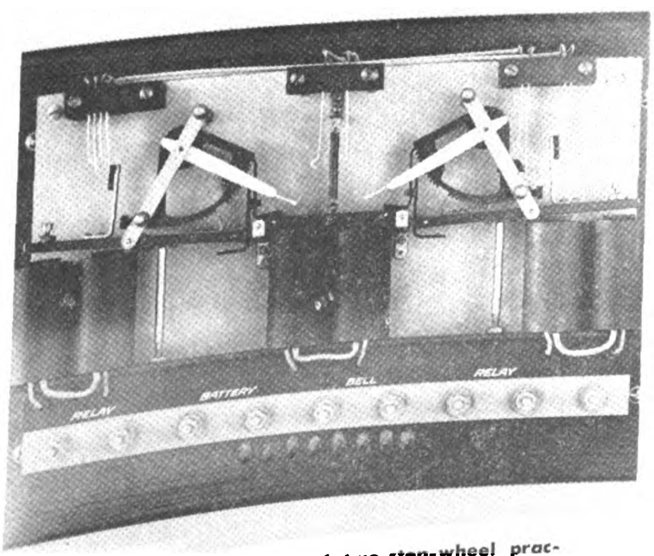
Santa Fe's second microwave system is San Bernardino-Cushenbury, Calif., 45 mi. Third system is Kansas City-Topeka, Kan.



Replica of Bell's first telephone through which speech sounds were first transmitted electrically in 1875



Gill selectors were used in telephone train dispatching on NYC 1907—View shows modern type Gill selector



The Groce selector, which used two-step-wheel practice, was developed on Illinois Central about 1911

Telephone Train Dispatching

In many respects railroad uses for telephones are different from those in public telephone services. The telephone, as invented by Bell in 1876, for conversations either way between two offices, was not readily adapted to railroad requirements. Furthermore, the central telephone switchboard system, connected to numerous subscribers by separate lines, was not adapted to railroad service on line of road. Therefore, except for central office—"subscriber" installations in large general office buildings and large shops, railroads made but limited use of telephones until a practicable telephone train dispatching system was developed.

In such systems, one line circuit extends from the dispatcher's office to all of the wayside offices used for issuing train orders on the entire division or dispatcher's district. The dispatcher uses selective apparatus to call any one office without actuating the ringers at others. When the line is not busy, the operator at any office can voice-call the dispatcher. Developments in telephone train dispatching up to about 1907 are discussed in articles in the issues of this magazine for August 1908 and January 1909.

A telephone train dispatching system using Gill selectors, made by the Hall Signal Company, was placed in service October 2, 1907, on the New York Central between Albany, N.Y., and Fonda. Also in 1907, the Burlington installed telephone train dispatching between Aurora, Ill., and Mendota, using a scheme of synchronous clocks. About three months later the Illinois Central installed a circuit using Sandwich selectors. Then G. H. Groce, Superintendent Telegraph and Signal, Illinois Central, got the idea of the two-step wheel selector which was developed and manufactured by the General Railway Signal Company. The Western Electric Company developed a selector that was put on the market about 1910.

In 1915 WE developed the 60-A selector. Its selection of stations depends not only on the number of impulses, but also on the number in each of three impulse trains.

In 1908 the St. Louis-San Francisco installed a combination including two copper line wires for telephone train dispatching and two for a selector controlled telephone message circuit. Long distance telephone and telegraph circuits were superimposed on these wires. Thus, as telephones came into use, copper line wires were installed, whereas previous to that time iron line wires for the most part were adequate for Morse telegraph line circuits. By January 1910 railroads in the United States had telephone train dispatching on 26,344 road miles.

For train orders, the telephone proved to be faster and more accurate than Morse telegraph. Furthermore, any person who could speak plainly could serve as an operator without the trouble of learning to send and receive Morse code. Thus, as years rolled by, telephone train dispatching was installed on the major portions of most railroads.

In 1952 the Baltimore & Ohio developed a useful application of transistors in connection with telephone train dispatching circuits. The problem was that, with a large number of phones connected to a long dispatcher's circuit, the transmission losses to the distant stations were very high and the receiver sensitivity was insufficient to allow satisfactory handling of train orders. The B&O solved this problem by building a transistor amplifier in each telephone subset. November 1952, p 774.

Private Automatic Exchanges

Some railroads have installed railroad-owned private automatic telephone exchanges in general office buildings and in large shop areas. These include the ACL, CB&Q, C&NW, IC, L&N, NYC, N&W, RI, UP and WM. On many roads these automatic exchanges are connected with trunks for dialing through to offices on the entire railroad, all on railroad-owned equipment and lines.

As part of facilities of a new classification yard at Nashville, Tenn., the L&N purchased and installed a 100-line automatic telephone system. A reporter, visiting this yard, asked: why automatic? why railroad owned? why so many phones in one yard? and how can they be connected to phones in other yards or offices, or to outside phones?

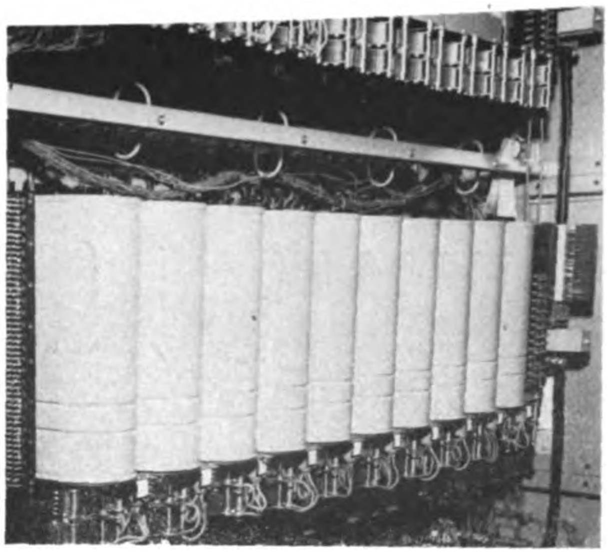
As compared with a manual switchboard, an automatic exchange puts the calls through without delay; gives no "wrong numbers"; and renders 24-hour service, seven days every week, with no operators. Based on present-day wages for just one operator around the clock, every day, the annual wage saving will pay for the automatic equipment in a relatively short time.

The L&N policy is that, by owning its own automatic telephone systems, the costs are controlled so that phones can be installed not only where used constantly, but also at other places where used infrequently, or even at locations where they will be used rarely, and only in emergencies. Phones are installed wherever needed on the entire railroad, and employees are encouraged to use these phones, with no limit on the number or duration of calls. No one has far to walk to find a phone.

The L&N automatic dial telephones are used strictly for calls between railroad men when working in the railroad offices, shops, yards and terminals. Thus, these phones are not intended for use in making outside calls. To talk outside, commercial telephone service is used. However, only a relatively few commercial phones are required in the railroad offices, shops or yards. For example, studies proved that of the total number of calls, only 15 per cent are between the public and railroad men (either way), compared with 85 per cent between railroad men on the railroad telephone system.

Commercial phones on the L&N are provided in offices of the passenger department, freight traffic department, ticket offices and other offices which deal directly with the public. In other departments, a limited number of commercial phones are centrally located where they can be used by several people. In these departments there are six railroad phones for each commercial telephone. September 1924, p 359; June 1940, p 329; June 1923, p 262; September 1941, p 473; L&N, May 1955, p 31.

Most roads other than the ten mentioned above have continued to use manual exchanges, leased from commercial telephone companies for telephone service in general office buildings and shops. This has necessitated railroad manual operators to handle calls to and from offices elsewhere on the railroad, regardless of whether these calls go over railroad-owned trunk lines or those of commercial phone companies. Within the last several years a few roads, such as the Southern Pacific, have leased automatic exchanges for use in major railroad office buildings. Through dialing is used for long-haul calls which are over railroad line circuits. For an explanation of the SP project see Railway Signaling and Communications, April 1957, p 23.



Automatic telephone switching equipment in an automatic telephone exchange, one of twelve owned by one railroad

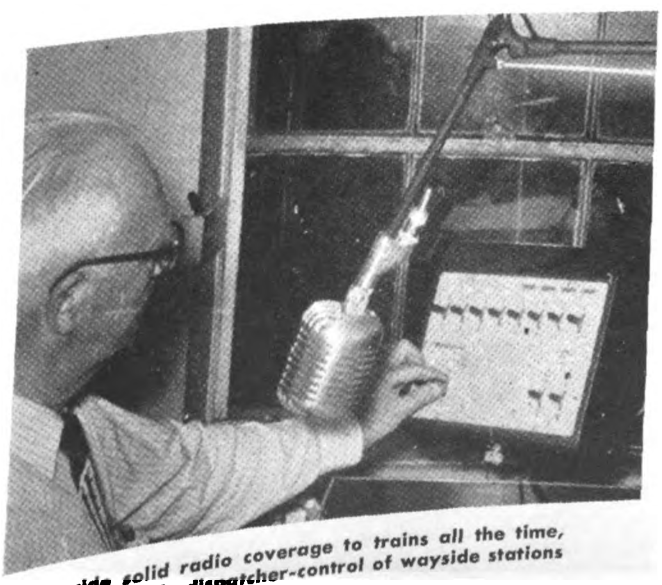
Due to low annual cost of railroad-owned automatic phones they can be installed at many places . . .

. . . wherever needed—No one need walk far to a telephone in service 24 hours every day

Radio—Slow Start—Big Boom

Railroad radio was first used between a moving train and Scranton, Pa. on the Lackawanna. Radio hop was 50 miles

Over 8,000 locomotives, both switchers and road engines, have been equipped with two-way railroad radio since 1946



To provide solid radio coverage to trains all the time, roads have put in dispatcher-control of wayside stations

Two-way wireless telegraph between a wayside station and a moving train was demonstrated on the Lackawanna as early as 1913. The next year, the same railroad demonstrated the use of radio telephone from a moving train to a station 50 miles away. From that time until about 1940, various railroads, including the CN, NYC, NC&StL and A&WP made installations of radio.

However, prior to World War II all radio equipment for uses other than military, operated at relatively low frequencies. Demands for channel assignment to general broadcasting, marine, police, fire protection, and other services, precluded permanent assignment to railroads.

Tests of inductive carrier train communication were made during the early 1920's. The first permanent installation in main line railroad service was in 1937 on the Bessemer & Lake Erie. Later the Pennsylvania, the Kansas City Southern and some other railroads made extensive installations of this inductive carrier form of train communication. In this system, high frequency energy put out by equipment on the locomotive, for example, is picked up inductively by the rails and the line wires, which "carry" it to be inductively picked up by receiving equipment on the caboose.

During World War II radio equipment was developed to operate at much higher frequencies. In 1944 and 1945 numerous tests of two-way radio train communication were made on railroads. A total of 15 articles concerning these tests and other matters concerning radio on railroads were published in this magazine in 1945, and 23 such articles were published in 1946. In February 1945 the Federal Communications Commission held hearings at which the railroads were represented under the auspices of the Communications Section, AAR. On May 17, 1945, the FCC made assignments to railroads, including 60 clear channels, each 60 kilocycles wide, in the 152-162 mc range, and also shared channels in the 44-108 mc and 186-218 mc range. Thus, since 1945 railroads have had adequate assigned radio channels.

In 1951, the RF&P installed a complete road-train radio system which provides two-way communication between the dispatcher's office and trains as head-to-rear and train-to-train. On the 110 miles between Richmond and Washington there are five unattended wayside radio stations, connected to the dispatcher's telephone line circuit. Calls end-to-end or train-to-train are on channel 1. Channel 2 is used to make calls from trains to the dispatcher via radio to nearest non-attended wayside station, then by wire to the dispatcher. The dispatcher replies on channel 1. December 1951, p 856.

In 1952, a combined road-train and wayside radio station project on 410 miles, all under the control of the dispatchers was placed in service on the Northern Pacific. One channel is used for end-to-end, and a second channel for train-to-wayside. By connections from dispatcher's telephone train dispatching line circuit to radio equipment in wayside offices, calls can be made either way from trains to the dispatcher or from dispatcher to trains. Such calls are made through unattended as well as attended wayside offices. If the line wires are torn down by storm, radio can be used between any two wayside offices. May 1952, p 316.

This NP installation and the RF&P project discussed above represent what may well be called a complete system of road train radio. Other similar systems were installed on other roads; SP, March 1953, p 184; November 1953, p 805; MP, November 1955, p 31; Erie, December 1948, p 754 and August 1950, p 490.

As part of radio projects several railroads have installed two-way radio equipment on maintenance of way department track machines, such as power tie tampers, etc. This radio is used to talk to flagmen, also equipped with radio, and to talk to enginemen of approaching train. This saves time for trains and time for the track machines. SP, February 1956, p 28; DT&I, June 1956, p 26.

General practice is to use 30-watt transmitters on both locomotives and cabooses, as well as at wayside stations. This insures a range for two-way conversations, not only the length of the train, but also to other trains and wayside stations within 20 to 25 miles except where terrain is adverse.

Up to about 1955, a general practice for 30-watt equipment on locomotives and cabooses was to have three separate units, transmitter, receiver and power supply. One reason for this was that if any unit failed, it could be replaced without disturbing the other two. Experience was that when the radio failed on the road, the location of the trouble was not readily apparent to men available, therefore in many instances all three units were changed. Another reason for having three units was to divide the total weight so any unit could be changed out readily by one man.

By using transistors in place of tubes, the power requirement was reduced, thereby reducing total weight. Thus the practice was developed in 1956 to combine the transmitter, receiver and power supply equipment all in one package, weighing not more than about 25-30 lb. This was an important development, now adopted by the Communication Section, AAR, and all the principal manufacturers of railroad radio equipment.

By means of the new transistorized power supply a 30-watt set on a diesel locomotive can now be operated directly from the 64-volt d.c. from the engine-starting battery, without vibrators or rotary converters.

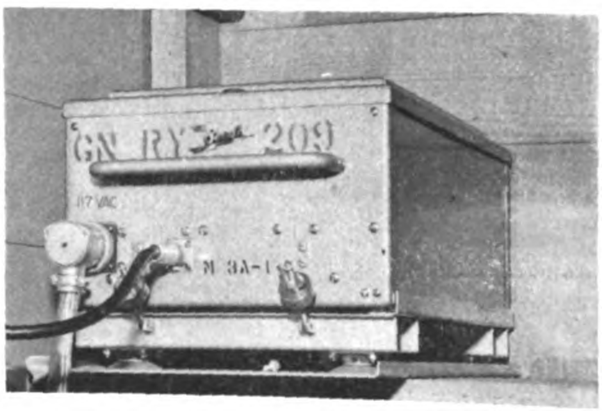
In addition to the 30-watt sets mounted in the locomotives and cabooses some roads provide portable walkie-talkie two-way radio sets in cabooses for use by conductors or trainmen when walking along the train to inspect cars, or when going out to flag. For head-to-rear, some few roads use walkie-talkies on the caboose instead of installing the 30-watt sets. Early models of walkie-talkies using tubes and heavier battery, weighed up to 15 lb. The modern transistorized walkie-talkie requires less power, and therefore smaller batteries, so that the total weight has been cut to 9 lb. Such a set is easily carried.

Railroad installations of radio for two-way train communication and yard communication have increased rapidly each year, reaching a maximum or 2,989 units of radio equipment installed in 1957.

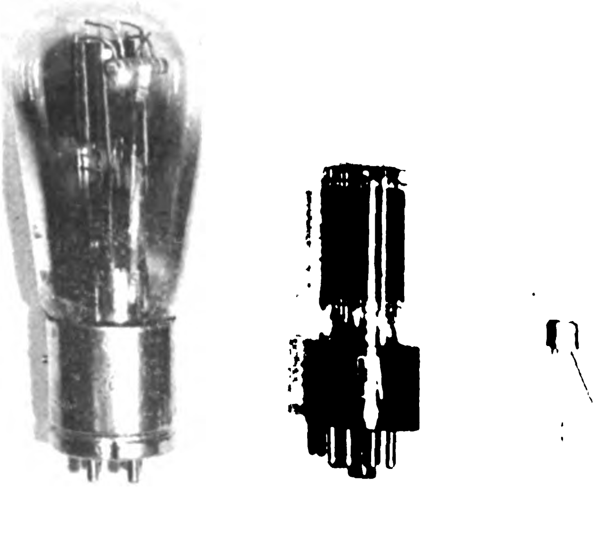
In 1957 the FCC authorized installations of 5,323 radio transmitters in railroad radio service, compared with an annual average of 2,863 during the previous four years. A total of 29,082 radio transmitters have been authorized in railroad service up to Jan. 1, 1958.

Now radio phone calls are made from conductors to engineers, or to operators in wayside stations as readily as you call your wife at home. Yardmasters talk to their crews anywhere in the yard or when they are delivering cars to industries miles away. Thus, within about 10 years since 1946, radio, as an entirely new field of railroad communications, grew from infancy to youth in seven years, and from youth to manhood in the three last years.

Walkie-talkies now number over 4,500 on American railroads. Car inspectors are rapidly becoming largest group of users



Single-package radio with transmitter, receiver and power supply in one standard-size unit was AAR approved in 1956



1 2 3 4 5

Less weight and small size of radio is due to tube development: left—1923; center—1945; right—transistor, 1953

All voice circuits terminate in yardmaster's console

Raising plunger lights lamp on yardmaster's console

Word Gets Around in Yards

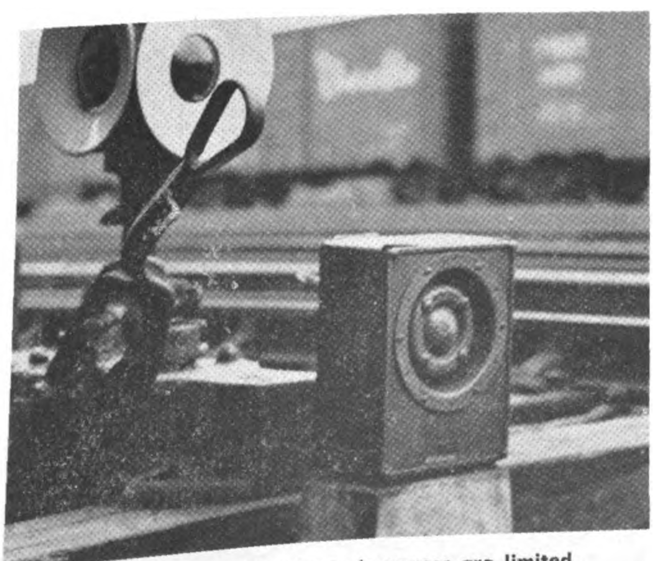
Up to 1941, yardmasters spent much of their time walking back and forth from one place to another to give directions to their crews. This was slow, and usually they were chasing trouble rather than preventing it. Communication developments changed all this, fast.

Early in 1941, the Alton & Southern developed a practice of locating the yardmaster in an elevated tower where he could see much of his yard. A system of two-way, voice-calling talk-back loudspeakers and paging speakers was installed for communication either way between the yardmaster's tower and talk-back speakers at numerous locations throughout the yard, especially along the leads where crews worked when doing much of the switching. The system was a success in expediting yard work. In 1946 the Southern installed a similar system at Birmingham, as explained on page 412, June 1946. In 1949 the Alton & Southern rebuilt its yard communication system as explained on page 381, June 1949 issue.

For use in smaller yards where the yardmaster is usually out in the yard rather than in an office or tower, the UP developed a special communication system. The yardmaster when anywhere in the yard can go to a nearby talk-back speaker and raises the plunger to put out a call over the other talk-back loudspeaker (speakers act as a paging system) to call any one elsewhere in the yard. The man called goes to the nearest talk-back to answer. April 1956, p 34. A means for selective calling over talk-backs was developed on the NYC. April 1957, p 62.

Combinations of radio, talk-backs, pagers, etc., in yard communication systems have been made by several roads. Southern, May 1954, p 50; UP, December 1955, p 26; May 1954, p 38 and with the SP January 1956, p 24; C&O, September 1956, p 28; Southern, July 1956, p 30. Numerous roads have recognized the benefits of paging and talk-back speakers in yards and have installed such systems in more than 376 yards, including 7,860 talk-back speakers and 3,331 paging speakers.

A unique combination of radio interconnected with paging loudspeakers for use by car inspectors was developed on the St. Louis-San Francisco in 1952. Each car inspector carries a Dick Tracy light-weight radio, which includes transmitter equipment only. When an inspector finds a defective car he speaks into the microphone in his Dick Tracy. The energy is transmitted to a receiving only antenna and receiving equipment at a central place in the yard. The output of this receiving equipment is connected through amplifiers to the circuit to the loudspeakers throughout



Low speaker on pedestal where clearances are limited

Dick Tracy transmitter works with paging speaker system

Freighthouse checker can work with up to five crews in cars

Caller in car has hands free to "spot number" packages

the yard and in the car foreman's office. The foreman, or other person being called, answers over the yard loudspeakers. March 1953, p 192 and C&O September 1956, p 28. On some roads, the inspectors carry walkie-talkies that transmit on one frequency and receive on another: RF&P August 1954, p 32, UP September 1953, p 624 and February 1957, p 30; EJ&E, June 1955, p 31.

Modern Communications in Freighthouses

Prior to 1950 a general practice in lcl freighthouses was to assign a checker with each crew unloading a car. This checker took the waybills into the car, and, as each package was brought out, he checked the bill and used chalk to mark each package to indicate the outbound dock or car to which it was to be trucked. This was too slow and expensive.

In 1950 the Frisco installed a private automatic telephone exchange system in its lcl freighthouse at Memphis. Portable phones on long cords were used by the unloaders in freight cars to talk with checkers working in a central office February 1950, p 106. Also in 1950, the Southern installed a central checking and paging system in its lcl freighthouse at Knoxville, Tenn. This Southern project included two-way voice-calling talk-back loudspeakers in cars, connected to checkers working in portable booths. July 1950, p 426. More complete systems of this character were installed on other roads, Milwaukee, March 1952, p 182; LV April 1953, p 256.

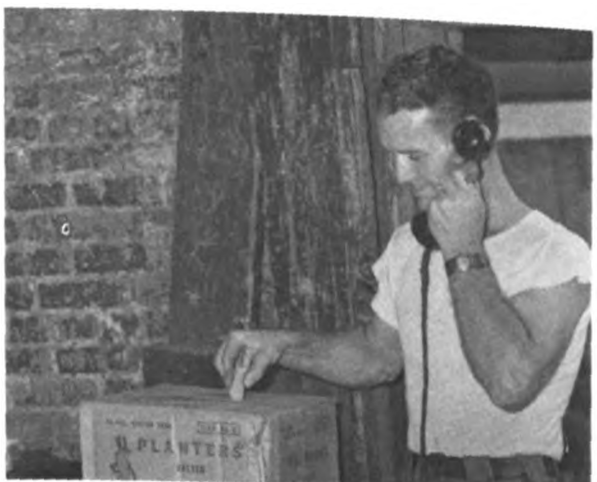
In these projects the use of talk-backs in the cars permitted the "unloader" to talk to the checker without going to the talk-back. However, the talk-back, in some houses, picked up too much noise. For this reason the Frisco used phones in the cars, on a common battery system. July 1953, p 484. The NP has a system that permits the unloaders to use either talk-backs or phones in the cars, December 1956, p 927.

Some of the more recent communication projects in freighthouses utilize Dick Tracy type portable light-weight radio transmitters for use anywhere in the cars or in the house. When a man speaks in one of these transmitters his voice is broadcast over the paging loudspeakers. February 1958, p 24.

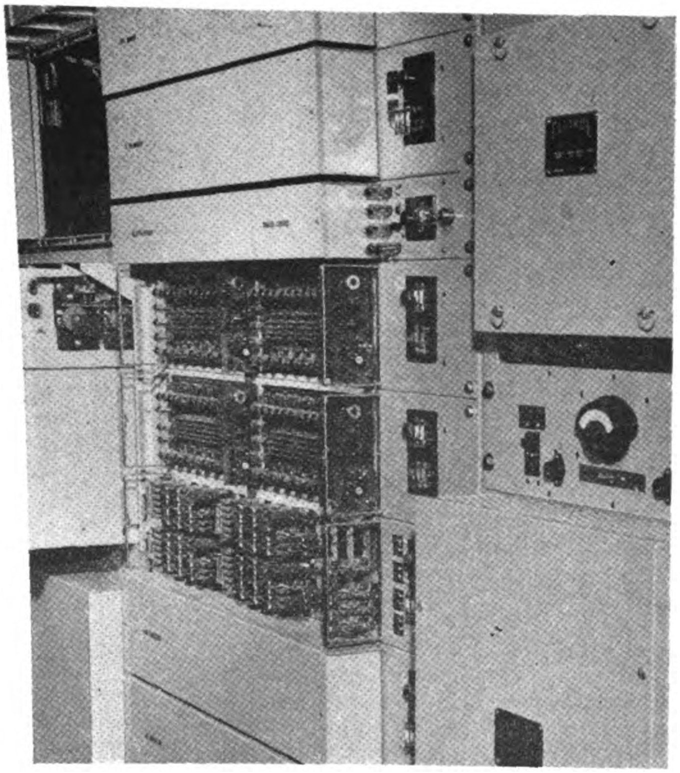
In addition to centralized checking, some projects include extensive use of two-way voice-calling talk-back speakers, an important project on the Texas & Pacific at New Orleans being explained in the June 1954 issue, p 44.

These freighthouse communication systems expedited the handling of freight and saved money because fewer checkers were required. These benefits were quickly recognized by other railroads, and therefore many similar systems have been installed in more than 340 freighthouses.

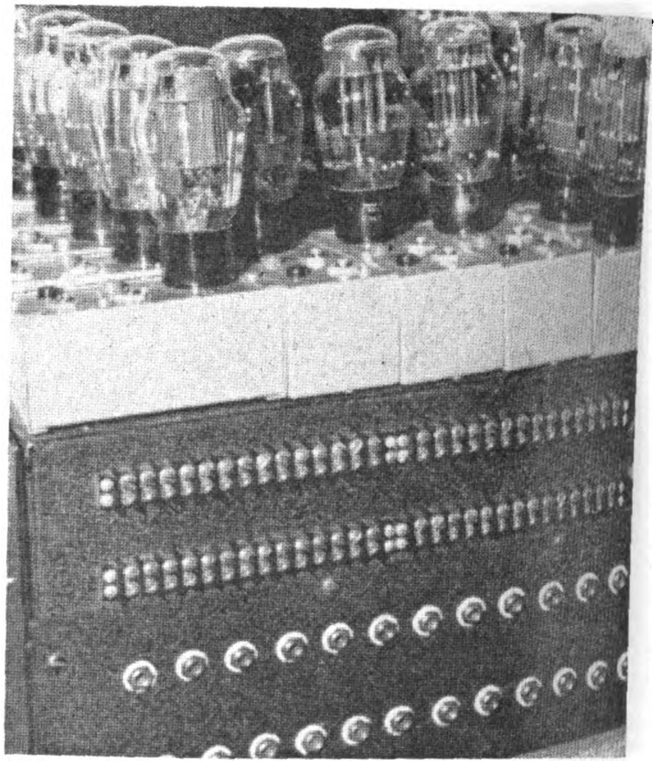
This checker's console has lines to all outlets in house



Phone handsets are preferred where ambient noise is high



Electronic sorter installed on Rock Island in 1956 automatically sorts car reports for various traffic office destinations



Erie developed electronic line multiplier in 1952 to provide simultaneous printing telegraph transmission without distortion

Car Reporting Calls for More Message Traffic

Back when Morse was used exclusively, message capacity was too limited to transmit train consists, wheel reports, or information concerning shipper, lading, consignee and destination, applying to each car. Trains arrived at yards with little or no advance information on how cars were to be classified or switched.

About 1920-1925 several roads, including the MP, installed printing telegraph to transmit car information from one terminal to the next, so yardmasters would have it well before trains arrived. This saved about 20 to 30 minutes delay for each car. In most of these operations the yardmaster at the next division point, as well as the telegraph office at a central headquarters on the railroad, had information on the shipper, lading, destination and consignee, all within 30 minutes to an hour after each train left each terminal. To improve accuracy and speed up the service, the Missouri Pacific, in 1937, developed the use of tape transmission to page printer, to handle wheel reports, train consists and car information, as explained in the September 1937 issue, p 523.

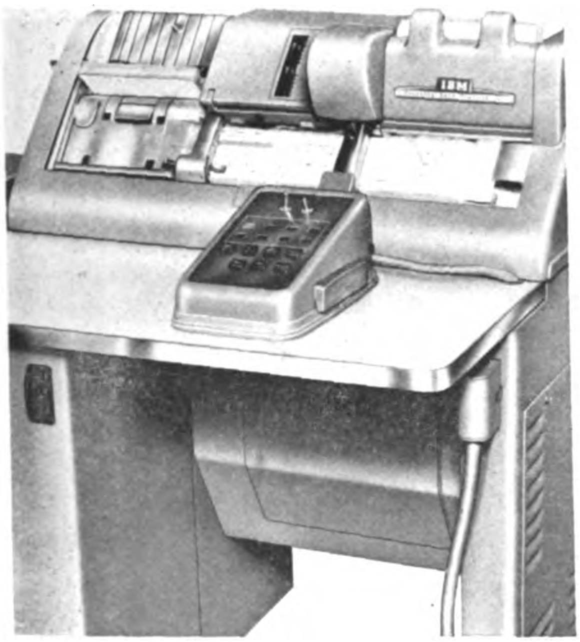
The next step was to make extra copies of some of these reports at general office headquarters for delivery to the traffice department, so they could send messages to shippers and consignees stating the progress of shipments enroute, especially if diversions were involved.

All this additional message traffic required more printing telegraph equipment and more line circuits, most of which was derived by installing carrier. How the Santa Fe made "the big switch" to printing telegraph and carrier is told in the December 1941 issue. This project on the Santa Fe required the purchase of 112 printers, 114 reperforators, and 101 transmitter-distributors. Also, this project required 29,619 miles of circuits, which was made available by installing carrier to derive 17,321 miles; physical circuits placed in duplex operation totaling 3,138 miles; and existing circuits changed over to new system, 9,160 miles.

How the B&O made these changes is explained on page 550 of the September 1948 issue. Previously when nearly all messages were handled by Morse, about 8,000 were handled daily through "GO" telegraph office in Baltimore. After the change to printing telegraph, about 15,000 were handled in addition to 450 wheel reports and numerous long lists which were never available by Morse. Similar changes and developments were made on many other railroads.

The problem of relaying in telegraph offices became significant as the number of messages increased, and most certainly reached the critical stage when railroads began handling car reporting traffic. One form of semi-automatic relaying was developed where the torn tape was inserted in the gate of a transmitter and the operator simply pressed a button to start transmission. One drawback was the requirement of the operator to continually check for a clear circuit.

One method to help alleviate congestion or reduce the amount of relaying, is simultaneous transmission. Originally this required a tape and transmitter for each circuit. Later, relays and circuitry were developed to connect one transmitter to several circuits simultaneously. To overcome distortion which sometimes accompanied simultaneous transmission with mechanical relays, the Erie developed an electronic line multiplier using vacuum tubes, November 1952, p 785. In most of these installations jack panels or pushbuttons are used to make the connections. By proper code markings, incoming tapes from reperforators can be read and properly routed to outgoing circuits. The C&O uses a semi-automatic system at their system relay office for their car reporting system July 1957, p 26. An automatic system in which the



Data transceiver "reads" a punch card, transmitting data over voice circuit to like unit that punches a new card

C&O's "brain" handling accounting and payroll data is fed by vast communications net utilizing printers and transceivers

tape of the reperforator is read and then fed into a transmitter for relaying is used by the New York Central, September 1956, p 22.

The Rock Island went a step further in this process of relaying of car reporting information. Using an electronic system, the incoming circuits are connected into the equipment which records the entire train consist on magnetic tape. The tape is then played back, the information for each car being sent to a reperforator associated with the traffic office concerned about the car. Proper coding on wheel reports assures that they only are fed into the electronic sorting system, because the incoming circuits also handle message traffic. March 1957, p 30.

As car reporting systems took hold, opinions varied as to the means for preparing the information for transmission from the yard office: punch cards and business machines or printer equipment. Up to now both systems are used, but the development of the transceiver had a far-reaching impact on the situation. This is so, because transceivers read punch cards, transmit the information over circuits, and produce punch cards at the receiving point identical to the cards at the transmitting end.

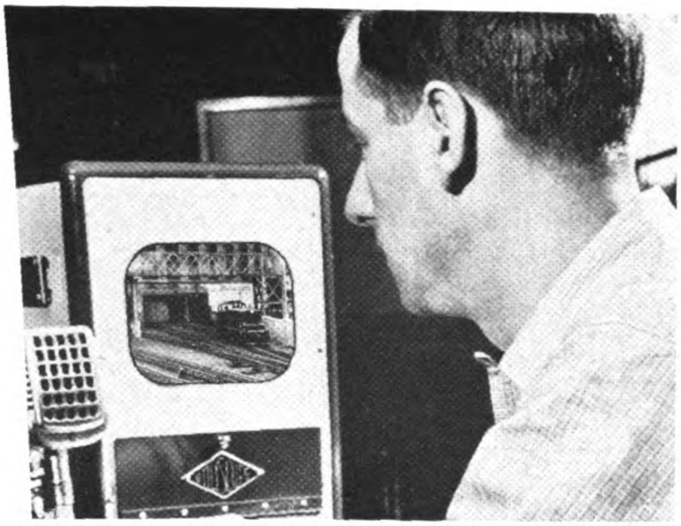
These transceivers, operating over voice channels, handle car report information at the rate of 133 words per minute, as compared with conventional printer operation of 60 or 75. Extensive tests by the Chesapeake & Ohio determined the increased capacity and reliability of transceiver operation, March 1957, p 33. Other roads such as the Union Pacific have used transceivers for handling payroll information between Salt Lake City, Los Angeles, etc., to headquarters in Omaha. These operations were so successful on the UP that they replaced their printer equipment with transceivers to handle car reporting information. January 1958, p 22.

As applying on numerous roads, with all this car information going through the telegraph office at general headquarters, the next step was to furnish copies to the car accounting department so they would have this information within an hour or two after each car left every major terminal. This data is quickly available not only for billing but also to keep track of car movements and to distribute empty cars more efficiently and promptly. This cuts down car shortages, thereby serving shippers promptly and reducing investment in new cars. Thus communication "came into" tangible savings that represent big money.

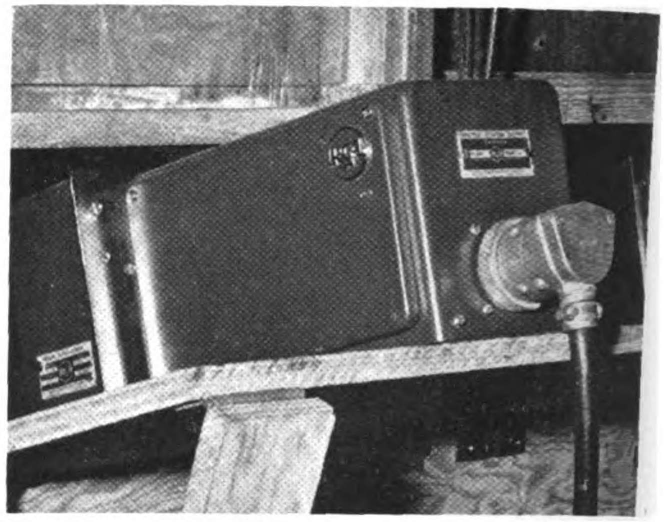
Business machines were introduced as a means of expediting car reporting and reducing operating costs in accounting practices. In 1945, the New Haven applied printing telegraph and punch card machines to handle interchange reports, wheel reports and yard records. This was the first civilian adaptation of this technique used by the U. S. Army during the war. This system was card-to-tape for transmission and from tape-to-card at receiving office.

Electronic Data Processing

The installations of electronic data processing machines at railroad headquarters, within the next few years, will bring about another big increase in telegraph message traffic that must be met by additional printing telegraph apparatus or transceivers, and line circuit capacity. Roads such as the Southern, Great Northern, Maine Central, Canadian Pacific and Chesapeake & Ohio, are a few of those which have already installed these electronic brains. The Canadian Pacific, for example, has tied their printer car reporting system into 8 data processing centers spaced across Canada. These centers take the tape and produce punch cards. These cards, plus others with payroll and other accounting information, are sent via transceivers to Montreal, where the information is fed into a computer. Car movement and distribution information processed at Montreal is sent via transceivers to the eight data centers for relay to specific traffic and yard offices.



TV enabled PRR train director to watch post office switcher



TV camera at yard entrance is focused on sides of cars

Closed-Circuit TV on Railroads

In 1952 the Baltimore & Ohio made an extensive test installation of closed-circuit television in a yard near Chicago. Cameras were located to (1) read car numbers and initials at remote yard entrances; (2) to monitor operations in remote portions of the yard; and (3) in pits under track to inspect brake beams, wheels, etc., on passing cars. See p 610, September 1952.

Since 1952, numerous uses have been found for closed circuit TV on railroads. The Pennsylvania uses TV to watch switching moves on the Post Office tracks at Pittsburgh. May 1954, p 56. In January 1955, the first permanent installation of TV to grab car numbers was placed in service on the RF&P, see February issue 1955, p 56, and March 1955, p 42.

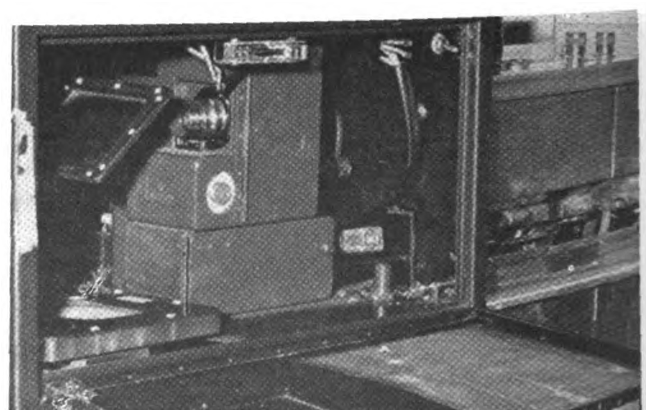
A system was installed in a yard on the Southern in Chattanooga, July 1956, p 30. TV cameras at two entrances to this yard are connected by cable to conventional TV viewing sets in the yard office. The incoming circuit from any of the cameras at yard entrances can be connected in the office to a special enclosed machine where a "movie" film is produced for later reading of car numbers. If two trains are arriving simultaneously, the motion-picture machine is used to record one train, while the clerk watches a TV screen for the other train. Closed-circuit television systems are due to be installed in at least six other yards in 1958.

A new and different use was made of TV by the Jersey Central at its Pier 18 coal dumping facilities in Jersey City, October 1957, p 34. The TV camera is focused on the barney pit, and enables the operator to see that the barney is properly positioned to push a loaded car up to the dumping platform on the dock.

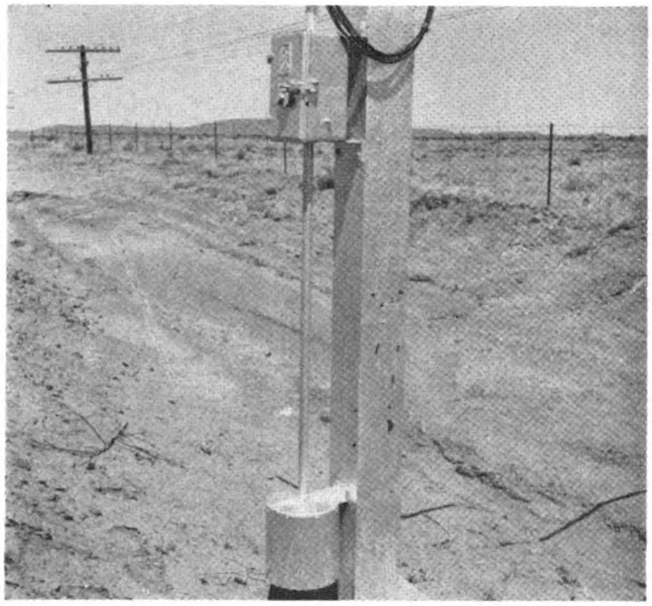
The largest closed-circuit TV installation on American railroads is in the Pennsylvania's ticket sales and service bureau at Penn Station, New York, using 100 cameras and 96 receivers. June 1957, p 34.

Another proposed use for closed-circuit TV is in grade crossing protection. Where tracks cross several busy streets at grade, installation of power gates, controlled by one man in a central tower might be opposed because of limited visibility. Use of one or two cameras at each crossing, with viewer sets in a central control tower, looks like a possible solution.

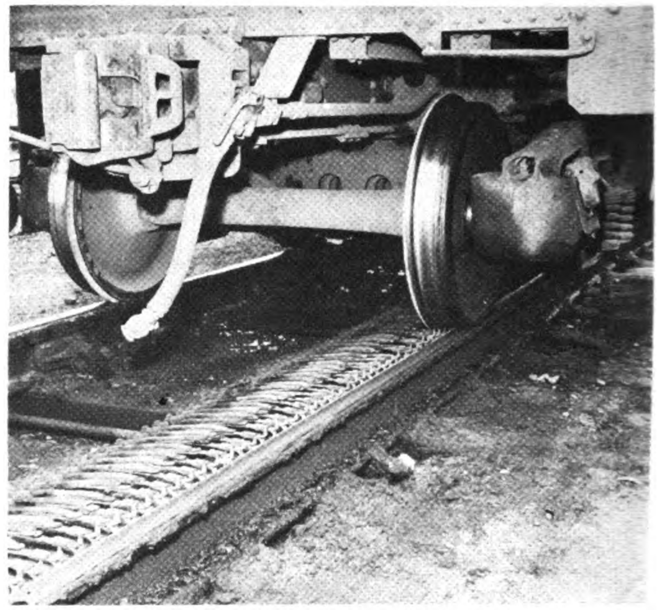
B&O clerk "grabs" car numbers via TV viewer in 1952 test



Movie camera on Southern puts TV image of train on film



Flood detectors in service on MP, M-K-T, SP and Milw.



Broken-wheel detectors on four roads in 1957

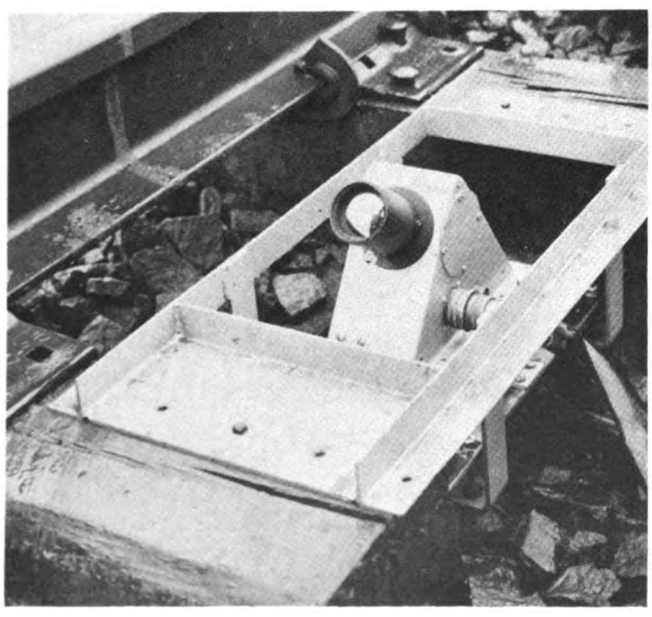
Safety Detectors: Prevent Accidents

By using ten forms of automatic apparatus at numerous locations on the road and in yards, hazardous conditions of tracks and bridges, as well as defects on passing cars and locomotives, can be detected automatically, and can control signals to stop trains. From now on there will be increasing need for these automatic safety detectors, not only because they are much more effective than previous practice of depending on train crews and men working along the wayside to see the defects, but also because fewer men are now working on the wayside.

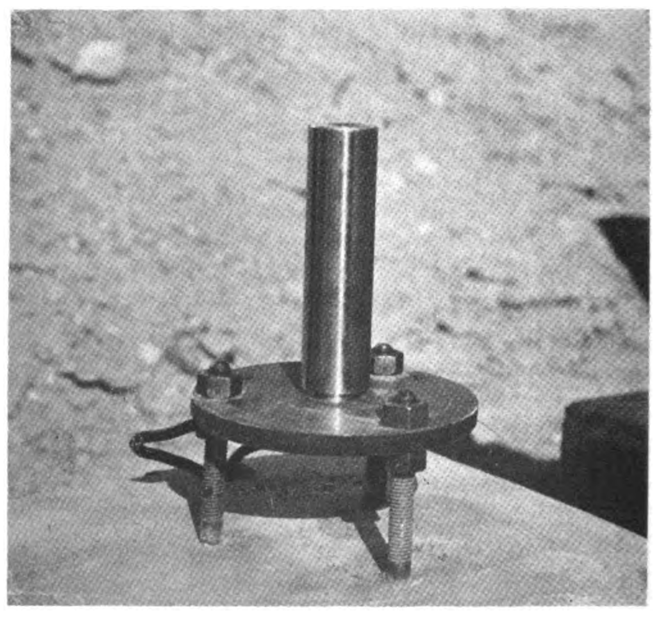
The newest type of detector is the infrared ray electronic hot box detector, the first explanation being about a project on the Reading, April 1957, p 19. Explanations of other installations were published: C&O, July 1957, p 46; B&M, November 1957, p 45, and NYC, March 1958. The B&M project detected 52 hot boxes in five months.

A device to detect broken flanges on car wheels has been under development and test for several years on four railroads. In 1957 this device was installed on two more roads, and shipments have been made for installation on two more. A set of these detectors installed on the NP September 5, 1957, has detected broken wheel flanges as follows: One 5-in., five 8-in., one 10-in. and one 22-in., as well as one wheel with 3 in. gone and a 36-in. crack in the flange.

Devices to detect defective equipment hanging or dragging from passing trains have proved their worth on a dozen or more roads during the past 20 years. Other devices to detect roadway hazards such as floods, rock slides, earthquakes, falling snow and freezing rain were developed years ago, and are in service on numerous roads. All these forms of detector were discussed in illustrated articles in Railway Signaling and Communications. A list of references will be sent on request to the editor.



Electronic hot-box detectors on six roads in 1957



Earthquake detectors installed on SP in 1956