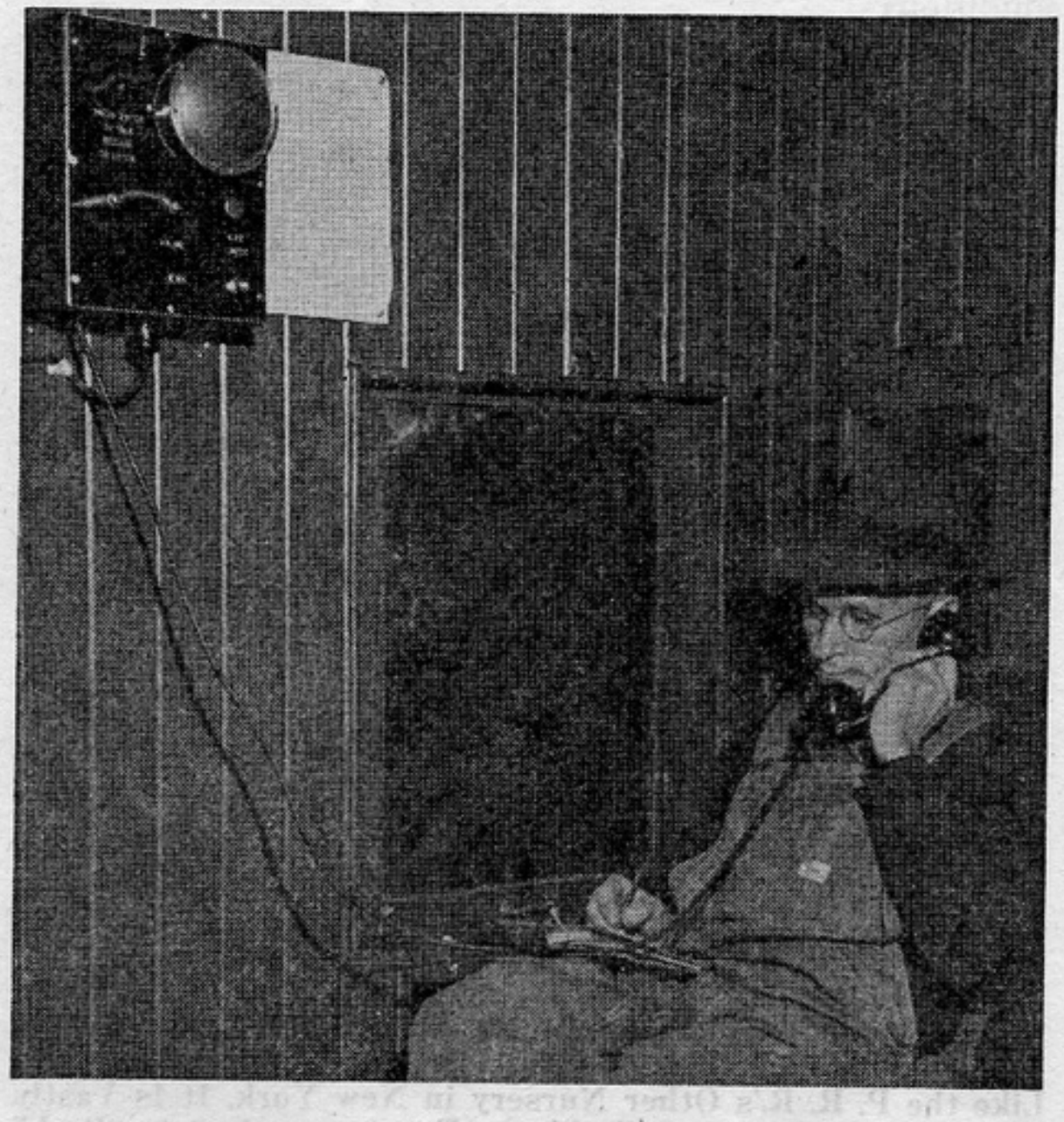
Train Communication on the K.C.S.

Carrier telephone system for two-way conversation head-end to rear of trains and with wayside stations

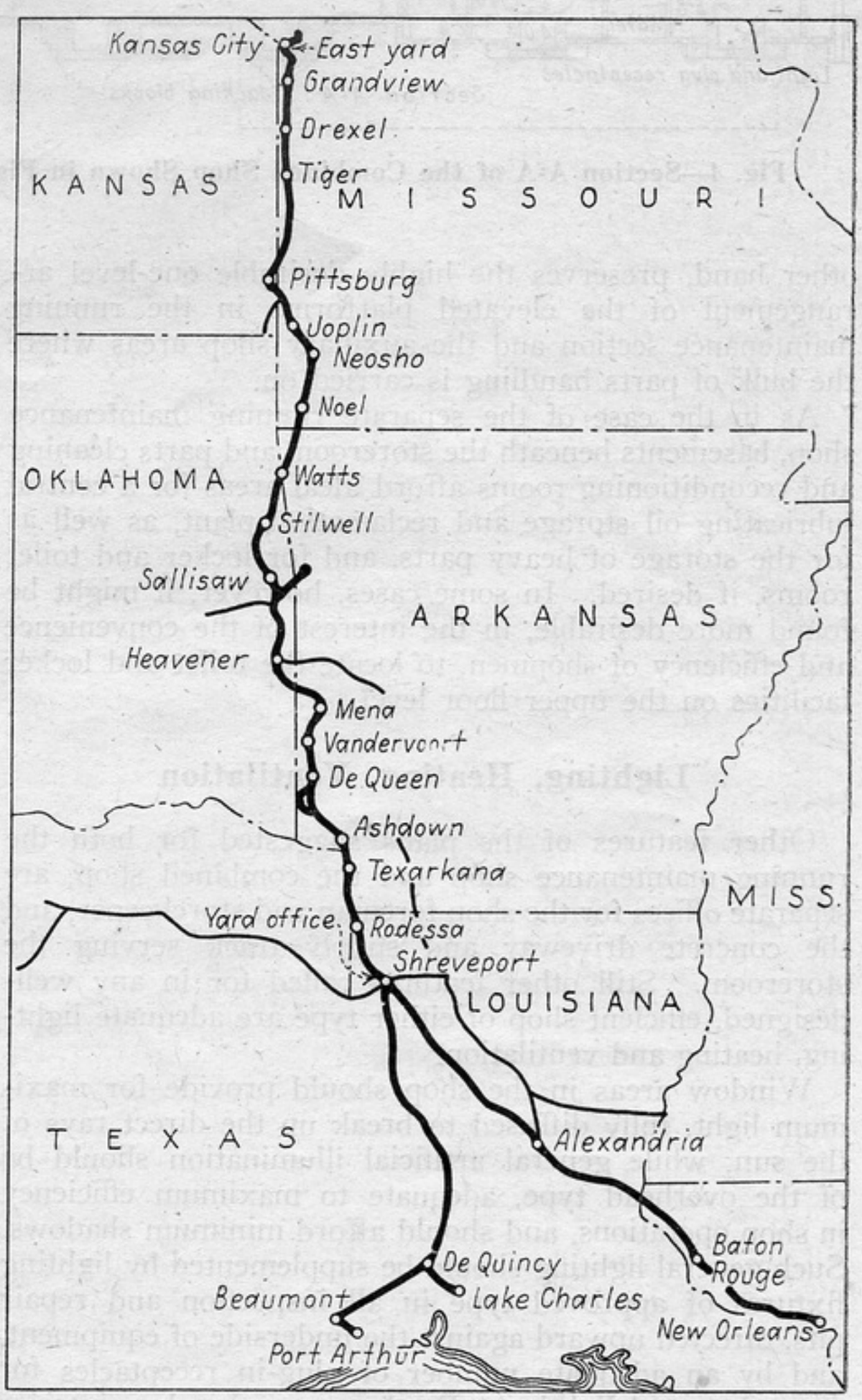
DURING the last ten months, the Kansas City Southern has made extensive tests and aided in the development of a carrier type two-way telephone train communication system. Most of the tests have been made with equipment on one freight locomotive and one caboose in connection with wayside stations at East Yard in Kansas City, Mo., at the dispatcher's office in Pittsburg, Kan., and at three intermediate offices at Grandview, Mo., Tiger and Drexel. Engineers of Aircraft Accessories Corporation, Kansas City, designed the equipment and developed its application to the Kansas City Southern.

Subject to obtaining priorities from the War Production Board and permission from the Federal Communications Commission, the railroad has entered into an agreement with Aircraft Accessories Corporation to purchase 22 wayside station sets and enough mobile sets for use on locomotives and cabooses to operate four trains continuously. The plan is to install the wayside sets at the stations shown on the accompanying map on the 560 miles of line between Kansas City, Mo., and Shreveport, La. After the benefits of these initial installations have been demonstrated, the plan is to equip the remainder of locomotives and cabooses used in road freight service on this territory.

Beyond Shreveport, the K. C. S. extends south 228 miles to the gulf ports, Beaumont, Tex., and Port Arthur, Tex. Also from Shreveport the associated line, the Louisiana & Arkansas, extends west 222 miles to Dallas, Tex., and southeast 312 miles to New Orleans, La. The traffic to and from these three lines is handled over one single-track line between Shreveport and Kansas City, and, therefore, the train communication is planned for this territory first as an aid in increasing track capacity and expediting train movements.



Conductor in the Caboose Using Train Telephone to Talk to the Engineman



Map Showing Location of Wayside Stations Between Kansas City and Shreveport to Be Equipped for Communication with Trains

Although telephone apparatus is in service for transmission of train orders on the lines between Shreveport and New Orleans, as well as between Shreveport and Port Arthur, the Morse telegraph is still used for train orders north of Shreveport. This is an additional reason for applying the telephone train communication system on the Kansas City-Shreveport territory first, because the system supplies an additional circuit for two-way telephone conversation, by carrier, between the dispatcher's office and the principal stations on the line.

The communication system is of the carrier induction type in which the previously existing wires on the pole line are used also to "carry" the train communication energy which is at 170 kilocycles carrier frequency, using narrow band frequency modulation with unity deviation ratio. The carrier frequency does not interfere with the ordinary use of the telegraph and telephone service on the line wires. This use of the line wires permits the operation of low power sending sets on the locomotives, cabooses and in the wayside offices. As a result the energy which goes no more than a few hundred feet beyond or outside the railroad right-of-way is less than the limit for which the Federal Communications Commission regulations require an assignment of radio wave length.

Locomotive Engineman Using Train Telephone to Talk to Conductor

Ordinarily the pole line is about 50 ft. from the track, and where the ground is practically level, the line wires are about 15 to 20 ft. above the level of the rails. In rough mountainous terrain in Arkansas, the pole line may be as much as 100 ft. distance from the track, and the line wires may be 50 ft. or more above or below the level of the tracks. The train communication equipment is designed to operate satisfactorily with the line wires up to 200 ft. distance, and 50 ft. above or below the level of the track.

Throughout the Kansas City-Shreveport territory, this pole line has a minimum of four line wires. Two No. 9 copper wires are used as a message telephone circuit, with 85 telephones at various stations along the line. Two No. 8 iron wires are each used to provide telegraph circuits. On the two copper wires, there are in operation five carrier channels using equipment manufactured by the Communication Equipment & Engineering Company of Chicago, one for telephone use which operates at frequencies of 9 and 18 kilocycles, and four for telegraph use which are operated at frequencies ranging from 4.5 to 20 kilocycles. A simplex circuit is also derived from the copper wires. In addition to all these services, the 170-kilocycle carrier for the telephone train communication system is superimposed on these wires. At the wayside offices one terminal of the equipment is connected to the ground and the other is connected through appropriate filter to two of the overhead line wires.

Antenna on the Mobile Units

The antenna on the locomotive consists of 12 turns of wire, 4 ft. high and 6 ft. long in a vertical plane, with the greater dimension in the direction of travel. On the caboose, the antenna consists of four turns of wire encircling the outside of the car in the direction of travel.

When transmitting from a mobile unit as, for example, the locomotive of a train, 170-kilocycle energy is applied to the antenna to create a magnetic field which cuts or links with the line wires on the pole line, thereby inducing in the wayside wires the 170-kilocycle energy which is carried along the wires to be picked up by the antenna on the caboose. In this operation the gap between the wires of the pole line and the mobile units is bridged inductively in two instances, and these losses, together with the slight loss along the line wires, require up to 50 watts output for a range of up to 10 miles when transmitting from one train to another train, or from head to rear end of one train.

When transmitting from a wayside office to a locomotive or caboose there is only one gap between the pole line wires and the antenna on the vehicles to be bridged inductively, and therefore only 3 to 6 watts power output is required at the wayside stations for communication with locomotives or cabooses on moving trains up to a maximum distance of 25 miles under adverse weather conditions.

Electronic Apparatus

The wayside offices should be spaced not more than 40 to 50 miles apart, thereby making the maximum distance from a mobile unit to a wayside office 20 to 25 miles. The 20 offices on the 560 miles between Kansas City and Shreveport are at the towns shown on the map. The dispatcher at Pittsburg handles the 236-mile territory between Kansas City and Watts, Okla. The dispatcher at Heavener, Okla., handles the 197 miles between Watts and De Queen, Ark., and the dispatcher at Shreveport handles the 125 miles between De Queen and Shreveport, in addition to 110 miles beyond.

In this two-way telephone train communication system, the sets of electronic apparatus on the locomotives, cabooses and at wayside stations each include sending as well as receiving equipment designed to operate at 170 kilocycles. The receiver has a sensitivity of approximately 100 microvolts and an audio output of 1 watt (6 watts in mobile equipment). All equipment is designed for

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frequency modulation with a deviation ratio of unity. The audio response is practically uniform from 200 to 3,000 cycles. The transmitter, also frequency modulated, is the oscillator-amplifier type. The sending and receiving sets for use on the locomotives and cabooses are similar to those used at wayside stations except for shock mounting and for the power output rating.

On the locomotives and cabooses, as well as at the wayside stations, the receiver apparatus is normally in operation and is connected to a loudspeaker, which in effect is used only as a calling device. A hand-set, combining transmitter and receiver, is normally hung on a hook-switch. If the conductor in the caboose, for example, hears a call for him coming in on the loudspeaker he removes his hand-set from the hook-switch. This cuts out the loudspeaker and cuts in the receiver on the hand-set. When he is ready to talk, he operates a small push button on the hand-set which cuts in the transmitter and cuts out the receiver in his hand-set. In order to minimize confusion, the volume control on the loudspeakers in the cabooses and on the locomotives is adjusted to bring in calls only from the nearest wayside stations.

Uses for Train Communication

On the Kansas City-Shreveport territory train movements are authorized by timetable and train orders. Automatic block signal protection has been in service for 19 years on 14 miles of single track between Oskaloosa, Mo., and Pittsburg, Kan., and materials have been ordered for automatic signaling on 35 miles between Gulfton, Mo., and McElhany. It is not the intention of the railroad to use the proposed train communication system to change the present practices for authorizing train movements. On the other hand, the new communication will provide supplemental information which, in the opinion of the management, will minimize train delays in numerous instances on each trip, and thus get the trains over the road in less over-all time between terminals, thereby improving service to the public and increasing the efficiency of existing track facilities, cars and locomotives, as well as reducing overtime.

During the numerous trips when the train communication has been in test service on certain freight trains in the past 10 months, various instances in which train time has been saved have been noted. For example when making up a train in the yard at Kansas City the engineman

and conductor can use the telephone when pumping up the train line and testing the air, as well as for the conductor to give the engineman a verbal high-ball to depart. If the conductor or trainman at the rear note any dragging equipment or a hot-box, the train telephone can be used to tell the engineman to stop the train. Otherwise the conductor would have to pull the air at the caboose which might result in pulling the train in two. In any instance when the engineman makes an unexpected stop he can use the telephone to inform the conductor of the reason. Either when the train is stopped or in motion, the conductor or engineman can inform the operator at the nearest wayside office concerning progress being made by the train or to explain any unusual delays. The operator in turn passes this information on to the dispatcher who may find it desirable to change orders to other trains, or to put out information to all concerned regarding special causes for certain trains being delayed.

Half Million for Complete Installation

Considering the Kansas City Southern and the Louisiana & Arkansas Lines as a whole, the management estimates that a complete installation, including 65 wayside offices and 270 mobile units, would cost about $500,000. Maintenance, replacements, depreciation and obsolescence is figured as 20 per cent of the original cost annually, so that there would be an annual charge of about $100,000, which would easily be justified by the benefits of the train communication.

In 1943 the railroad paid $1,780,000 for per diem hire of freight cars, and over $500,000 for overtime and constructive allowances to freight train crews, totaling $2,280,000 of which the $100,000 is less than 5 per cent. The management is of the opinion that, by minimizing long delays on extra freight trains, the expenditures mentioned above can be reduced more than $100,000 annually.