Carrier Communication Equipment

Installed on the Santa Fe

Multi-channel high frequency apparatus provides network of ultra-modern system-wide telephone and telegraph service

THE Atchison, Topeka & Santa Fe has expanded its communication system by the adoption of modern multi-channel carrier equipment which ties together its offices on the Great Lakes, the Gulf of Mexico, the Pacific Coast and intermediate points, with long-distance telephone and telegraph circuits. In non-technical terms, carrier communication is accomplished in somewhat the same way as radio broadcasting, in that high frequency wave bands are transmitted. In radio broadcasting, the wave bands are of a frequency adapted to transmission through the air, whereas in the carrier system, the wave bands are of a frequency adapted to being "confined to" and "carried" on line wires. Therefore, the messages or conversations transmitted over the carrier are not only secret, but the system does not interfere with radio broadcasting or affect the conventional telegraph and telephone service on the wires.

The installation of these carrier systems supplements the existing physical "through" and "local" conversational telephone and telegraph circuits, and provides trunk lines for establishing connections between the private branch exchange switchboards in the executive offices at Chicago, and the grand division offices at Topeka, Kan.; Galveston, Tex., and Amarillo, and Los Angeles, Cal., as well as the traffic offices at San Francisco, Cal., and various division offices and important stations throughout the system. The program has as its ultimate aim a comprehensive network of telephone circuits whereby it will be possible to establish connections between any two telephones on the entire railway.

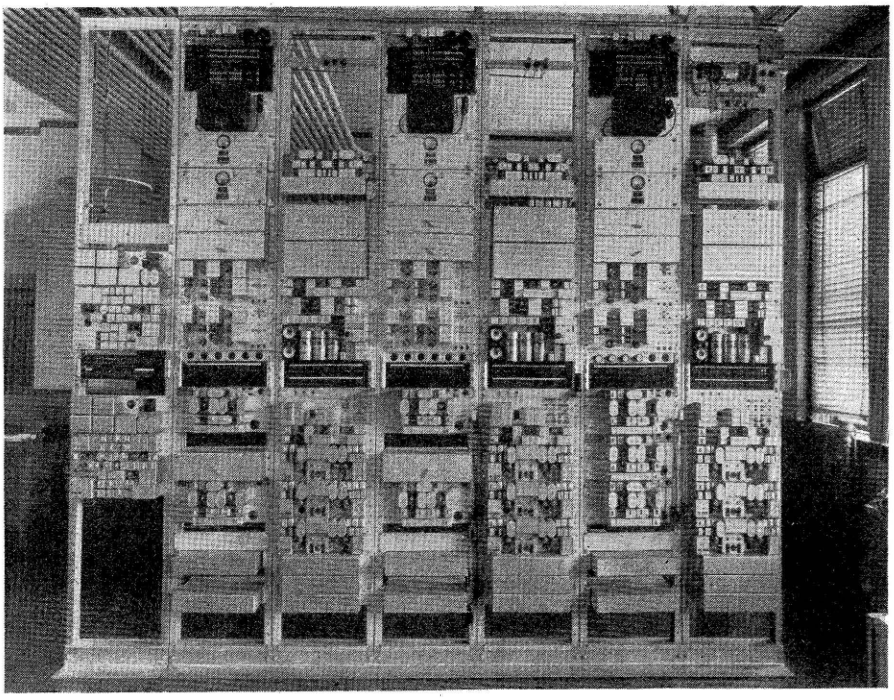
Types of Carrier Systems Used

Two types of carrier systems, with different capacities, are embraced in the installation. The H-1 type, superposed on a two-wire line circuit, has a capacity of one channel. In other words, only one conversation, in addition to that provided by the existing physical open wire telephone circuit, can be handled at any one time. This type operates on frequencies between 4 and 11 kilocycles. The C-5 type is a multi-channel telephone system, operating in the frequency range of 6 to 30 kilocycles, and provides facilities for superposing three additional telephone circuits upon an existing physical open wire voice frequency telephone circuit.

H-1 carrier systems were installed for operation between the offices at Chicago and Topeka, 516 miles; Topeka and La Junta, 490 miles; Ft. Worth and Amarillo, via Sweetwater, 496 miles; and between Los Angeles and San Diego, 126 miles. These facilities are normally used in trunk line telephone service between their respective terminals. Type C-5, three-channel, carrier systems were installed between Chicago and Los Angeles, via Topeka and Amarillo, 2,240 miles; between Topeka and Galveston, via Ft. Worth, 883 miles; between Amarillo and La Junta, via Boise City, 258 miles; and between Los Angeles and San Francisco, 606 miles.

Use of Channels

Between Chicago and Los Angeles, channel 1 of the C-5 system is assigned for through telephone trunk service, and this is also true between



Telephone carrier terminal equipment at Topeka, Kans.

Relay telegraph office at Topeka

Topeka and Galveston. In the above mentioned territory, channel 3 is normally used for through telephone trunk service between each carrier terminal point. Both channels 1 and 3 are used for through telephone trunk service between Amarillo and La Junta, and Los Angeles and San Francisco. The accompanying diagram illustrates the layout of the carrier channels and associated physical trunk line telephone circuits.

Telegraph Carrier System

Telephone channel 2 of the C-5 system is to be used for telegraph purposes. This channel will provide a maximum of 14 narrow-band telegraph channels, each of which may be used in duplex or two-way operation. The additional telegraph circuits thus obtained will provide up to a maximum of 14 two-way telegraph circuits for through service between Chicago, Topeka, Amarillo, Galveston, Los Angeles and San Francisco, thus releasing existing overland wires for advantageous use as intermediate facilities, and thereby providing the necessary telegraph circuits for establishing direct service between all important points on the system where teletype or printers are now in service, or may hereafter be installed.

Where through circuits are not set up for permanent use, direct service is accomplished by switching centers located in certain designated relay telegraph offices. The telegraph traffic between more than 80 principal points on the Santa Fe System is now handled by printer or teletype machines and this traffic includes not only ordinary messages, but also wheel reports, train consists, waybills, etc.

Outside Plant Improvements

The line wires on which the carrier systems were superposed had to be appropriately tested, and, where necessary, improved to meet the new requirements. In order to eliminate inductive interference and co-ordinate

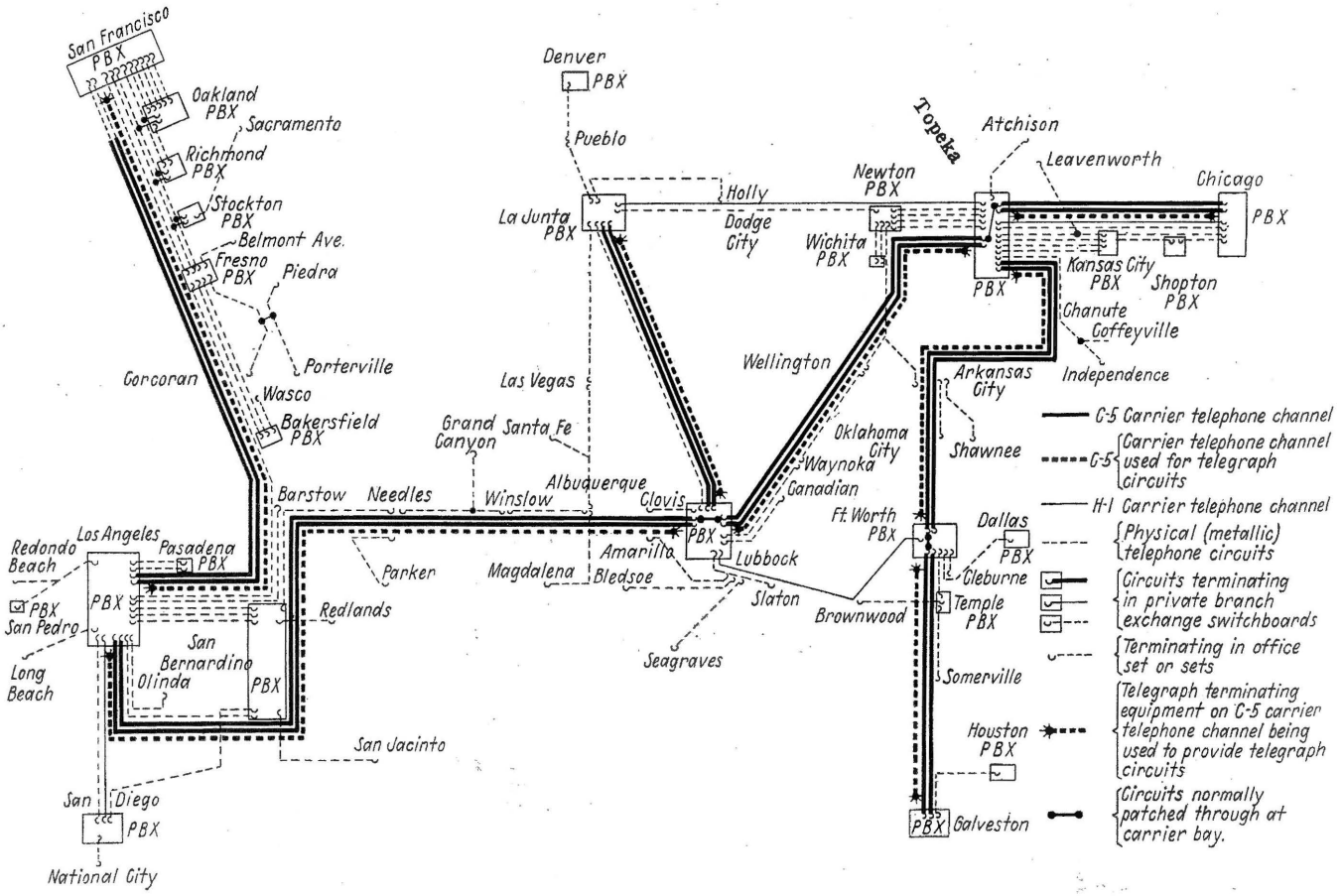
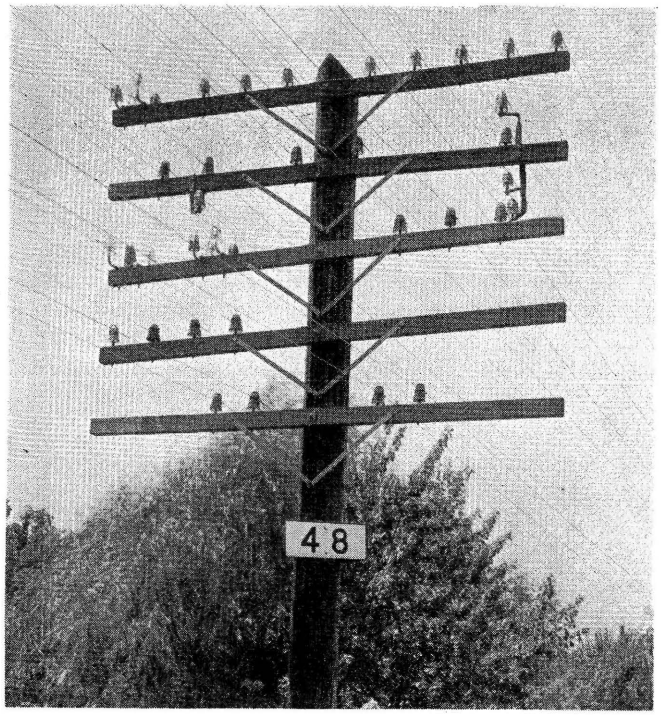


Diagram of carrier communication facilities on Atchison, Topeka & Santa Fe



Typical pole illustrating point-type transposition bracket used in the 30-kilocycle transposition

with other circuits, 30-kilocycle transposition layouts were installed on some of the lines.

To compensate for the loss in volume that occurs in the operation of telephone circuits of any appreciable length, amplifiers, or repeaters were installed at appropriate points varying from 100 to 200 miles apart. Over long distances such as are involved in the circuit between Chicago and Los Angeles, wide variations in temperature and weather conditions exist at all times, and to compensate therefor, repeaters and terminals of the multichannel systems are equipped with automatic regulating devices which insure the voice being maintained at a uniform and efficient level throughout the entire length of the circuit.

The expanded communication service has proved of inestimable value in the administration and operation of the railway, speeding up trains by providing terminal and yard forces with all records of train movements in advance of arrival of the train, and meeting the added and growing requirements imposed by extraordinary handling of telephone and telegraph matter pertaining to the operation of high-speed trains and other changed conditions brought about by the modern tempo of railroading, necessitating that matters of importance be discussed and decided upon in the course of minutes, rather than hours or days.

The engineering and installation of these carrier systems were handled by the telegraph department of the Santa Fe, under the jurisdiction of T. P. Brewster, superintendent of telegraph, in collaboration with engineers of the Western Electric Company, the Western Union Telegraph Company and the Bell Laboratories. The telephone carrier equipment was developed in the Bell Laboratories and was manufactured by the Western Electric Company. The equipment for the voice-frequency telegraph channels on the carrier system is being manufactured by the Western Union Telegraph Co.

Accident at Interlocking

On September 11, at Odin, Ill., an eastbound Baltimore & Ohio freight train occupied a crossing and was struck by a southbound Illinois Central passenger train. A summary of the report of the Bureau of Safety concerning this accident follows:

The crossing involved is protected by an interlocking. After an I. C. southbound train has entered the approach circuit, the route cannot be lined for a B. & O. train until the time release has operated an interval of 3 min. 40 sec. The route was lined for the I. C. train involved at 5:42 p.m., the time it entered its approach circuit. The B. & O. train passed its approach signal, which was displaying Approach, passed the home signal, which was displaying Stop, and had just stopped with the second car standing across the I. C. southward main track when this car was struck by the engine of the I. C. train at 5:45 p.m.

According to the statement of the engineer of the B. & O. train, both the approach signal and the home signal were displaying Approach. The speed of his train was 40 m.p.h. as his engine passed the approach signal and he partially closed the throttle. The engineer and the fireman kept the home signal under constant observation throughout a distance of about 4,400 ft. As the home signal was approached, the engineer called at least twice its indication as Approach. No one observed whether the marker light on the home signal was displayed. The engineer said that if the marker light was not displayed, the yellow aspect which he saw displayed by the home signal would be an imperfectly displayed signal. When the engine reached a point about 200 ft. west of the home signal, the speed of his train was 25 or 30 m.p.h., and he observed that the indication of this signal was Stop. He immediately moved the brake valve to emergency position but the distance was not sufficient for stopping short of the crossing. Had the speed of the B. & O. train been controlled in accordance with the Approach indication of the approach signal, it is probable this accident would have been averted.

The investigation disclosed that the B. & O. home signal, as seen from the engine of the approaching B. & O. train when it was in the vicinity of the approach signal, displayed a yellow light, which was caused by a combination of the sun's rays being reflected by the signal background and the red rays from the signal lamps, and which was interpreted as an Approach indication. This indication continued to appear to be displayed until the engine reached a point 950 ft. west of the home signal, then the Stop indication was observed.

Three months previous, the B. & O. home signal was painted with black paint of the glossy type instead of the dull type generally used. When the sun was low in the western horizon and the red lamps of the Stop aspect were lighted, the reflection of the sun's rays from the glossy surface of this signal, together with the red rays from the signal lamps, resulted in the display of a yellow light, which gave the effect of a phantom indication.

If the members of the crew on the B. & O. engine had been able to see the true indication displayed by the home signal when it first came into their view, it is probable this accident would have been averted. It is found that this accident was caused by failure to operate the B. & O. train in accordance with interlocking signal indications. It is recommended that the Baltimore & Ohio take necessary measures to insure that the home signal involved in this accident is brought into conformity with Section 42 of the Commission's order of April 13, 1939, "Action shall be taken when necessary to prevent phantom indications from reflected external sources."