RELAYING BY RADIO

Towers Spaced Across the Nation Will Act as Repeater Stations to Carry Television and Other Services—First Tests Begun in 1923

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SLENDER towers standing like lighthouses on the peaks of high hills and stretching in parade-file over flatlands hold promise today of becoming the means by which television programs will be made available to the entire nation. Using this medium, television signals comprising the sound-and-sight entertainment of the future will be "bounced" by radio from one tower to another, leaping gaps of 20 to 50 miles at each jump. Now that research scientists and engineers have brought television to a point where it is ready to create a new American industry, the planning and erection of these repeater stations is the next logical step.

For the past twenty years, the Radio Corporation of America has conducted experiments in radio relaying. Beginning with a radio carrier frequency of 182 kilocycles, research and development have gradually increased the utilized frequency to 500 megacycles. At the same time modulation bands have increased in width from 2000 cycles to four megacycles.

In 1923, RCA began the development of a radio relay station at Belfast, Maine. Its purpose was to intercept longwave transoceanic telegraph signals at a location where directional reception would reduce interference from lightning storms and to relay intercepted signals on another frequency to the RCA receiving station at Riverhead, Long Island. A year later, a second relay transmitter was completed at Belfast to operate on frequencies around 3 megacycles. This transmitter is believed to be the second one in the world equipped for quartz crystal frequency control, and the first to be put to practical use. By means of this unit the first broadcast programs were brought from London to New York for rebroadcast purposes. For RCA, it marked the beginning of shortwave equipment development and propagation tests which contributed to the present world-wide networks for international radio communication.

Four Firms Cooperate

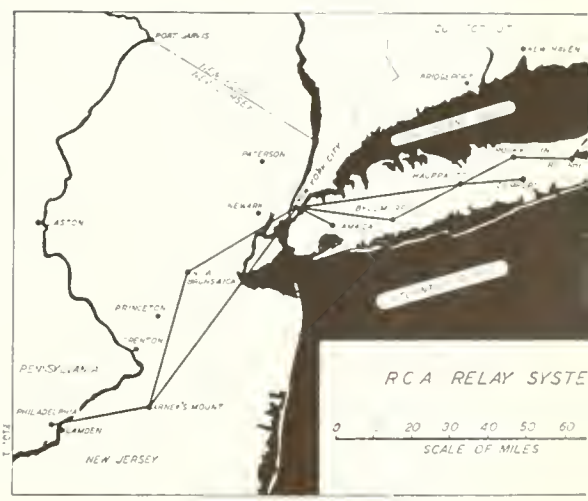
Soon thereafter, an experimental station was installed in the Empire State Building in New York City. It was at this stage of progress that the ultimate necessity for a television network, with which to carry programs from city to city, became apparent. Consequently, RCA and NBC, in cooperation with the General Electric Company and Westinghouse, undertook in 1932 the development of a relay station to carry experimental television from New York to Camden, New Jersey. A site on Arney Mount near Mt. Holly, New Jersey, was selected for the repeater and its 165 foot tower.

Although the apparatus was demonstrated successfully in 1933, using images with a fineness of 120 lines, tests soon convinced engineers that the relaying of television transmissions would have to be done at far higher frequencies than could be utilized at that time due to the lack of suitable vacuum tubes.

However, by the end of 1939, enough progress had been made in the development of new vacuum tubes for use at very high frequencies, and in the correlated development of radio repeaters and relay stations, to permit the establishment on Long Island of several radio relay stations operating in the vicinity of 450-500 megacycles. This relay system, which repeatedly "hopped" signals from the Empire State Building to a receiver in the RCA Laboratory at Riverhead, accommodated the full band-width permitted by television standards then in force. Later the addition of a third repeater station at Bellmore, Long Island, made it possible to relay signals from New York to Riverhead and back to Radio City.

A striking characteristic of properly designed radio relay systems, operating on frequencies above 500 megacycles, is that they require much less amplification in a given distance than concentric cable systems, when both are required to meet the present and future television modulation band-width requirements.

As television broadcasting moves to the higher frequency portions of the spectrum and as it becomes possible to include color, it is natural that the band-width required for transmission will be increased. For this reason it seems probable that radio relaying will receive greater recognition as the most promising means, technically and economically,



EXTENSIVE RADIO RELAYS OPERATING BETWEEN NEW YORK, EASTERN LONG ISLAND AND CAMDEN, N. J., IN 1939, LAID THE GROUNDWORK FOR NATION-WIDE RELAYS NOW IN PROSPECT.

ANTENNAS TOPPING HIGH TOWERS SIMILAR TO THE ONE SHOWN HERE WILL RELAY TELEVISION AND OTHER SERVICES ACROSS THE COUNTRYSIDE.

for the distribution of television programs.

In establishing a radio relay system, a major portion of the cost is represented by sites and towers. It is a fortunate circumstance that no development foreseen at present will destroy the value of these investments. Moreover, it is anticipated that future developments will make it possible to utilize higher radio frequencies thus providing more perfect reproduction of modulations without requiring substantial alterations in sites and towers.

Before the war the development of vacuum tubes and repeaters had been carried far enough to make it practical to utilize frequencies for television relaying in the range of about 300 to 1000 megacycles. It is anticipated that as soon as restraints due to the war are removed, the frequency range will be extended upward until eventually, frequencies of 3000 megacycles or more may be used.

Some Applications

Since the only justification for investing large sums of money in radio relay systems, and for getting involved in the toils of technical development, business promotion and government regulation, is the usefulness of the systems, it is appropriate to consider some of the applications.

Radio relays have so many outstanding technical and economic advantages for television distribution that eventually they should be regarded as essential for this service. However, the costs of adequate radio relay systems are substantial and, unless the outlay for relay station sites, towers and facilities can be spread over a number of channels and services, the financial burden may delay the initial spread of television service.

In holding unit costs down, it is essential that the relay stations be designed and equipped to provide several television channels, all utilizing the same towers. It is also essential that investment and operating expenses be shared with as many secondary services as possible.

In general, relay stations will occupy the highest points of land or buildings and provide the highest towers in each community. They are therefore the natural choice for location of radio broadcasting stations. By combining relaying and broadcasting, where this is possible, both can benefit.

High Towers are Attractions

High towers are natural gathering places for pleasure seekers and the curious. In many cases observation platforms, television theatres, restaurants and other entertainment facilities might be installed at the top of the relay towers to give a greater public service and to help in paying the costs.

One of the most natural secondary services, from a technical standpoint, will be that of facsimile communication, the transmission of any sort of picture or message which is to be recorded at the receiving end as a copy of the original. An adequate television radio relay circuit has a potential speed of transmission of 108,000 pages per hour.

There are as many uses for facsimile service as there are for existing telegraph and mail services. It is a means for giving the services with far greater speed and less effort. Soon, for example, facsimile could provide nationwide newspaper delivery faster than papers can now be printed.

There is another probably important use for future radio relay systems which is closely related to the struggle just beginning to obtain the use of frequencies above 30 megacycles. It is that of providing radio services to airplanes.

As airplanes increase in number, the demands for aviation radio service will increase to such a degree that it will be unreasonable to expect that radio frequencies and facilities can be provided so that all airplanes flying over land may communicate by radio over long distances. Furthermore, as the speed and efficiency of airplanes have increased, it has become more unreasonable to equip planes with either large protruding antennas, or powerful equipment, both of which are needed to operate on the frequencies required to reach great distances.

Looking to the Future

Looking ahead it seems inevitable that much of the communication with aircraft must be limited to short distances and carried out on higher frequencies with more compact equipment and without protruding antennas. This will require a large number of ground stations, spread out along the air routes, and because these same routes will be followed generally by the radio relay systems, radio relay stations are natural sites for airline radio ground stations.

Railroads, long distance bus and truck lines and portions of the traveling public have communication needs similar in character to those of the airlines. Radio relay systems might very well contribute to the fulfillment of these needs.

To make radio relaying a great new American industry requires a more general understanding of its value; a well-defined and stable licensing policy; a relaxation of restraints which not only dampen the hope of expansion and profit but discourage joint action by those in need of relay service, and a few promoters who have caught the vision.