CHAPTER III

DISTANCE ATTAINED IN ULTRA-HIGH FREQUENCY TRANSMISSION

Engineers have looked longingly toward the ultra-short wave portion of the radio spectrum, since the tremendous bands there available promise to furnish the vehicle needed for new radio services. A radio channel for television of good definition, for example, might require a band of radio frequencies two million cycles wide. When it is considered that present broadcasting channels are only ten thousand cycles wide, it is apparent that new radio services must find their vehicle of transmission in new and hitherto unused portions of the radio spectrum. Such an area is found in the realm of ultra-high frequencies or, to state it inversely, ultra-short waves, which comprise that part of the radio spectrum between ten meters and one meter.

Not only are wide channels necessary for the transmission of electronic television of high definition, but these wave bands are useful for the transmission of facsimile, and also afford many communication channels. There was one tremendous stumbling-block, however—the transmission range of ultra-high frequencies (ultra-short waves) has heretofore been limited to "line-of-sight" distances. In short, the effective distance of ultra-high frequency transmission has been, in the past, limited to the optical horizon; and by placing the sending antenna upon a tall building and having the receiving antenna placed high, about 50 miles was regarded as the effective range.

The R.C.A. Three-Meter Radio Circuit

This obstacle, the obstacle of distance, has now been overcome. The successful demonstration of a two-way ultra-high frequency circuit between New York and Philadelphia (See Fig. 78), operating on three meters, and using automatic,

unattended relay stations, would seem to indicate that ultra-high frequency transmission no longer suffers the limitations of distance.

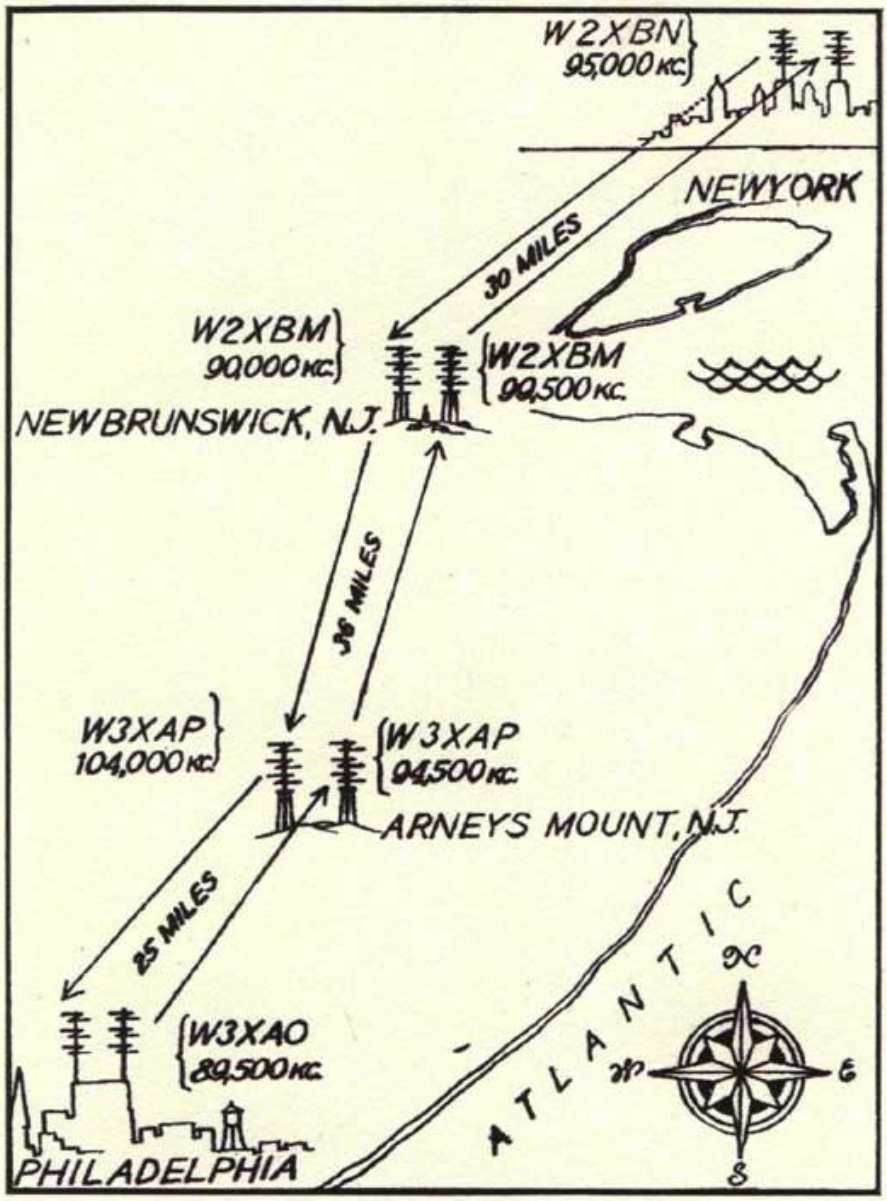


Fig. 78. Schematic Diagram of the R.C.A. New York-Philadelphia Ultra-High Frequency Circuit

Most ingeniously the research forces of the Radio Corporation of America have attacked and solved this previously

baffling problem. It was, of course, apparent almost from the first that the distance could be extended indefinitely by the use of relay stations, but the operation and maintenance of a number of relay stations, manned by operators, would

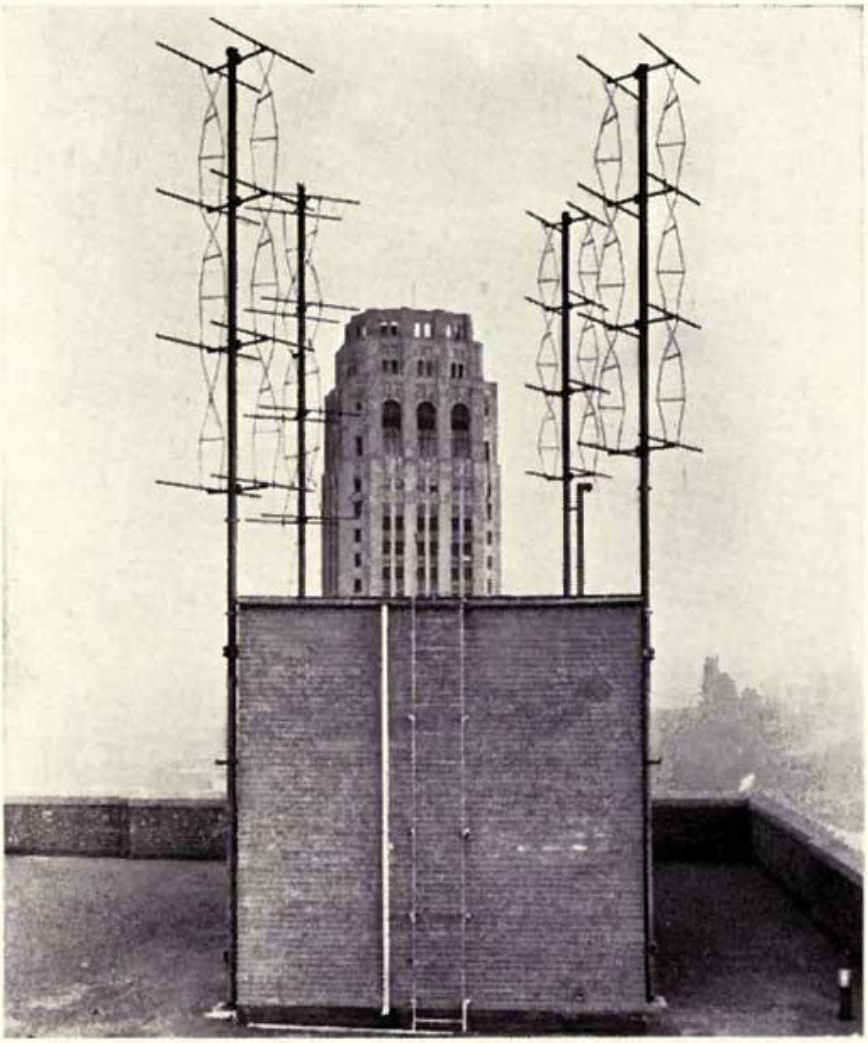


Fig. 79. Transmitting Antennas Used on the New York End of R.C.A.'s New Ultra-Short Wave Radio Circuit to Philadelphia

be costly and cumbersome. The problem, therefore, that presented itself was to have automatic, unattended, relay stations that would not interfere in their reception and sending. This has been accomplished.

Briefly the R.C.A. New York-Philadelphia circuit is made

up as follows: In sending from New York to Philadelphia (southward): the New York station (W2XBN) (See Fig. 79), the antennas of which are placed on top of a tall building some 600 feet above sea-level, sends on a frequency of

Fig. 80. Antenna Atop an Office Building in New York for Reception of Ultra-Short Waves, in the New York-Philadelphia Circuit of R.C.A.

95,000 kc. At New Brunswick, N. J., 30 miles distant, relay Station W2XBM, with antennas some 250 feet tall, picks up station W2XBN, and retransmits at a frequency of 90,000 kc. This, in turn, is picked up by relay station

W3XAP, situated on a hill at Arney's Mount, N. J., 36 miles distant, which in turn retransmits at 104,000 kc.

Twenty-five miles distant, atop a tall building in Phila-

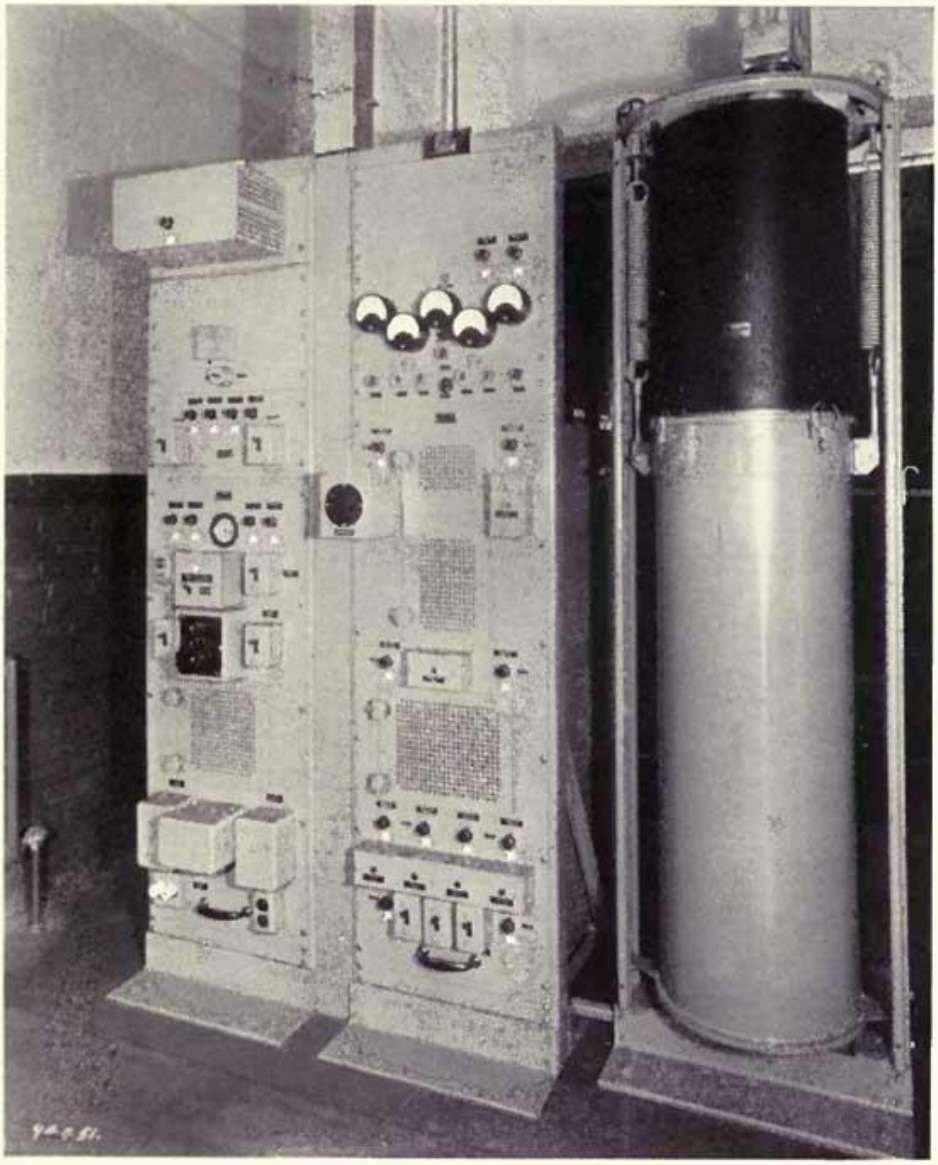


Fig. 81. Three Meter Transmitter Used in R.C.A.'s New Ultra-Short Wave Radio Circuit Connecting New York and Philadelphia

delphia, is station W3XAO, which receives from relay station W3XAP.

Now in transmissions northward, from Philadelphia to

New York, Station W3XAO, Philadelphia, sends at a frequency of 89,500 kc. This is picked up by Station W3XAP (Arney's Mount), and retransmitted at a frequency of 94,500 kc. which in turn is picked up by W2XBM (New Brunswick) and in turn retransmitted to New York at a frequency of 99,500 kc.

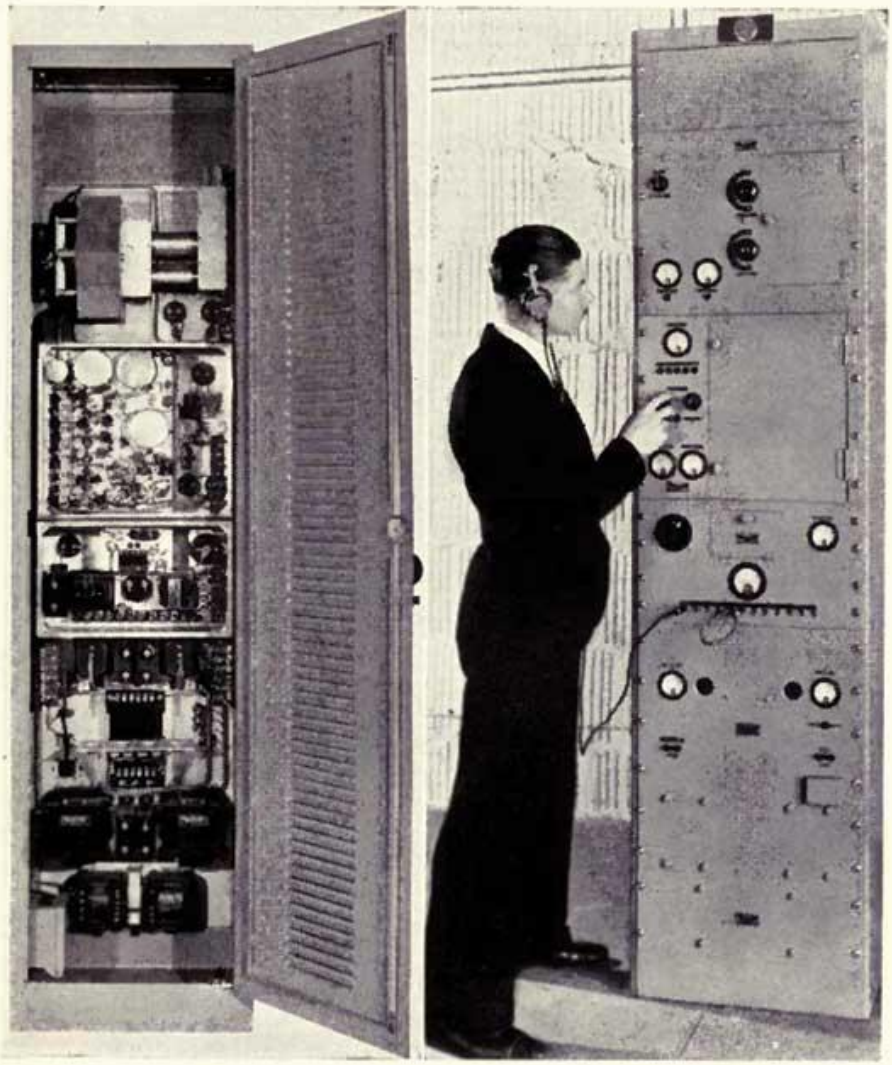
It will be seen that each of the relay stations employs two different transmitting wave-lengths, one for sending southward and one for sending northward. The two terminal stations each use a different wave-length, making a total of six wave-lengths, or frequencies used. These frequencies have been so ingeniously arranged that there is no interference, between transmission northward and southward, at the same time, from the same station.

Should it be desired to extend this circuit farther, these same six wave-lengths could be used over and over again in the same sequence. In short, two waves of the same length would be generated at points about one hundred miles apart, and would not interfere with each other, because of the "line-of-sight" limitation to their respective ranges. There seems to be no serious obstacle against extending a circuit such as this for any distance desired.

Interesting indeed is the method by which the unattended relay stations may be turned on or off from either one of the terminal stations by radio. The receivers at each of the four stations are always alive and ready to catch impulses from their assigned transmitters. When it is desired to make the circuit ready for traffic, New York or Philadelphia starts up its transmitter and sends a certain musical note which the receiving circuits are pre-set to "recognize." At the unattended receiver at New Brunswick, for instance, the tone passes through electric filters somewhat like a key passes through the tumblers of a lock. Electrical circuits "accept" the tone and relays are actuated, turning on the power for the "south" transmitter, which, when in operation, passes the tone on by radio to the

Arney's Mount station. There the operation is repeated.

When the tone reaches the Philadelphia station, the transmitter at that city is also automatically turned on, and the tone starts on its return journey back to New York.



(Fig. 83) (Fig. 82)

Fig. 82. Receiver Employed in R.C.A. Ultra-Short Wave Radio Circuit between New York and Philadelphia
Fig. 83. Rear View of R.C.A. Ultra-Short Wave Receiver

Operators in New York know that when the tone comes back to them from the "north" transmitter at New Brunswick the entire circuit is in full operation and ready for

traffic. The constant presence of the tone keeps the relay closed, and the circuit is in operating condition. When the tone is withdrawn from the circuit, relays click in the same succession over the round trip to Philadelphia, and, one by one, the transmitters are automatically turned off. Philadelphia has the same control over the circuit as New York.

Antennas, used in this circuit, because of their curious form, have been characterized as "Christmas trees" and "turnstiles." Odd shapes of certain parts of receivers and transmitters result from the application of the principle of "resonant lines" to both transmitters and receivers. This principle, developed by R.C.A. engineers for this use, eliminates crystal control and provides economical and efficient means of maintaining radio equipment in steady tune at extremely short wave-lengths.

The heart of the receiver is the "shoe button" or "acorn" tube, so called because of its small dimensions, and in the transmitters there are new power tubes specially designed for microwave service.

This circuit, as now developed, enables the transmission of drawings, type matter, handwriting, and other visual material in facsimile, along with the simultaneous operation of automatic typewriter and telegraph channels. It is completely secret, in that if the composite signal were "picked up" by any other than the designated receivers, it could not be "unscrambled" into its component parts.

Facsimile transmission does not, of course, fall within the scope of electronic television, for the scanning is mechanical and there are many other divergent features; yet this circuit has proved that the obstacle of distance in ultra-high frequency transmission has been overcome.

Thus, it will again be seen, that electronic television is not a thing apart, since the ultra-high frequency radio circuits that might, in the future, be used for television are also highly useful for other means of communication.

When the ultra-high frequency radio circuit between Phil-

adelphia and New York was opened, David Sarnoff, president of the Radio Corporation of America said, "Radio communication is today placing in useful public service, a region of the radio spectrum which only yesterday was virtually unexplored and scientifically unconquered territory. Having developed a technique of operation for the three meter band of radio wave-lengths, we find in that region, a medium of transmission unlike anything that we have known."