

**THE LATEST WORD
IN
COMMUNICATIONS**

**"MICROWAVE"
NEW YORK-BOSTON SYSTEM**

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PLANT DIVISION ONE
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"This pamphlet was prepared by the employees of Division One for those interested in some of the highlights of the New York-Boston Microwave System."

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THE LATEST WORD IN COMMUNICATIONS

The latest word in communications was presented to the American public on November 13, 1947, during the inaugural program of a radio relay system between New York City and Boston, Mass. This radio relay system employs the use of microwaves as a basic means of transmitting large amounts of information — for example, many different conversations — simultaneously over long distances. Such a system is designed to become an integral part of the nationwide Bell Telephone System communications network and climaxes two decades of research on practical methods of radio relaying. When completed, it is expected to furnish intercity facilities for long distance telephony, television transmission, and other services.

THE MICROWAVE TERMINALS

The two terminal points of this microwave radio relay system are the headquarters building of the American Telephone and Telegraph Company's Long Lines Department at 32 Avenue of the Americas in New York and, at Boston, the Bowdoin Square building of the New England Telephone and Telegraph Company.

Between terminal points, the microwave beam makes eight jumps via seven intermediate radio relay stations spaced about thirty miles apart. The relay stations are built on hilltops in order to provide an unobstructed view between the antennas which is necessary in microwave transmission. The distances between the seven relay stations and their respective elevation above sea level may be seen by turning to the center fold. The hilltops are located as follows: Jackie Jones Mountain, five miles west of Haverstraw, N.Y.; Birch Hill, about three miles south of Pawling, N.Y.; Spindle Hill, five miles north of Waterbury, Conn.; John Tom Hill, at Glastonbury, Conn.; Bald Hill, five miles east of Stafford Springs, Conn.; Asnebumskit Mountain, five miles northwest of Worcester, Mass.; and Bear Hill at Waltham, Mass.

BOSTON TERMINAL

The Boston terminal of the Bell System radio relay route between New York and Boston is situated in the Bowdoin Square Building of the New England Telephone and Telegraph Company. The microwave antennas can be seen on the roof.



NEW YORK TERMINAL

The New York terminal of the Bell System radio relay route between New York and Boston is in the long distance headquarters at 32 Avenue of the Americas. The microwave antennas can be seen on the roof.

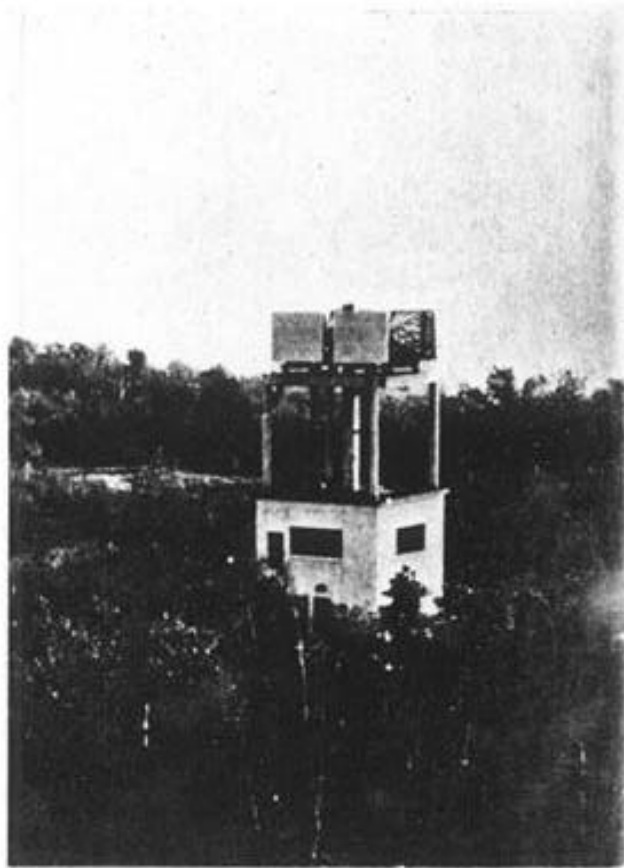
THE RELAY STATIONS

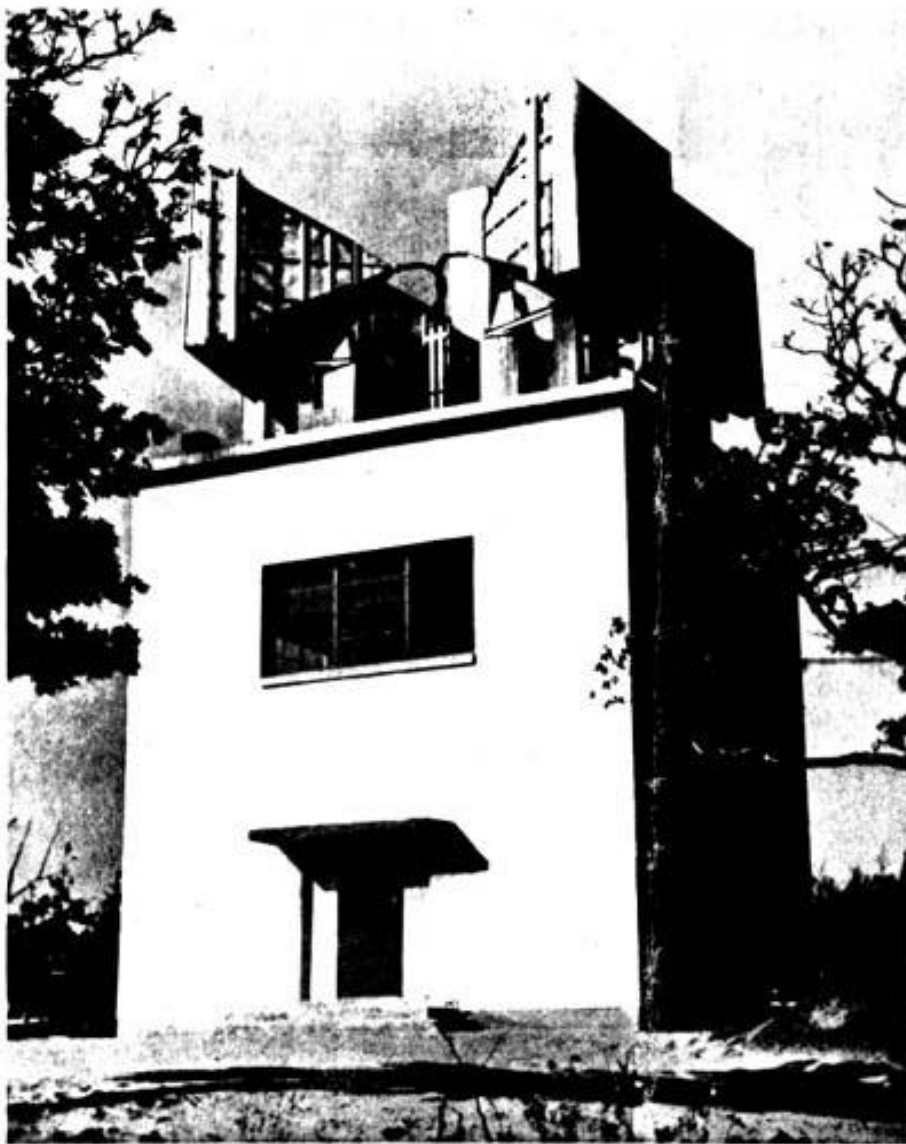
On the roof of each radio relay station are four lens-horn microwave antennas; two facing along the route toward New York and two facing along the route toward Boston. The purpose of these antennas is to pick up the microwave beam from the previous relay station and to direct it on its way to the next relay station. These antennas are ten feet square and incorporate a metal lens capable of focusing the microwave signals into a beam sharper than that provided by an anti-aircraft search light.

At each station, there are repeaters, or amplifiers, to keep the signals up to the proper strength as they are relayed along to the next station. The microwave signals are

MICROWAVE TOWER on John Tom Hill near Glastonbury, Conn.

Because radio relay communication must be beamed along a line-of-sight path, all stations on the Bell System route between New York and Boston stand on hilltops. The special antenna horns of this station rise above the trees on John Tom Hill near Glastonbury, Conn.





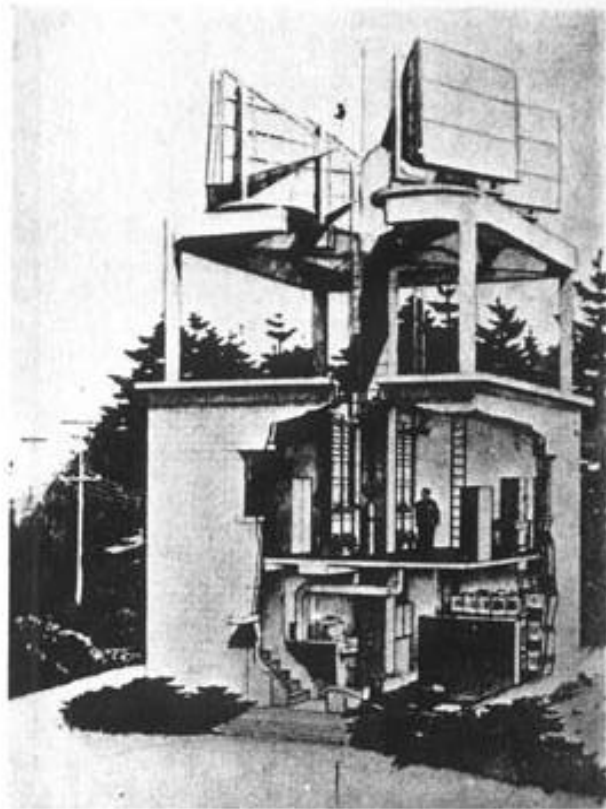
BEAR HILL MICROWAVE TOWER

Typical of the seven intermediate stations on hilltops along the Bell System radio relay route between New York and Boston is the one at Bear Hill, near Waltham, Mass. Electromagnetic lenses in the horns seen on the roof receive and beam long distance communications between the two cities.

carried from the receiving antenna to the repeaters and out again to the transmitting antenna through hollow metal tubes called wave guides. These guide the microwaves in much the same way that water is guided down the inside of a pipe. There are four such guides—one associated with each of the four antennas at each station.

The first floor of each of the relay stations contains heating and ventilating equipment, as well as an emergency battery and power supply generator to furnish protection against failure of the regular commercial power. The operation of the emergency power supply equipment is automatic and no interruption to the services will occur because of outside power failure.

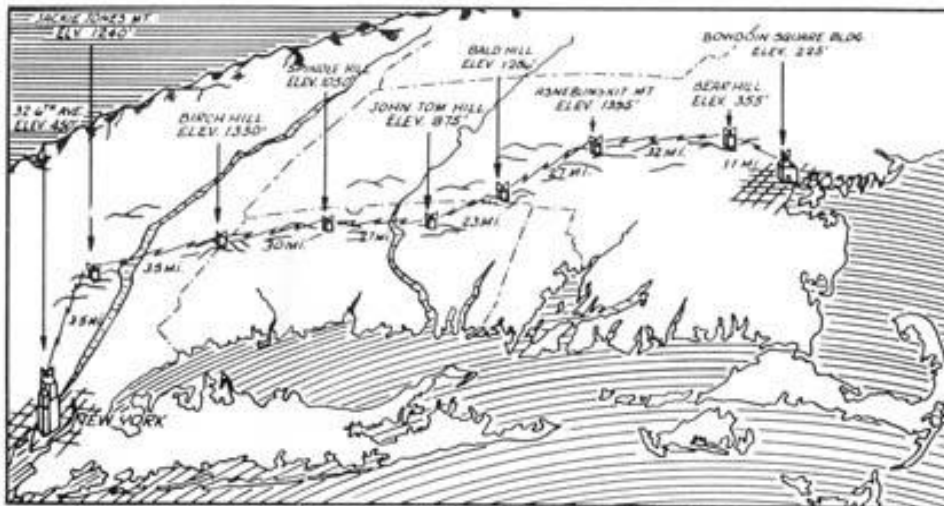
Cut-away view of a typical radio relay station on the Bell System radio relay route between New York and Boston, showing the arrangement of equipment in the building. Emergency power equipment and storage batteries are on the first floor, radio equipment on the second floor.



WHAT ARE MICROWAVES

It might be well to stop here and ask ourselves, "what are these microwaves?" In general, we may define microwaves as very small electric waves whose frequency of oscillation is in billions of cycles per second. We might compare these waves with those of sound which alternate between hundreds and tens of thousands of cycles per second or of light waves which alternate around several hundred trillion cycles per second. The microwaves which are used in the circuits between New York and Boston range in frequency between 3.7 and 4.2 billion cycles.

If this concept of electric waves which alternate in billions of cycles appears confusing to us, we can convert them to their physical length in free space. When converted these waves are found to be only 3.0 inches or 7.5 centimeters in length. A comparison might be made with the length of the average radio broadcasting waves which are some 1400 feet or 16,800 inches in length. Our microwaves are more closely related to the light waves than they are to the waves used for broadcasting and this accounts for the fact that they travel in straight lines from one point to the next, can be reflected by smooth bright surfaces or concentrated into a point source by a lens.



MOUNTAIN TOP ROUTE OF THE MICROWAVE RADIO RELAY SYSTEM INSTALLED BETWEEN NEW YORK AND BOSTON

MICROWAVE RELAY ROUTE

The chart above shows the path of the microwaves as they travel between New York and Boston. This route was selected only after much perusal of maps and trips to the field in which many mountain and hill tops were climbed and studied. It was really quite a chore to find building sites which would satisfy all of the requirements, some of which are given below.

There had to be an unobstructed line of sight between adjacent terminals and relay points. This explains the use of mountain tops with no higher points between. A maximum separation of about 35 miles between points needed to be maintained in order to insure reliable transmission during all types of weather and atmospheric conditions. The route of the system also needed a zig-zag path, as this tends to eliminate interference between adjacent relay sections.

Another important point was that the sites be accessible throughout the year. Our employees must be able to reach the relay points when required for necessary repairs and adjustments and a reliable supply of electric power, fuel and other necessities must be assured.

Trial tests and operation of the system since its completion have shown that the locations for the seven relay stations were well selected. We have had to build roads, plow snow and apply sand to ice during winter months but overcoming such difficulties are not entirely new to Telephone people.

WHAT'S IN A NAME!

In building its microwave radio relay system between New York and Boston, the Bell System became the proud owner of seven hilltops, all of which sport microwave towers similar to the one shown at Bear Hill. Aside from sporting the microwave towers, these hilltops also sport names, the origin of which has occasioned numerous questions and comment. Here, to quote the *Long Lines* magazine for August 1947, are some of the answers: "Starting from Boston, our first relay point is on Bear Hill. This, unfortunately, is a bad start, because nobody seems to be quite sure why Bear Hill is called Bear Hill. Local opinion favors the theory that a bear (or bears) lives there or at least has been seen loitering on the slopes. That seems reasonable."

Indian Jaw-Breaker

"The next tower is on Asnebumskit Mountain, still in Massachusetts. Asnebumskit, which actually is part of Mt. Monodnock, comes from two Indian names: *Hassum*, meaning 'stone' and *Ompsh*, meaning 'standing rock.' If you can make 'Asnebumskit' out of that, which the Indians apparently could—you come up with a combined meaning of 'out or near a section—rising from stony land' or 'standing rock rising from stony surroundings.' In any case, that describes the mountain. It is practically one big rock-pile. Some of the old deeds don't go along with the present spelling, preferring 'Hasnebumskeat' or 'Hasnebumskeag.' But most New Englanders solve this problem by simply referring to the place as 'Bumskit.'"

Reformed Cue Ball

"The third hill, Bald Hill, takes us south into Connecticut. The name is something of a fraud. Although the summit at one time *was* bald, there seems to have been some rejuvenation of the scalp in recent times and the hill is partly wooded."

"Its elevation of 1,286 feet was put to good use by surveyors before the Civil War, and today the United States Coast and Geodetic Survey still take advantage of its height occasionally in making coastal surveys. There was, until recently, a log cabin on top—first used as a fire lookout and later as an observation-post by an anti-aircraft unit during the war. The ex-fire-lookout, however, went up in smoke not long ago during one of Bald Hill's more ironic moments."

"Also in Connecticut is John Tom Hill near Glastonbury. Called 'Washiack' by the Algonquin Indians (from *Washqua* meaning 'high' and *Auk* meaning 'place'), the hill is believed to have got its present name from one Thomas Strickland, born in 1813. Strickland received the land from his father, Jonathan, and to distinguish it from other Strickland properties, he referred to it as John Tom's Hill. The possessive has been dropped, but descendants of the Strickland family still own much of the land nearby."

"Next is Spindle Hill near Walcott, Conn. At any rate there is an A. T. and T. hill there, but whether or not it should be called 'Spindle' is a subject of much debate. Maps of the area generally refer to it as such, but then they use the same name for a few others in the vicinity. As a matter of fact, some people who live on a neighboring hill claim that their hill is the real McCoy, or rather the real Spindle — and they have a D.A.R. plaque in their house to prove it.

"This plaque explains that the name came from the fact that two women, many years ago, got into an argument over a spindle there. We shall rest our case at this point, without worrying whether the argument took place on Spindle Hill or another place by the same name 2 miles up the valley.

"The radio relay route continues west and slightly south across the New York State border to Patterson — not to be confused with Paterson, N.J. Here stands Birch Hill, another microwave tower site. And the research staff didn't do much better with Birch Hill than they did with the Bear. In a word, you'll just have to assume it's called 'Birch' because there are a lot of birch trees around, no one of which has probably ever been argued over by two women."

Jake's Place

"Drop southwest to Jackie Jones Mountain, however, and there is a little more information available. This relay hill, the first one out of New York City, stands in an old tract known as the Cheese Cock Patent — one of the later subdivisions of a grant made by Charles II to his brother, the Duke of York, in about 1664. As the years went by, the land was cut up into smaller parcels, sold and resold and the hill came to be known as Pine Hill.

"This was in the latter part of the 1700's and people were beginning to move in — miners, timber-cutters, basket-makers, charcoal manufacturers and wood-carvers. Among these were Jacob Jones.

"Mr. Jones acquired title to most of the land on the present radio relay site. His nickname was Jakey or Jackie — and the rest is history."



At 1,400 feet from the entrance we encountered plenty of boulders and a sharp slope.

This is the same point as seen above with the road about 90 per cent complete.



SEVEN ROADS TO THE HILLTOPS

Did you know that the Bell System is not only in the business of building telephone communication highways but also builds other highways known to most of us as just plain roads?

The fact that one may now ride from a neighboring state or county highway to each of the microwave towers on the seven hilltops is a tribute to the road building ability of Bell System engineers. Altogether, in order to gain access to the seven

microwave tower sites, it was necessary to build 13,622 feet of new road, rebuild 3,630 feet of old road and construct about 200 feet of driveway. The longest of these new roads is a strip 3,860 feet long. This strip was constructed at the Birch Hill tower location. The shortest road was built at John Tom Hill where only a 200 foot driveway was necessary.

Building roads to hilltops is one of the more difficult types of road construction. In order that the maximum possible safety be provided for persons traveling these roads during the months of ice, sleet and snow, it was necessary for the Bell System engineers to select routes which eliminated grades in excess of about 10 per cent. Final routes called for blasting through solid rock and ledge at some points and fills at others. The photos show, perhaps better than words, the nature of some of the terrain over which the new roads were constructed.

The photos, which illustrate various stages of construction at several points on the Bear Hill road, are typical examples of the problems encountered. The road at Bear Hill is about 2,250 feet long and rises approximately 225 feet. If this road could have been built straight up from the entrance point to the microwave tower site, it would have required only about 650 feet of new road.



At 1500 feet from the entrance we encountered a sharp rise and a solid ledge of rock covered with a few inches of dirt.

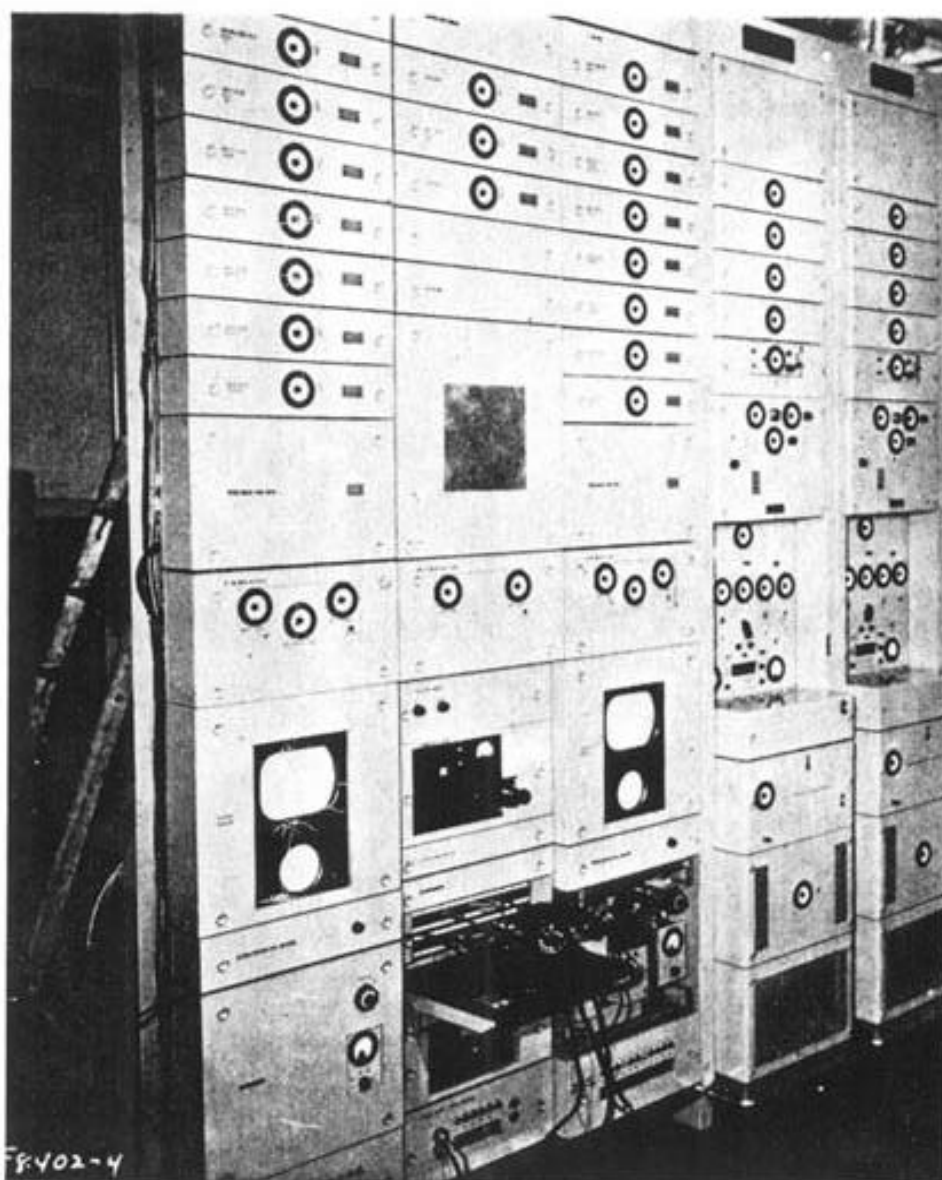
The drilling and dynamic crews have done a good job of blasting a hole in the ledge for our road bed.



Here is the completed road at this point.



BELIEVE IT OR NOT! These pictures were all taken from the same spot!



MICROWAVE TERMINAL EQUIPMENT

The microwave terminal equipment shown above is located inside the Bowdoin Square Building of the New England Telephone and Telegraph Company at Boston, Mass. Similar equipment is located at the New York end of the microwave circuit at the long distance headquarters at 32 Avenue of the Americas.

HISTORY

The excellent work of Engineers, Technicians and others in carrying out the research, engineering, construction and testing which culminated in the official opening of the Boston-New York microwave circuit on November 13, 1947, is now history. However, during the time which elapsed in carrying out the project, a number of historical events took place. A few of the most interesting of these events, together with their approximate dates, are shown in the table below.

November 15, 1943	Joint start on "Plan" by Bell Telephone Laboratories and Long Lines.
December 1, 1943	Survey work started on possible routes between Boston and New York.
March 17, 1944	Public announcement of project.
May 9, 1944	Purchase of first site — Asnebumskit Mt., near Worcester, Mass.
October 4, 1945	First road started — Jackie Jones Mt.
July 29, 1946	First microwave towers started — Jackie Jones Mt. and Birch Hill.
March 24, 1947	Installation of microwave repeater equipment started at New York.
June 9, 1947	First station in operation — New York.
June 23, 1947	First section lineup — including antennas — New York, Jackie Jones and return.
November 13, 1947	Official opening to public and press — New York, Boston and return. (Program material consisted of both television and telephone transmissions.)