

Jan. 6, 1942.

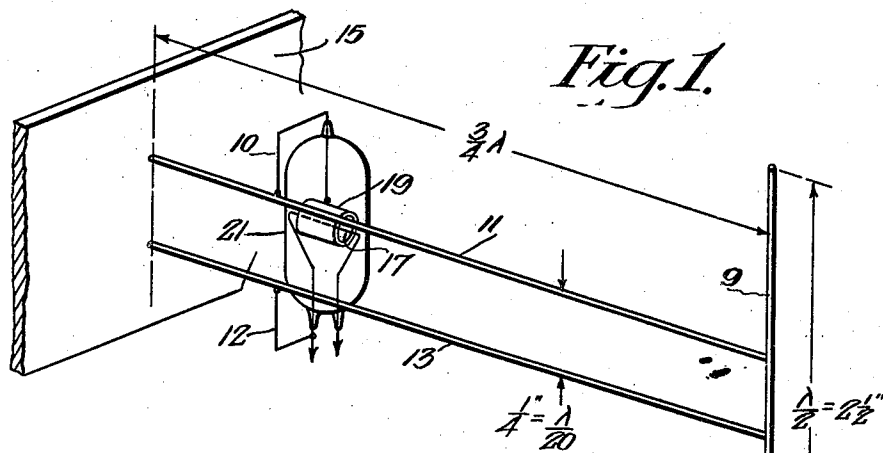
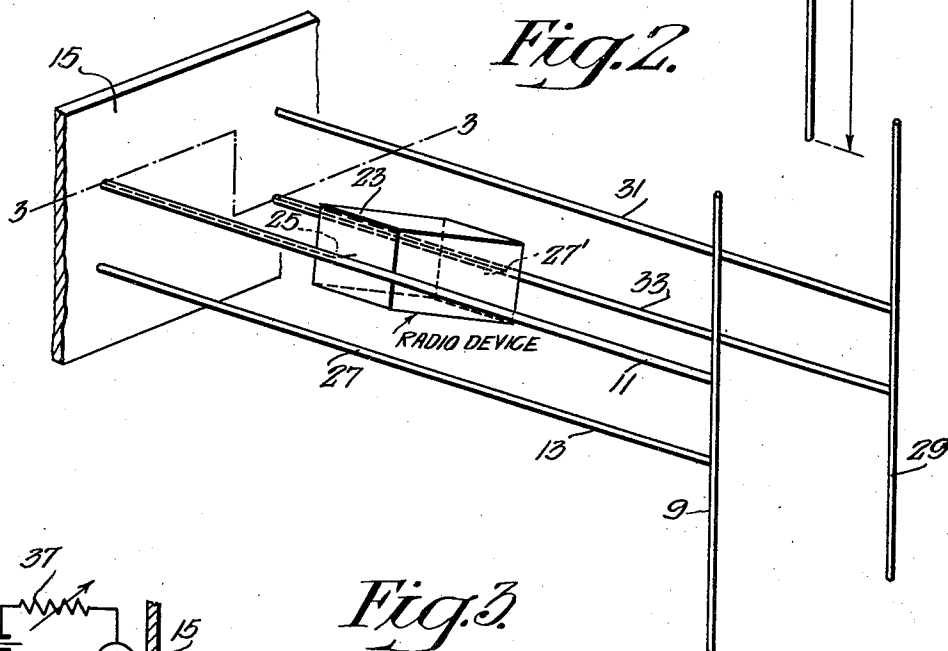
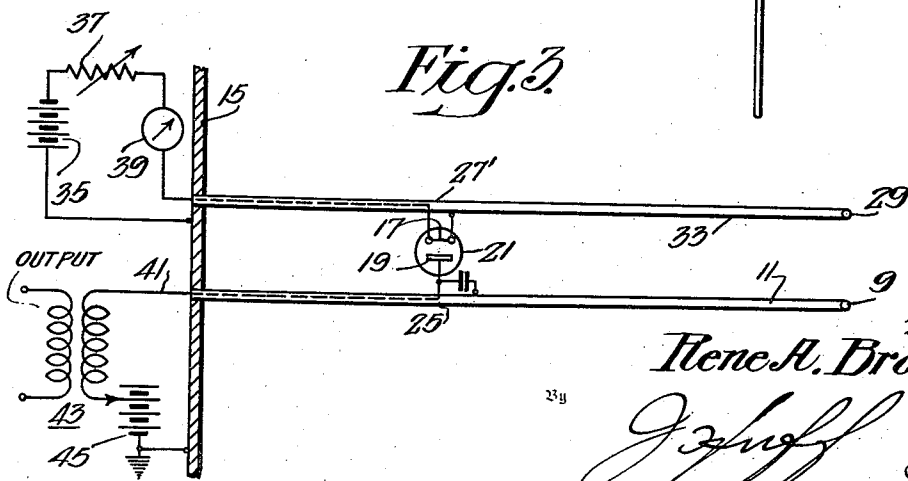
R. A. BRADEN

2,268,639

ULTRAHIGH FREQUENCY RADIO DEVICE

Filed Feb. 14, 1939

2 Sheets-Sheet 1



Inventor
René A. Braden

J. Huff
Attorney

Jan. 6, 1942.

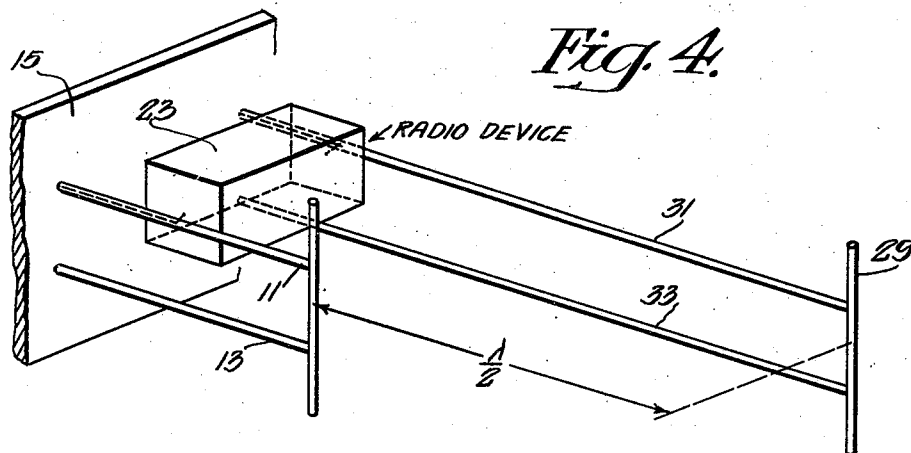
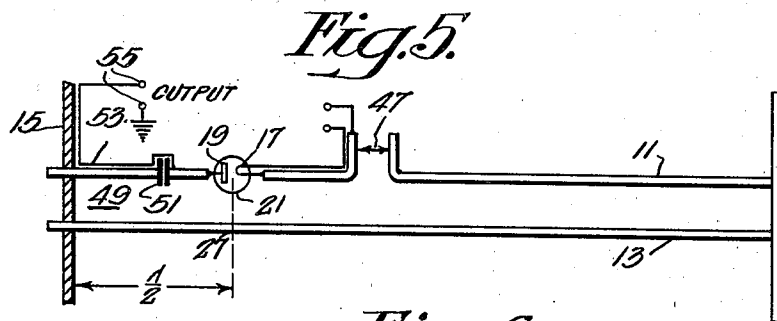
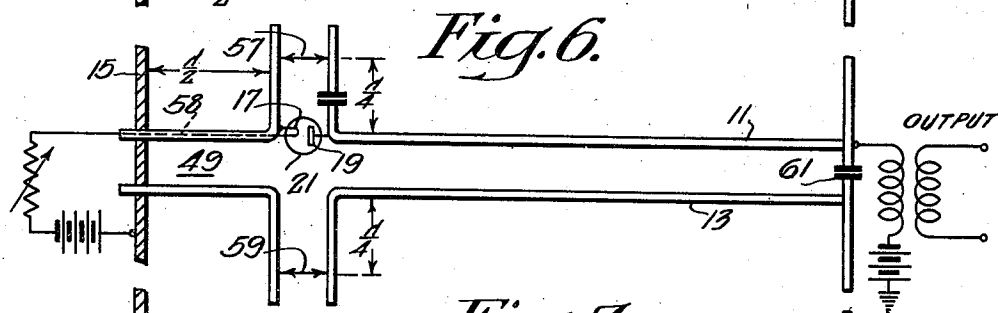
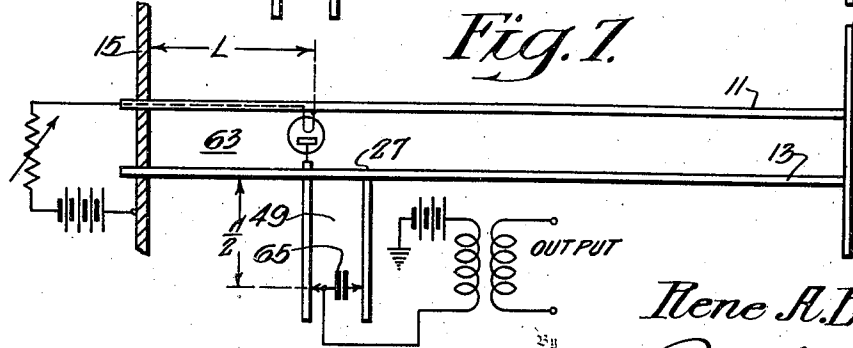
R. A. BRADEN

2,268,639

ULTRAHIGH FREQUENCY RADIO DEVICE

Filed Feb. 14, 1939

2 Sheets-Sheet 2



Inventor

Rene A. Braden

J. J. Huff
Attorney

UNITED STATES PATENT OFFICE

2,268,639

ULTRAHIGH FREQUENCY RADIO DEVICE

Rene A. Braden, Collingswood, N. J., assignor to
Radio Corporation of America, a corporation of
Delaware

Application February 14, 1939, Serial No. 256,268

7 Claims. (Cl. 178—44)

This invention relates to ultra high frequency radio devices and more particularly to a method of and means for circumventing certain difficulties inherent in the construction of ultra high frequency apparatus due to the considerable impedance represented by extremely short sections of conductor.

Experiments are being carried on at ultra high radio frequencies of the order of 2500 megahertz. Such frequencies are obtained by magnetron or Barkhausen-Kurz oscillators, or the like. At these extremely high frequencies, the impedance represented by a conductor of a length which is negligible at lower frequencies assumes a great importance. For example, at 2500 megahertz a conductor $2\frac{1}{2}$ inches long is approximately a half wave length long. Certain radio devices which are used in connection with ultra high frequencies of this range are inherently of such a size that it is impossible to make connections to them without introducing an appreciable length of conductor in the circuit.

Among the objects of this invention are the provision of a method of connecting radio devices to a source of energy; the provision of means for applying a source of voltage to a radio device at ultra high frequencies; the provision of means for effectively connecting a physically large radio device to a physically small transmission line; and the provision of means for reproducing at a more distant point a voltage which is developed between two adjacent points.

While this invention is applicable to the connection of any radio device to any other radio device, for the sake of simplicity it will be described in one form in which a diode detector is connected to a pair of parallel conductors which constitute an electric wave transmission line. It is evident that the detector may be replaced by an oscillator or an amplifier without departing from the scope of this invention.

This invention will be better understood from the following description when considered in connection with the accompanying drawings, in which Figure 1 is a perspective drawing illustrating the problem which it is the purpose of this invention to solve; Figure 2 is a perspective view of one embodiment of this invention; Figure 3 is a schematic diagram partly in cross-section, taken on the line 3—3 of Fig. 2, showing the circuit connections of the device illustrated in Fig. 2; Figure 4 represents a modification of this invention; and Figures 5, 6 and 7 are views of

further modifications in which a somewhat different principle is employed.

Referring to Fig. 1, a system is illustrated which is frequently used for microwave reception. A half wave vertical antenna 9 is connected at appropriate points to a pair of parallel conductors 11 and 13 which constitute an electric wave transmission line. It is well known that in order to attain a maximum transfer efficiency, the spacing between conductors 11 and 13 must bear a definite relation to the operating wave length. It has been found that the spacing should be not greater than $\frac{1}{20}$ of the wave length. At a frequency of 2,500 megahertz, which will be taken as an example, this fraction of a wave length is approximately equal to one-quarter of an inch. Increasing the spacing between the conductors of the transmission line results in decreased efficiency and is undesirable also from the point of view of the increased pick up from local disturbances.

The transmission line is terminated in a metal plate 15 which may be a portion of a parabolic reflector, or the like. The length of the transmission line is adjusted to such a value that a voltage node occurs at the point at which it terminates in the reflector.

Simple diode rectifiers which are frequently utilized as detectors in micro-wave systems of this nature may include a cathode 17 and an anode 19 which are mounted within an envelope 21. It is necessary to provide an envelope of sufficient size to allow the leads from the electrodes to be sealed by the application of intense heat without destroying the electrodes themselves. It is, therefore, necessary to make such rectifiers at least an inch in diameter. At the frequencies involved, the length of the conductor within the tube itself cannot be neglected. In addition, if such a rectifier is to be connected across a transmission line, it is apparent that additional lengths of conductors 10 and 12 must be provided. This makes it impossible to impress the voltage which is available on the transmission line directly on the electrodes of the rectifier.

In accordance with one embodiment of this invention, this difficulty is overcome by reproducing at the terminals of the radio device a voltage which corresponds to the voltage at the point to which a connection is desired.

Referring now to Fig. 2, this method will be described in connection with a radio device 23 which may be, as noted above, a rectifier, oscillator, amplifier, or any other device. As before,

the antenna 9 and transmission line consisting of conductors 11 and 13 are shown. Assuming that it is desired to connect the radio device between points 25 and 27 which are on conductors 11 and 13, respectively, this invention is carried out in the following manner: A second antenna 29 and a second transmission line, comprising parallel conductors 31 and 33 are provided. The additional antenna and transmission line are identical to the original. The standing wave pattern on each of the two transmission lines is identical. Consequently, a point 27' on conductor 33 will be at the same potential as point 27 on the corresponding conductor 13. Since there is no critical value for the spacing between the two transmission lines, they are so adjusted that the terminals of the radio device may be connected between one conductor of each line with a minimum lead length. The spacing between the conductors of a transmission line has thus effectively been increased to accommodate connections to a radio device without decreasing the transfer efficiency of the system.

The device which is shown in Fig. 2 is further explained by reference to Fig. 3 which shows a complete circuit diagram of a micro-wave receiver. One terminal of the cathode 17 is connected directly to conductor 33 which functions as one conductor of the cathode energizing circuit. The remaining terminal of the cathode is connected to a lead which is brought out through conductor 33 or through a small metal tube which is fastened to it. Cathode current is supplied by a battery 35 and may be controlled by a resistor 37. If desired, a meter 39 may be utilized to indicate the cathode heating current. The anode 19 is connected to a lead 41 which is brought out through conductor 11 and which is connected to the primary of a transformer 43. The secondary of transformer 43 is connected to the output circuit. If desired, a positive or negative bias may be applied to the anode 19 by means of a battery 45 which is connected between the primary of transformer 43 and ground. The radio frequency potential which exists between points 27' and 25 of conductors 33 and 11, respectively, is impressed across the cathode and anode of rectifier 21, and an output voltage induced by the resultant rectified current flowing through the primary of transformer 43 is available at the output terminals.

The arrangement shown in Fig. 2 shows the radio device 23 connected between the upper conductor 11 of one transmission line and the lower conductor 33 of the other transmission line. The purpose of this cross connection is to provide a potential difference across the terminals of the radio device, since it has been pointed out that the potential at the point 27' is identical to that at point 27. In accordance with a modification of this invention, the same result is accomplished without cross connecting the radio device by adjusting the phase of the voltages in the two transmission lines, as shown in Fig. 4. In this instance, conductors 31 and 33 are the same as in the preceding illustrations, but conductors 11 and 13 have been decreased in length by an amount which is equal to a half wave length at the operating frequency. The instantaneous polarity of the voltage in conductor 11 is therefore opposite to that in conductor 31, and the radio device 23 may be connected between conductors 11 and 31, as shown.

The modification of this invention which is shown in Fig. 5 does not depend upon the provi-

sion of a second antenna and transmission line. The length of conductor which is internal to the rectifier tube is utilized as a portion of the standing wave system. In Fig. 5, a transmission line consists of parallel conductors 11 and 13, as before. Conductor 11 terminates at the cathode 17 so that the point of maximum potential falls at the cathode within the tube structure. An adjustable tuning section 47 is included in series with conductor 11 to compensate for the effect of the interelectrode capacity and to properly tune the line.

In order to connect the anode 19 to the point of maximum potential 27 on conductor 13, a half wave resonant section 49 is utilized, the length of which includes the internal anode lead. Since the impedance between the open terminals of a pair of parallel or coaxial conductors one-half wave length long, and shorted at the far end, is substantially zero, the anode 19 is effectively connected to point 27, as desired. To provide an output circuit for the rectified voltage, a small capacitor 51 is connected in series with one leg of the half wave resonant section 49. A conductor 53 is connected to anode 19 and brought out to a point of low radio frequency potential either by inserting it within the conductor, by closely associating it therewith, or by inserting a radio frequency choke in the circuit. Rectified output is therefore available at the output terminals 55.

In the modification shown in Fig. 6, the serially connected tuning section 47 of Fig. 5 is replaced by a shunt connected tuning section 57. This permits the characteristics of the line to be adjusted so that the anode is placed at the proper maximum potential. To provide an improved balance, an additional adjusting section 59 is included at the termination of conductor 13. In this modification, it is also to be noted that the arrangement of the cathode and anode have been reversed to permit the cathode heating current to be supplied by a conductor 58 which is associated with one leg of the half wave resonant section 49 and the audio output to be obtained at the midpoint, or low radio frequency potential point, of the antenna. The antenna is divided into two sections by a radio frequency bypass capacitor 61, thus permitting the anode to be biased as before.

In the modification shown in Fig. 7, the half wave resonant section 49 which is utilized to connect the anode of the rectifier to the desired point 27 on the line 13 is placed at an angle to the line and an additional section 63 is connected across the line 11, 13. The electrical length of the section 63 is determined by and is usually equal to the impedance of the rectifier across which it is connected. The physical length "L" for maximum sensitivity is somewhat less than a quarter wave length, the actual value depending on the resistance and reactance of the rectifier. For increased selectivity the distance "L" is made smaller than the value for maximum sensitivity. This arrangement permits a more convenient circuit arrangement than was possible in the arrangement shown in Fig. 5, for example. Thus, the cathode excitation is readily brought to the tube by a conductor which is run through one leg of the section 63, and the output is conveniently obtained by a connection to the low radio frequency point of the half wave section 49. A bypass capacitor 65 is provided to isolate the anode circuit from the grounded cathode circuit to prevent grounding direct and audio frequency currents.

I have thus described a system for overcoming the effect of the impedance of connecting leads by providing a duplicate system which may be conveniently placed to permit connections of minimum length to be made.

I claim as my invention:

1. A radio system including in combination a radio device having a pair of terminals, a pair of transmission lines including four spaced conductors arranged parallel to each other and responsive in pairs to signals from a common source to establish waves of like phase on like conductors of said pairs, and means connecting said terminals respectively to points of instantaneously opposite polarity on each of said pairs of transmission lines.

2. A radio system which includes a radio device having two terminals, a pair of two conductor transmission lines arranged parallel to each other and simultaneously responsive to waves from a single source so that similar standing waves are simultaneously established on said lines, and means connecting said terminals respectively to points of opposite instantaneous polarity on each of said lines so that the distance between said conductors establishes a minimum impedance at the point of said connections.

3. A radio system which includes a radio device having two terminals, a pair of transmission lines, means for producing standing waves on said lines, one of said lines being a half wave length longer than the other of said lines, said terminals being connected respectively to one conductor of each of said lines at points which have potentials of opposite polarity, the distance between said points being such that the impedance of said connections is a minimum.

4. A radio system which includes a radio device having two terminals spaced apart a substantial portion of a wave length, a pair of two conductor transmission lines arranged parallel to each other and spaced less than said terminal spacing and simultaneously responsive to waves from a single source so that identical waves are simultaneously established on said lines, and means connecting said terminals respectively to points of opposite instantaneous polarity on each of said lines so that the distance between said conductors establishes a minimum impedance at the point of said connections.

5. In a system including an ultra high frequency radio device having two terminals spaced apart a substantial portion of a wavelength at the operating frequency and a source of voltage, low impedance means for coupling said terminals to said source, said means comprising a pair of two-conductor transmission lines the conductors of which are spaced apart a distance less than the distance between said terminals, each of said lines being coupled separately to said source and having identical standing waves induced simultaneously thereon, and means connecting said terminals to a point on one conductor of each of said lines, the distance between said points being such that the impedance of said connecting means is a minimum.

6. In a system including an ultra high frequency radio device having two terminals spaced apart a substantial portion of a wavelength at the operating frequency and a source of voltage, low impedance means for coupling said terminals to said source, said means comprising a pair of two conductor transmission lines the conductors of which are spaced apart a distance less than the distance between said terminals, each of said lines being coupled separately to said source and having identical standing waves induced simultaneously thereon, and means connecting said terminals between a conductor of each of said lines to points of instantaneously opposite polarity, the distance between said points being such that the impedance of said connecting means is a minimum.

7. An ultra high frequency radio system which includes a radio device having two terminals, a pair of closely spaced parallel conductor transmission lines, common means for energizing said lines to produce simultaneously identical standing waves thereon, and means including said lines for coupling said device to said energizing means, said coupling means comprising a connection from one of said terminals to one conductor of one of said lines, and a connection from the other of said terminals to the other conductor of the other of said lines, said connections having a length such that it represents substantially a zero impedance at the frequency of operation.

50

RENE A. BRADEN.