Oct. 26, 1937. G. H. BROWN 2,096,782

ANTENNA

Filed May 14, 1936

Fig. 1.

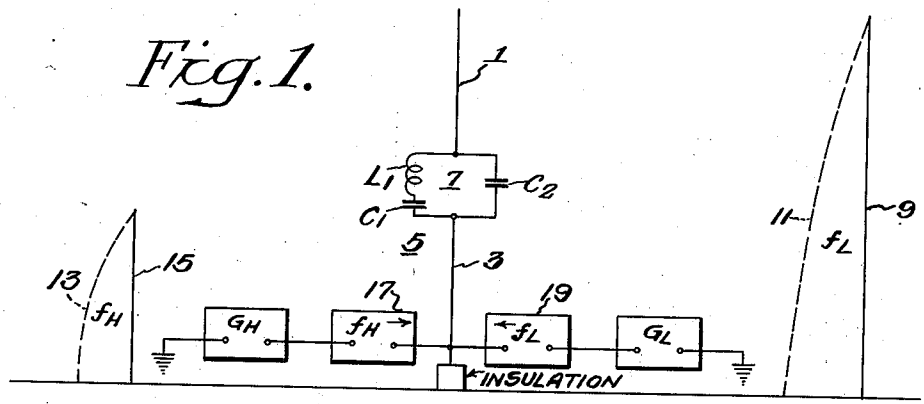


Fig. 2.

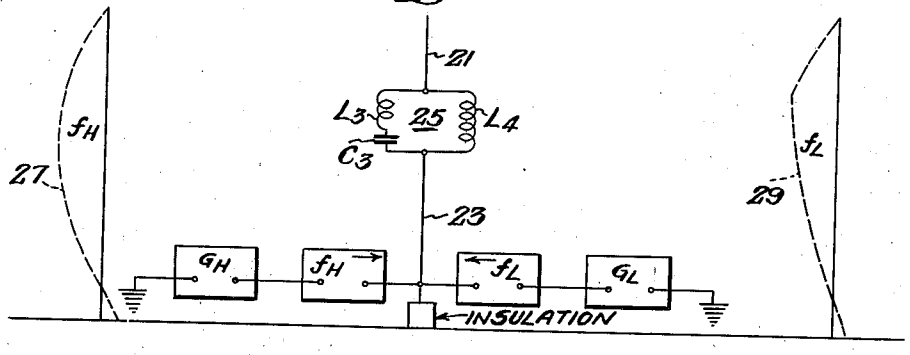


Fig. 4.

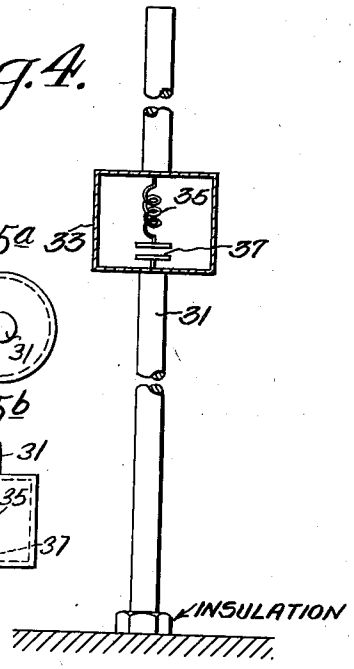


Fig. 5a

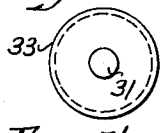


Fig. 5b

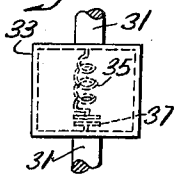
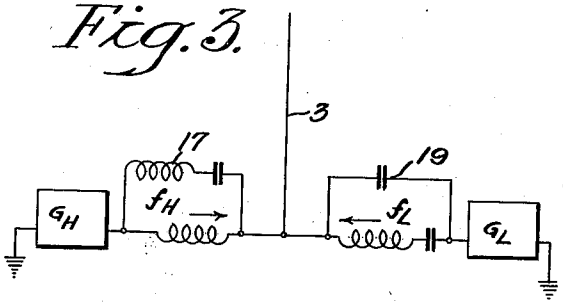


Fig. 3.



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UNITED STATES PATENT OFFICE

2,096,782

ANTENNA

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Application May 14, 1936, Serial No. 79,635

13 Claims. (Cl. 250—33)

This invention relates to antennas. More specifically to a single antenna which may be operated at desired fractions of wave lengths at a plurality of frequencies without resorting to retuning or switch means within the antenna.

I am aware that a single antenna system may be used to radiate a plurality of fields, generated by apparatus operating at different frequencies, by retuning the antenna system. Numerous arrangements have been proposed for switching reactances by means of which antenna systems may be resonated to a plurality of frequencies.

The present invention has for one objective a single antenna which may be operated at different effective lengths without requiring either switching apparatus or retuning. Another object is to arrange a single antenna of the required height at one frequency and to automatically vary the current distribution so that the effective height at some other frequency is that which has the required angle of radiation. A further object is to adapt a single antenna so that its characteristics offer maximum effectiveness for the radiation or reception of fields of two or more different frequencies.

In the accompanying drawing Figure 1 is a schematic circuit diagram representing one embodiment of my invention,

Figure 2 is a circuit diagram of a modified arrangement of antenna system,

Figure 3 is a schematic illustration of a filter network which may be used in the transmission lines to the antenna, and

Figure 4 is an arrangement which may be used in connection with one form of antenna.

Figure 5A is a plan view of the shielded inductor section of the antenna illustrated in Fig. 4.

Figure 5B is a side elevational view of the shielded inductor of Figure 5A.

In Figure 1, reference numerals **1** and **3** represent two sections of an antenna **5**. The lower section **3** is, by way of example, of an effective length equal to one-quarter wave of currents of frequency f_H from the generator G_H. The combined sections **1**, **3** have an effective length equal to one-quarter of a wave length of currents of frequency f_L from the generator G_L. The two antenna sections are connected by a filter network **7**.

The filter network **7** is comprised of capacitors C_1, C_2, and inductor L_1. The capacitor C_1 and inductor L_1 are series resonant to currents of frequency f_L. Thus the antenna, comprising sections **1**, **3** and series resonant of filter L_1C_1 has an effective height equal to one-quarter wave length with respect to currents of the lower frequency f_L, generated by G_L, because the filter L_1C_1 offers very low impedance to these currents. The antenna for the lower frequency f_L is represented by the solid line **9** and the current distribution therein by the dash line **11**.

For currents of the higher frequency f_H, the filter network C_1C_2 and L_1 is parallel resonant. The resonant filter is located at an effective distance of one-quarter wave length along the lower antenna section **3**, and thereby effectively excludes currents of the higher frequency f_H from the upper section **1**. The current distribution of the lower section is represented by the dash line **13**, while the antenna is represented as the solid line **15**.

If the signals from the two generators G_H and G_L are to be used alternately, it is simply necessary to switch the antenna to the required generator. If simultaneous operation is desired, a pair of filters represented by numerals **17** and **19** should be included in the transmission line between the generators and the antenna. The filter **17** connected between G_H and the antenna **5**, should be designed to offer low impedance to currents of frequency f_H and high impedance to currents of frequency f_L. Likewise, filter **19** is included in the transmission line between G_L and the antenna **5**. This filter **19** offers low impedance to currents of frequency f_L and high impedance to currents of frequency f_H.

The method of coupling the generators and antenna systems is shown, described and claimed in U. S. Patent 2,082,096 which issued June 1, 1937 on application, Serial No. 50,500 filed November 19, 1935 by George H. Brown and assigned to the same assignee as this application. The schematic circuit arrangement of suitable filters **17** and **19** is shown in Figure 3. These filters, connected in the transmission line between the generators and the antenna, prevent the interactions of the two generators. In the event that alternate transmission is used, the filters may be omitted in favor of switching the antenna to the required generator.

The modification indicated in Figure 2 is a schematic illustration of an antenna system which is operated at two frequencies, f_H and f_L,—f_H indicating the higher frequency and f_L the lower. In this arrangement, the antenna for the lower frequency may be of the "sectionalized type" described and claimed in U. S. Patent 2,068,261 which issued January 19, 1937 on application Serial No. 33,281, filed July 26, 1935, by George H. Brown and assigned to the same assignee as the present

application. The antenna sections are represented by reference numerals 21, 23. The upper section 21, by way of example, may be of the order of one-half of the length of the lower.

The upper and lower antenna sections 21, 23 are joined by a filter network 25, which is composed of inductors L_3 and L_4 and capacitor C_3. The inductor L_3 and capacitor C_3 are made series resonant to currents f_H from the generator G_H. The antenna length is chosen as a half-wave length with current distribution represented by the dash line 27. The inductor L_4 is of a value which will give the required current distribution for a sectionalized antenna. That is, the inductor L_4 establishes the current distribution which will give angular radiation of the type required for a given effective service area. One such current distribution is indicated by the dash line 29.

It should be understood that instead of adjusting L_3C_3 to series resonance at one of the frequencies, L_3C_3 may be proportioned so that the filter offers reactance and acts like a sectionalizing inductor or capacitor at one frequency, while L_4 operates as the sectionalizing reactance at the other frequency. In this manner, the angle of radiation of the fields of both frequencies may be adjusted to the degree which will establish the required service area. The foregoing antenna systems may be used with any type of supporting towers. If a structural tower is used as an antenna the tower must have an insulated section. The filter network is used to join the sections as described above.

If a tubular mast 31 is used as the antenna, as illustrated in Figure 4, an enlarged section 33 may be used as an inductor. This inductor is of toroidal shape and takes the place of inductor L_4 of Figure 2. The series resonant circuit is comprised of the inner inductor 35 and capacitor 37, which are respectively equivalent to inductor L_3 and capacitor C_3. This particular arrangement offers several advantages in that no insulation is required between the antenna sections, and the inner elements 35, 37 are shielded within a suitable housing which is also the outer inductor 33. In this, as well as the previously described arrangements, the antennas are preferably insulated from ground. The transmission lines from the generators may be coupled to the antenna through conventional coupling means.

It should be understood that my invention is not limited to the use of two frequencies. By employing suitable filters between several sections of proper length, a plurality of frequencies may be employed and the several sections successively energized to radiate at the predetermined proper wave length. Likewise, the single antenna may be "sectionalized" for a plurality of frequencies. By the terms "sectionalized" or "sectionalized antenna" I mean an antenna in which the current distribution is adjusted to vary the angle of radiation in accordance with a desired relation between the components of ground wave and sky wave.

I claim as my invention:

1. An antenna responsive to currents of different frequencies comprising a plurality of sections, and a filter network connected between said sections, said filter being series resonant to currents of the lower frequency and parallel resonant to currents of the higher frequency.

2. An antenna responsive to currents of high and low frequency comprising a pair of sections, and a filter connected between said sections, said filter being series resonant to the currents of the lower frequency and parallel resonant to currents of the higher frequency.

3. An antenna for radiating a high frequency field and a low frequency field comprising a pair of sections, one of said sections having a length substantially equal to a quarter wave length with respect to one of said frequency, and a filter located between said sections, said filter being series resonant to the lower of said frequencies and parallel resonant to the higher of said frequencies.

4. An antenna for radiating a high frequency field and a low frequency field comprising a pair of sections, one of said sections having an effective length substantially equal to a quarter wave length of the field of higher frequency, and the sum of said sections having an effective length substantially equal to a quarter wave length of the field of lower frequency, and a filter connecting said sections, said filter offering low impedance to currents of the lower frequency and high impedance to currents of the higher frequency.

5. An antenna for radiating a high frequency field and a low frequency field comprising a pair of sections, the effective length of the sum of said sections being substantially equal to one-half wave length of said high frequency field, and a filter connecting said sections offering low impedance to currents of said high frequency, and offering reactance to currents of said low frequency to thereby adjust the current distribution and angle of radiation of said low frequency field.

6. An antenna for radiating a high frequency field and a low frequency field comprising a pair of sections, and a filter connecting said sections offering different values of reactance to currents of said frequencies and so constructed and arranged that the distribution of currents of said frequencies may be varied to establish desired angles of radiation of said fields.

7. In a device of the character of claim 6 a pair of generators of currents of said high and low frequencies and means coupling said generators to said antenna.

8. In a device of the character of claim 3 a generator of currents of said high frequency, a generator of currents of said low frequency, a filter connected between said generators and said antenna offering high impedance to currents tending to flow between the generators and low impedance to currents flowing from either generator to said antenna.

9. In a device of the character of claim 5 a pair of generators of currents of said high and low frequencies and means coupling said generators to said antenna.

10. In a device of the character of claim 5 a generator of currents of said high frequency, a generator of currents of said low frequency, a filter connected between said generators and said antenna offering high impedance to currents tending to flow between the generators and low impedance to currents flowing from either generator to said antenna.

11. In a device of the character of claim 6 a pair of generators of currents of said high and low frequencies and means coupling said generators to said antenna.

12. In a device of the character of claim 6 a generator of currents of said high frequency, a generator of currents of said low frequency, a filter connected between said generators and

said antenna offering high impedance to currents tending to flow between the generators and low impedance to currents flowing from either generator to said antenna.

13. In a device of the character of claim 4 a generator of currents of said high frequency, a generator of currents of said low frequency, a filter connected between said generators and said antenna offering high impedance to currents tending to flow between the generators and low impedance to currents flowing from either generator to said antenna.

GEORGE H. BROWN.