Aug. 29, 1950 R. F. LEWIS ET AL 2,520,154

RADIO ANTENNA

Filed Oct. 16, 1948

Fig. 1.

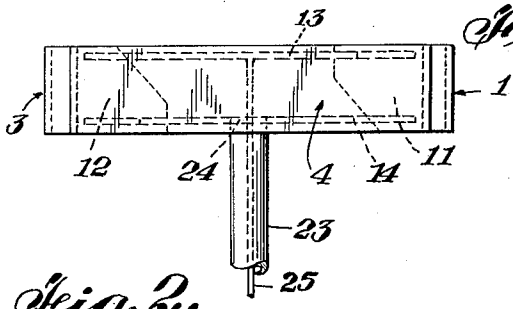


Fig. 3.

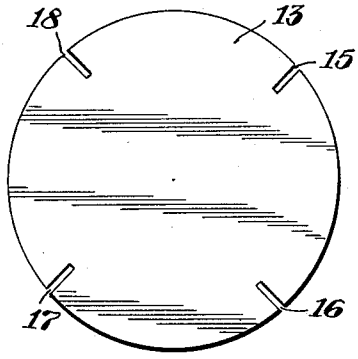


Fig. 2.

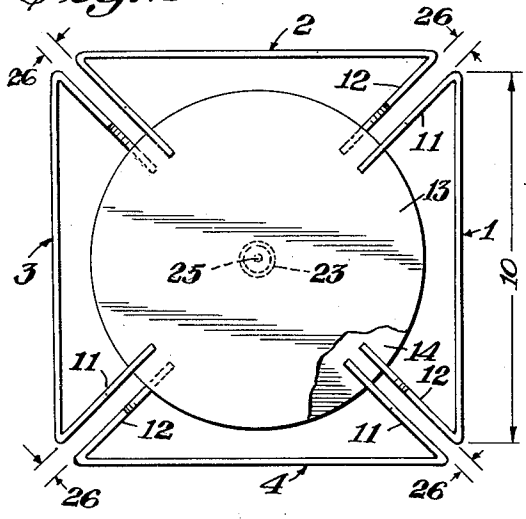


Fig. 4.

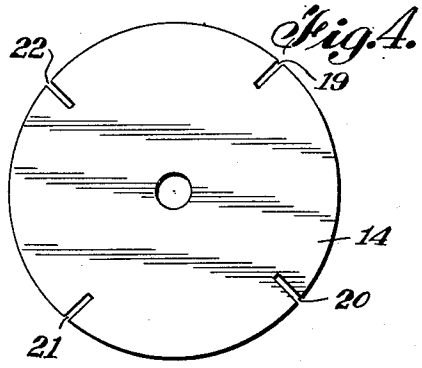


Fig. 5.

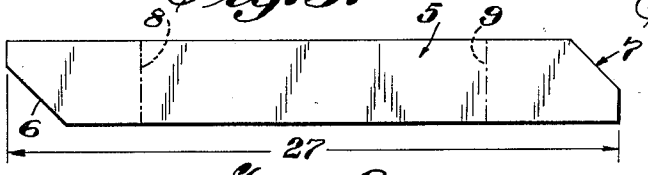


Fig. 8.

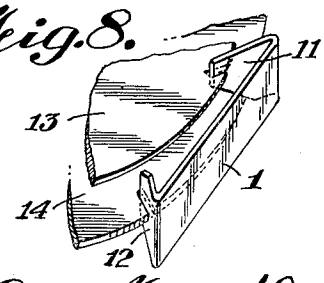


Fig. 6.

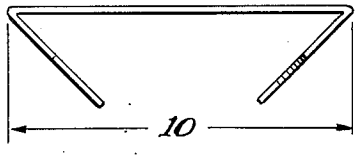


Fig. 9.

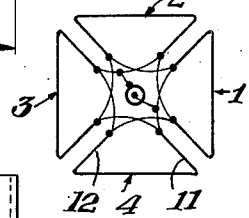


Fig. 10.

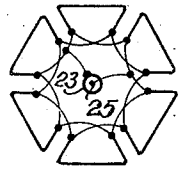
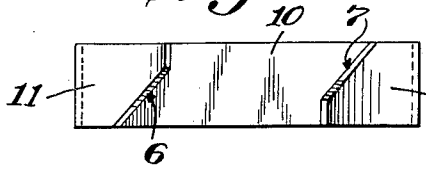


Fig. 7.



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RADIO ANTENNA

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8 Claims. (Cl. 250—33)

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This invention relates to antennas, and more especially to antennas adapted for efficient operation over a relatively broad frequency band.

A principal object of the invention is to provide an improved structure for antennas of the type having a series of antenna members disposed around a common center and energized in appropriate phase relations to form, in effect, a substantially closed radiation loop.

Another object is to provide an antenna structure of the substantially closed radiation loop type, which lends itself readily for use in a stacked-up array to form an antenna system of high gain and omni-directional characteristics.

Another object is to provide a broad frequency band antenna which is of relatively low impedance.

Another object is to provide an improved antenna structure for circularly polarized radiation.

A feature of the invention relates to a novel antenna structure of the substantially closed radiation loop type, wherein the loop members are in the form of metal plates interconnected with, and between, a pair of spaced metal discs to form a rigid unitary antenna assembly, whose electrical characteristics are not materially disturbed by accumulations of snow, moisture and the like.

Another feature relates to an improved rigid antenna assembly unit for horizontally polarized waves.

A further feature relates to a structurally rigid antenna assembly for circularly polarized waves which can be fabricated from a small number of parts and without requiring elaborate interconnecting arrangements between the parts.

A further feature relates to a simplified loop antenna for circularly polarized radiation which lends itself to economical manufacture and ease of assembly.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood, by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a front elevational view of an antenna structure according to the invention.

Fig. 2 is a top-plan view of Fig. 1 with the upper disc partly broken away.

Fig. 3 is a top-plan view of the upper antenna disc.

Fig. 4 is a top-plan view of the lower antenna disc.

Fig. 5 is a developed view of the blank for forming one of the radiation loop members.

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Fig. 6 is a top-plan view of the blank of Fig. 5 bent to the final shape.

Fig. 7 is a front elevation view of Fig. 6.

Fig. 8 is a partial perspective view showing the relation of certain of the antenna parts.

Fig. 9 is a schematic wiring diagram of the antenna connections.

Fig. 10 is a modification of Figs. 1 to 9.

Various antenna structures have been devised heretofore for use with horizontal and circularly polarized radiation. In general, these antennas consist of a series of radiation members which are disposed around a common center and with the ends of adjacent members capacitively coupled and connected to a transmission line in such relative phase that the instantaneous current flow through all the members, considered as a continuous loop, is in the same direction. In order further to increase the circular polarization effect, the flow of instantaneous current in the capacitive coupling elements between adjacent members is in opposite phase. The present invention relates to this general type of antenna but provides an assembly which is rendered structurally rigid without the use of complicated or expensive fastening members, and which can be fabricated from a small number of parts that can be readily punched out from sheet metal.

Referring to Figs. 1 and 2, the antenna comprises four radiating elements designated 1, 2, 3, 4, which can be punched out of suitable sheet metal. Each of these members can be formed as a punched-out blank such as the blank 5 of Fig. 5 in the form of an elongated flat metal strip with two of the diagonally opposite corners 6, 7, cut off for purposes to be described. The end sections of the blank of Fig. 5 are then bent back along the dotted lines 8, 9, to provide a main radiating section 10 and a pair of line feed sections 11, 12. Preferably the section 10 is of a length less than one-half the wavelength of the mean operating frequency at which the antenna is to be used, for example the section 10 may have a length which is from one-tenth to one-fifth of a wavelength long at the said operating frequency. When the blank is bent back to the shape shown in Figs. 6 and 7, it will be seen that the cut-off corner 6 is located adjacent the lower edge of the blank 5, while the cut-off corner 7 is located adjacent the upper edge of the blank 5.

When four such blanks are thus formed, they are interlocked with a pair of spaced circular metal discs 13, 14. The upper disc 13 shown in plan view in Fig. 3, has four inwardly-extending slots 15, 16, 17, 18, which are approximatey the same width as the thickness of the metal stock

of the blank 5, so as to form a tight fit when the parts are interlocked. Likewise, the lower circular metal disc 14 has four inwardly-extending slots 19, 20, 21, 22. The discs are located in spaced parallel planes and disposed so that the slot 15 in the upper disc and the slot 19 in the lower disc, are offset slightly from each other when vertically considered. Likewise, the slot 16 and the slot 20 are also slightly offset in respective vertical planes, as are the slots 17, 31, and the slots 18, 22. The blank which constitutes section 1 is then interlocked with the discs so that the upper edge of the line feed section 11 fits within the slot 15, and the lower edge of the line feed section 12 fits within the slot 20 in the lower disc. It will be observed that the corners 6 and 7 are cut so that when the members are interlocked, the feed section 11 is electrically connected to the upper disc 13 while the feed section 12 is connected to the lower disc 14, this relation being more clearly shown in the partial perspective view of Fig. 8. Similarly the blank constituting antenna section 2 is interlocked with the discs 13 and 14, so that the upper edge of the bent-back line feed section at one end of the blank fits into the slot 18 in the upper disc, and the lower edge of the bent-back line feed section at the other end of the blank fits into the slot 19 in the lower disc; and likewise for the interlocking of the remaining sections 3 and 4 with the discs 13 and 14. When the discs are thus interlocked with the four bent-back blanks, the straight sections 10 of each antenna member form a rectangular or square configuration and by reason of the adjacent parallel bent-back feed portions 11 and 12, the adjacent antenna sections are capacitively coupled together.

In order to feed the several antenna sections, the lower disc 14 can be fastened to a hollow metal pipe 23, which forms the outer conductor of a coaxial transmission line, and the disc 14 has a central opening 24 in registry with pipe 23. The central conductor 25 of the coaxial line extends upwardly through the opening 24 and is connected to the upper disc 13. As a result of this manner of assembly and feed, the four radiating sections 1, 2, 3 and 4, are excited in the appropriate phase so that at any given instant the current flows around the radiation loop in the same direction as indicated by the dotted arrows.

By reason of the cut-off corners 6 and 7 of each of the blanks, when the parts are assembled as above described, they are automatically connected with the coaxial line in the proper phase to achieve the desired current flow. This relation is more clearly shown in the schematic diagram of Fig. 9. It has been found that by employing the above construction, it is possible to feed the antenna from a coaxial line without requiring the use of any of the conventional balancing transformers or separate impedance-matching transformers to connect the antenna to the line. Tests made on an antenna such as that described operating at 110 megacycles, show a feed line standing wave ratio of less than 2.5 over ±10% band when connected directly to a 52 ohm line.

If such matching of the antenna to special feed lines is required, the diameter of the discs 13 and 14 can be appropriately chosen, and likewise the length of the bent-back or line feed sections 11 and 12 of each blank can be likewise appropriately chosen, as can the width of the metal blanks 5 and the spacing 26 between adjacent feed sections of adjacent blanks. In one antenna that was found to produce the desired results, the spacing 26 was three inches, the length of each radiating section 10 was 19½ inches, the length 27 of the blank was 39½ inches, and the discs 13 and 14 each has a diameter of 17½ inches. Such an antenna gave a maximum standing wave ratio of 3.6:1 at 98 megacycles, a minimum standing wave ratio of 1.30:1 at 100 megacycles, and a maximum standing wave ratio of 3.6:1 at 122 megacycles when fed with a 52 ohm line.

While in the foregoing embodiment the blanks 5 are shown bent in such a way that the radiating sections 1, 2, 3 and 4 are planar, it will be understood that they may be given any other desired shape such as circularly bowed, elliptically bowed, and the like. Furthermore, while Figs. 1 and 2 show an antenna formed with four similar radiating sections, it will be understood that a greater or less number may be employed. Thus, Fig. 10 shows an antenna constructed with six such sections each formed from a blank similar to that of Fig. 5 and with opposite corners cut away so that when the blanks are interlocked with respective circular discs, they are interconnected in the phase relation which is schematically illustrated in Fig. 10.

It has been found that for a lightweight antenna, the tight interlocking fit between the discs and the bent-back blanks provides a sufficiently rigid and permanent structure without requiring any additional spacing or insulating means between the parts. If desired, the bent-back feed sections 11 and 12 may be provided with complementary slots to interlock with the respective slots in the two circular discs. If heavyweight metal stock is used, the various bent-back feed sections can be united by a suitable insulator so as to impart further rigidity to the structure, and likewise if desired the discs 13 and 14 may be provided with separate spacer struts or elements.

It has been found also that with an antenna structure such as disclosed, the antenna is not subject to change in its electrical constants with changes in weather conditions. For example, the antenna can be covered with snow or with wet cloth or moisture without materially affecting its desired radiation characteristics. If desired, the entire antenna structure can be enclosed within a suitable plastic housing or bag.

While we have described above the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention.

What is claimed is:

1. A radio antenna comprising a plurality of individual radiant acting members forming a substantially closed radiation loop, each of said members being in the form of a metal strip having the opposite ends bent back to form inwardly converging line feed sections, a first metal disc to which each corresponding line feed section of said members is fastened, and a second metal disc spaced from the first disc and to which the other corresponding line feed sections of said members are fastened.

2. A radio antenna according to claim 1 in which a coaxial line has its outer conductor connected to the first disc to form a supporting mast for the antenna, and the inner conductor of said line passes centrally through the first disc and is connected to the second disc.

3. A radio antenna according to claim 1 in which the corresponding line feed sections of

said members are interlocked only with the first disc, and the remaining corresponding line feed sections of said members are interlocked only with the second disc.

4. A radio antenna, comprising a plurality of metal blanks having their diagonal opposite corners cut away and with the ends of each blank bent back to form inwardly converging line feed sections, a first metal disc connected to the upper uncut corners of each of said line feed sections, and a second metal disc spaced from the first disc and connected only to the lower uncut corners of said line feed sections.

5. A radio antenna according to claim 4 in which each of said discs has radial slots in its margin which are interlocked with the said bent back ends of said line feed sections.

6. A radio antenna, comprising a plurality of antenna sections each section consisting of a metal blank bent to substantial triangular configuration, said members being mounted with the bases of the triangular sections forming a substantially closed peripheral loop, and with the converging legs of adjacent triangular sections in spaced parallelism to form capacitive couplings between the sections, a first metal disc fastened to the alternate upper corners of the triangular converging legs, and a second metal disc connected to the alternate lower corners of the remaining converging legs, and a transmission line having one conductor connected to one disc and the other conductor connected to the other disc.

7. A radio antenna according to claim 6 in which each of said discs is provided with a corresponding series of peripheral slots for receiving the said corners of said converging triangular legs.

8. A radio antenna comprising a plurality of individual radiant acting members forming a substantially closed radiation loop, each of said members being in the form of a metal sheet having the ends bent back to form inwardly converging line feed sections, and common central support means to which all said line feed sections are attached, said common central support means including a pair of spaced horizontal metal discs with the upper edges of the corresponding line feed sections of said members interlocked with one of said discs and with the lower edges of the corresponding line feed sections of said members interlocked with the lower disc.

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