June 22, 1965 B. PARZEN 3,191,177

DIRECTION FINDING ANTENNA

Filed May 24, 1961 2 Sheets-Sheet 1

FIG. 1

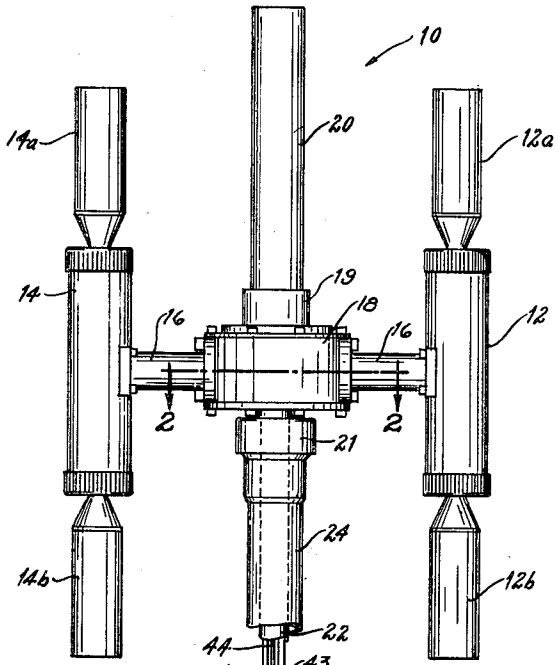
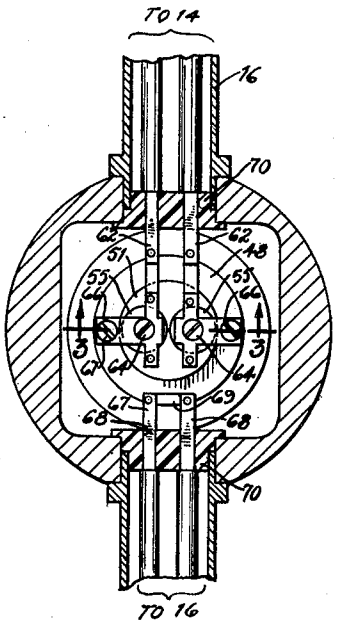



FIG. 2



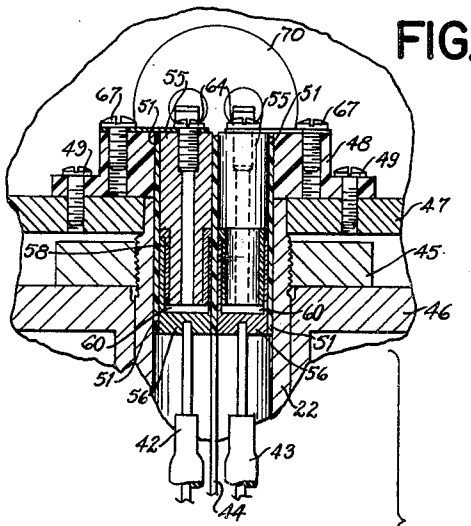

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Filed May 24, 1961 2 Sheets-Sheet 2

FIG. 3a



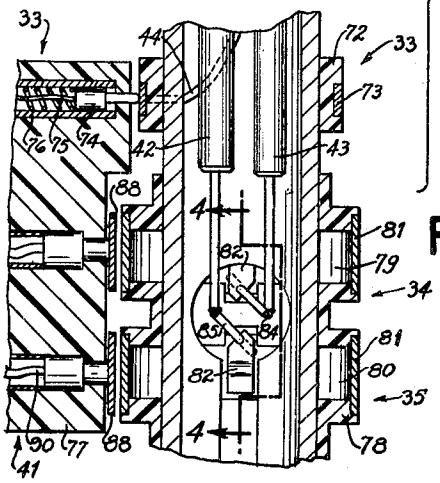
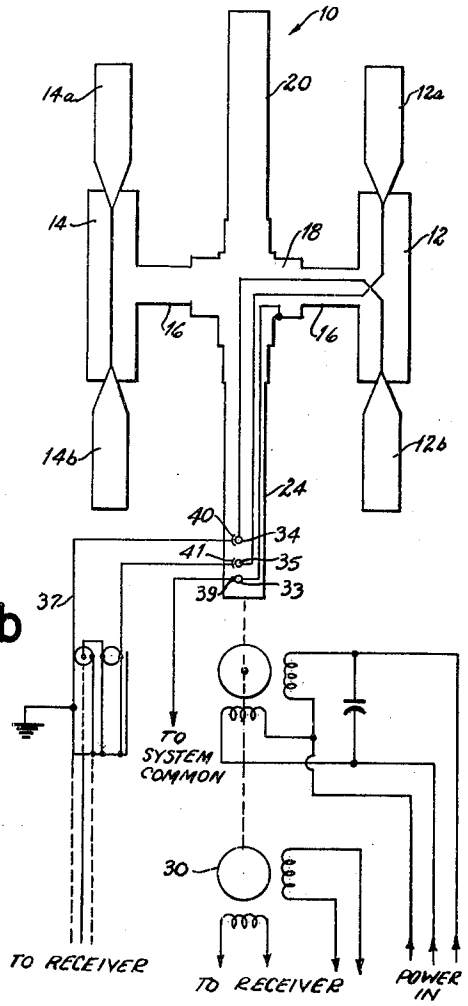




FIG. 3b

FIG. 5



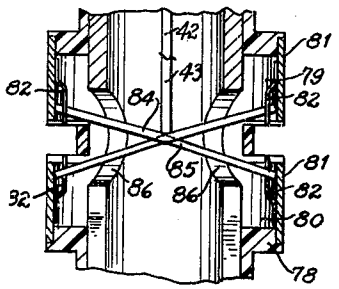




FIG. 4

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3,191,177

# DIRECTION FINDING ANTENNA

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6 Claims. (Cl. 343—766)

This invention relates to the general field of antennas and more particularly to an antenna which produces a high speed rotating directional pattern for use in a direction finding system.

In a typical direction finding system for use at a fixed station or on aircraft, shipboard, or other moving installation, a vertically polarized antenna is usually provided which has a directional radiation pattern, for example, in the form of a cardioid. The antenna is mechanically rotated, thereby rotating the directional radiation pattern, and the rotated pattern is compared in phase with a reference signal to produce a directional indication of a received signal. Systems of this type are well known in the art and are fully described in the technical literature.

In some direction finding system installations, the antenna is rotated at a relatively high speed in order to achieve the desired result for the system. The use of high antenna rotational speeds presents problems in providing mechanical structures which operate smoothly and reliably at the necessary speeds to ensure proper rotation of the antenna pattern. Once a smooth and reliable mechanical structure is designed, it is also necessary that the mechanical structure does not derogate from the formation of the desired antenna radiation pattern characteristics. The present invention is directed to an antenna wherein the mechanical structure thereof not only provides for smooth running rotation but also enhances the antenna radiation pattern characteristics.

In accordance with the present invention, an antenna of the rotating type is provided. The antenna has an active dipole and a passive dipole reflector which are connected to opposite ends of a cross-piece. The cross-piece is in turn mounted on a shaft which rotates within a stationary outer tube. A top tube which is a continuation of the stationary tube is mounted between the active dipole and the passive reflector and rotates therewith. The top tube serves as an additional directional element for the active dipole to sharpen the antenna radiation pattern, and because of the symmetrical construction the antenna is mechanically balanced. Therefore, in accordance with the invention, the antenna is dynamically balanced for relatively high smooth running rotation and simultaneously achieves excellent electrical radiation pattern characteristics.

It is therefore an object of this invention to provide a rotating direction finding antenna.

Another object of the invention is to provide an antenna which is dynamically balanced for high speed rotation.

Still a further object of the invention is to provide an antenna with a rotating active dipole, passive dipole reflector, and a second reflector which rotates with the antenna structure.

Other objects and advantages of the present invention will become more apparent upon reference to the following specification and annexed drawings in which:

FIGURE 1 is a plan view of the antenna structure partly broken away and taken in elevation;

FIGURE 2 is a cross-sectional view of the antenna rotating mounting base taken along lines 2—2 of FIGURE 1;

FIGURE 3A is a cross-section taken in elevation along lines 3—3 of FIGURE 2 showing the capacitive pickoff and connecting members at the top of the antenna;

FIGURE 3B is a cross-section of the antenna taken in elevation along lines 3—3 of FIGURE 2 showing the pickoff at the base of the antenna;

FIGURE 4 is a cross-section of the capacitive pickoffs at the antenna base taken in elevational lines along lines 4—4 of FIGURE 3B; and

FIGURE 5 is an over-all schematic view of the antenna and associated electrical equipment.



Referring to FIGURE 1, the antenna 10 has an active dipole 12 formed by two electrically insulated elements 12*a* and 12*b* and a similarly shaped passive dipole reflector 14 whose two elements 14*a* and 14*b* are shorted together. The entire antenna 10 is mounted by a suitable base 15 to a structure such as the top or bottom of an aircraft, ship, or other suitable stationary or mobile structure. Mounting is normally effected so that the dipoles 12 and 14 are vertical with respect to the earth's surface, with the antenna thereby being vertically polarized. It should be realized, of course, that the whole antenna structure 10 can be mounted in a horizontal plane to horizontally polarize the antenna.

The antenna elements 12 and 14 are connected by a cross-piece 16 to a rotating mounting base 18. The cross-piece is formed by two substantially similar separate pieces of approximately equal length mounted opposite each other on the mounting base 18. A top tube 20 is fastened to a flanged collar 19 which is connected to the top of the mounting base 18 and extends upwardly between the active dipole 12 and the passive dipole reflector 14. The mounting base 18 is rotated by a shaft 22 which is located within a stationary bottom tube 24. The bottom tube 24 is coaxial with and of substantially the same diameter as the top tube 20. The shaft 22 rotates on ball bearings (not shown) which are held within a cap-holder 21 at the top of tube 24.

The antenna 10 has a lower base housing 26 within which are mounted a drive motor 28 and an alternator 30. The output shaft of the motor 28 drives a coupling member 32 to which is connected the shaft 22. The shaft 22 extends through the bottom tube 24, with the lower end of tube 24 being mounted in a hole in a base 32 which is fastened to the top of the housing 26. The alternator 30 is driven by an output shaft (not shown) at the lower end of the motor 28 in order to produce a reference voltage for a purpose to be described.

Spaced at the bottom of the shaft 22 for rotation therewith are three pickoffs 33, 34 and 35. In the preferred embodiment of the invention, pickoff 33 is of the electrical commutator type and provides a common connection through an electrical contact 39 between the upper (rotating) portion of the antenna and the antenna base or installation to which the antenna is mounted. Pickoffs 34 and 35 are of the capacitive type, and couple out the received energy to a balun transformer 37 by means of two stationary capacitor plate pickoffs 40 and 41. The output of the balun 37 is to an RF jack (not shown), which in turn leads to the direction finding receiver or other electronic circuits used with the direction finding system.

Located within the rotating shaft 22 are two transmission lines 42 and 43 and a common lead 44. The various lines 42, 43 and 44 are held within the shaft 22 to rotate therewith by several insulating blocks (not shown) spaced along the length of shaft 22 and held therein. The transmission lines 42 and 43 are connected between the two elements 12*a* and 12*b* of the active dipole 12 and the pickoffs 34 and 35, while lead 44 is connected between the antenna base mounting 18 and the pickoff 33.

FIGURES 2 and 3A show the details of the antenna construction at the rotating mounting base 18. The shaft 22 is threaded near its end to accommodate a threaded

collar 45 which fastens the shaft to the substantially circular bottom piece 46 of the mount 18. A metallic base plate 47 is placed over the narrowed end of the shaft 22. The base plate 47 has a downwardly extending circular portion (not shown) which is fastened near the outer edge of piece 46 by a plurality of screws (not shown).

A circular flanged insulating block 48 is fastened to the top of the base plate 47 by suitable fastening means such as the screws 49.

An insulating ring 51 is located within the top of the shaft 22 and extends upwardly to a point flush with the top of the insulating block 48. The insulating ring 51 is substantially circular and has two cylindrical bores 53 formed therein. The ring 51 also has an indentation or cutout (not shown) formed along a part of its height at the rear thereof so that the common lead 44 may be placed in the cutout to be fastened to the base plate 47 under one of the screws 49. In this manner the antenna common connection is made at the base 18.

A capacitive pickoff is placed within each of the bores 53 to couple the received energy from antenna elements 12*a* and 12*b* to respective transmission lines 42 and 43. The pickoff is formed by telescoped upper and lower metal pieces 55 and 56 which are separated by an insulating member 58. Each of the upper pieces 55 is under-cut at its bottom end to accommodate an insulating member 58 which is placed around it. The insulating pieces 58 are bent at their tops to completely separate pieces 55 and 56, and an air space 60 is left between the bottom of pieces 55 and the top of pieces 56. In this manner, a capacitor is formed with the plates of the capacitor being the upper and lower pieces 55 and 56 and the dielectric being the air space 60.

The ends of transmission lines 42 and 43 are bared and electrically connected to a respective lower capacitor plate 56. Connections are made from the upper capacitor section 55 to the antenna lead-ins 62 of the active dipole elements 12*a* and 12*b* by screws 64. The ends of the lead-ins 62 have extended pieces 66 which are fastened to the top of the insulating ring 48 by screws 67. If desired, matching coils or inductances can be connected to the lead-ins 62 of the active dipole by means of the screws 67. The ends of the lead-ins 68 for the elements of the passive dipole 14 are connected together by a shorting piece 69 and the lead-ins 62 and 68 are held in place by an insulator member 70 on the inside of each cross-piece 16.

Located near the motor end of the rotating mast 22 are the output pickoffs for the antenna. These are shown in detail in FIGURES 3A and 4 and include two capacitive pickoffs formed by respective rotating and stationary sections 34 and 40 and 35 and 41 for the respective transmission lines 42 and 43 and an electrical contacting pickoff formed by rotating and stationary sections 33 and 39 for the common wire 44.

The electrical pickoff 33 is formed by an insulating ring 72 which is mounted around the shaft 22. The insulating ring 72 has an electrical contact 73 around its outer surface to which the common lead 44 is connected. The stationary pick-up contact 39 has a metallic contact 74 mounted in an insulating block 77 which is urged against the metal contact 73 by means of a spring 75. The lead 76 which is connected to contact 74 is connected to the antenna base or to the common side of the direction finding system in the installation. In this manner, a common conection is always maintained between the rotating antenna and the direction finding system.

The rotating capacitive pickoffs 40 and 41 are formed by an insulating ring 78 which is fastened around shaft 22 and has two protruding sections 79 and 80. A circular metal plate 81 is fastened to each of the sections 79 and 80 to form one plate of the capacitive pickoff and a spring clip 8D is soldered to each of the metal plates 81 inside sections 79 and 80 at diagonally opposite points.



The ends of transmission wires 42 and 43 are bared and have connected thereto respective V-shaped connecting pieces 84 and 85. Both ends of these connecting pieces pass through a hole 86 in the shaft 22 to make contact with a respective spring clip 82. Connecting piece 84 is V-shaped upwardy so that it contacts the spring clips 82 in section 79, while piece 85 is bent downwardly to contact the spring clips 82 in lower section 80. Located opposite each of the metallic plates 81 is a curved stationary plate 88 which is fixedly connected to the insulating block 77. The stationary plates 88 form the second plates of the capacitor pickoffs and the wires 90 connected thereto are connected to the inputs of the balun 37, which is in turn connected to the direction finding system input. In this manner the signals received by the antenna are capacitively coupled to the direction finding system both at the rotating base 18 and the output end of the antenna.

FIGURE 5 shows the over-all electrical schematic for the antenna system. As can be seen, the shaft tube 24, together with the top tube 20 constitutes a reflector for the active dipole 12 in addition to the passive dipole reflector 14. The shorted dipole 14, which acts as a reflector, also serves to mechanically dynamically balance the configuration so as to make possible a smooth-running, rotating assembly. Upon proper selection of the lengths and the diameters of the dipoles 12 and 14 and the top and shaft tubes 20 and 24, an approximately cardioid pattern is obtained for a fairly wide frequency band. An antenna has been constructed according to the principles of the invention, which works very well and produces a cardioid pattern over the full range of approximately 200 to 400 megacycles per second.

The output of the antenna at the balun 37 approximates a sinusoidal alternating component at a frequency equal to the number of revolutions of the motor 28. The alternator 30, which is attached to and driven by the motor, produces a two-phase reference signal of the same frequency. The rectified signal from the antenna plus the alternator signal when fed to a phase meter-type indicator produces a direct reading indication of the direction of the signal received by the antenna. Such systems for performing the phase measurement indication are well known in the art, and they form no part of the present invention.

Therefore, it has been seen that an antenna has been provided which is capable of high-speed rotation while producing a fairly directive pattern. In this antenna, the elements which are used to produce the directivity in the pattern are also used to mechanically balance the moving parts of the antenna so as to make possible a smooth-running, rotating assembly.

While certain preferred embodiments of the invention have been shown and described, it is to be understood that the invention may be otherwise embodied and practiced within the spirit of this disclosure and within the scope of the appended claims.

What is claimed is:

**1.** A rotating antenna assembly comprising a shaft, means connected to one end of said shaft for rotating the same during operation of the antenna, an antenna mounting base connected to the other end of said shaft for rotation therewith, a cross-piece member connected to said mounting base, an active antenna element connected to one end of said cross-piece member substantially parallel to said shaft, a passive antenna reflector element connected to the other end of said cross-piece member substantially parallel to said active element, and a top tube element connected to said mounting base substantially parallel to said antenna elements for use as an additional passive antenna reflector element.

**2.** A rotating antenna assembly comprising a stationary bottom tube, a shaft mounted for rotation within said bottom tube, means connected to one end of said shaft for rotating the same during operation of the antenna, a mounting base connected to the other end of said shaft, a

cross-piece member connected to said base, an active dipole element connected to one end of said cross-piece member, a passive dipole reflector element connected to the other end of said cross-piece member, and a top tube mounted on said base for rotation therewith and extending between said two antenna dipoles, said active and passive dipole elements serving to mechanically dynamically balance the rotating antenna structure and said top tube and said bottom tube acting as an additional passive antenna dipole reflector element.

3. A rotating antenna assembly comprising a stationary bottom tube, a shaft mounted for rotation within said bottom tube, means connected to one end of said shaft for rotating the same during operation of the antenna, a mounting base connected to the other end of said shaft, a cross-piece member connected to said base, an active dipole connected to one end of said cross-piece member, a passive dipole reflector connected to the other end of said cross-piece member, a top tube mounted on said base for rotation therewith and extending between said two antenna dipoles, a transmission line mounted within said shaft to rotate therewith, a capacitive coupling in said base between one end of said transmission line and said active dipole, a utilization device, and a capacitive coupling at the other end of said transmission line near the end of said shaft opposite said base for coupling the antenna assembly to said utilization device, said active and passive dipoles serving to mechanically dynamically balance the rotating antenna structure and said top tube and said bottom tube acting as an additional passive dipole reflector for the antenna.

4. A continuously rotating antenna assembly comprising a stationary bottom tube, a rotating shaft mounted within said bottom tube, an antenna mounting base connected to one end of said rotating shaft, a cross-piece member connected to said base, an active antenna dipole connected to one end of said cross-piece member, said active dipole being substantially parallel to said bottom tube, a passive antenna dipole reflector connected to the other end of said cross-piece member substantially parallel to said active dipole, and a top tube mounted on said base and extending upwardly therefrom between said two dipole elements, said passive dipole reflector serving to mechanically dynamically balance the rotating antenna structure and said top tube and said bottom tube acting as an additional passive antenna reflector element for the antenna.

5. A continuously rotating antenna assembly comprising a stationary bottom tube, a rotating shaft mounted within said bottom tube, an antenna mounting base connected to one end of said rotating shaft, a cross-piece member connected to said base, an active antenna dipole



connected to one end of said cross-piece member, said active dipole being substantially parallel to said bottom tube, a passive antenna dipole reflector connected to the other end of said cross-piece member substantially parallel to said active dipole, a top tube mounted on said base and extending upwardly therefrom between said two dipole elements, a transmission line mounted within said shaft to rotate therewith, a capacitive coupling in said base between one end of said transmission line and said active dipole, a utilization device, and a capacitive coupling at the other end of said transmission line near the end of said shaft opposite said base for coupling the antenna assembly to said utilization device, said passive dipole reflector serving to mechanically dynamically balance the rotating antenna structure and said top tube and said bottom tube acting as an additional passive antenna reflector element.

6. A vertically polarized rotating antenna assembly comprising a stationary bottom tube, a shaft mounted for rotation within said bottom tube, means connected to the bottom end of said shaft at the bottom of said bottom tube for continuously rotating said shaft during operation of the antenna, a mounting base connected to the top end of said shaft at the top of said bottom tube, a top tube extending upwardly from said base, said top tube being substantially coaxial with said bottom tube, a cross-piece connected to said base substantially perpendicular to said top and bottom tubes, an active dipole connected to one end of said cross-piece with the longitudinal axis of said active dipole being substantially perpendicular to the axis of said cross-piece and said dipole being substantially parallel to said top and bottom tubes with the top of said dipole being below the upper end of said top tube, and a passive dipole connected to the other end of said cross-piece and substantially parallel to said active dipole, the top of said passive dipole being at the same position with respect to the upper end of said top tube as the top of said active dipole, said passive dipole serving to mechanically dynamically balance the rotating antenna structure and said top tube and said bottom tube acting as an additional passive dipole for the antenna.


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