March 7, 1944. W. P. LEAR 2,343,306

LOOP ANTENNA SYSTEM

Filed Dec. 14, 1939 2 Sheets-Sheet 1

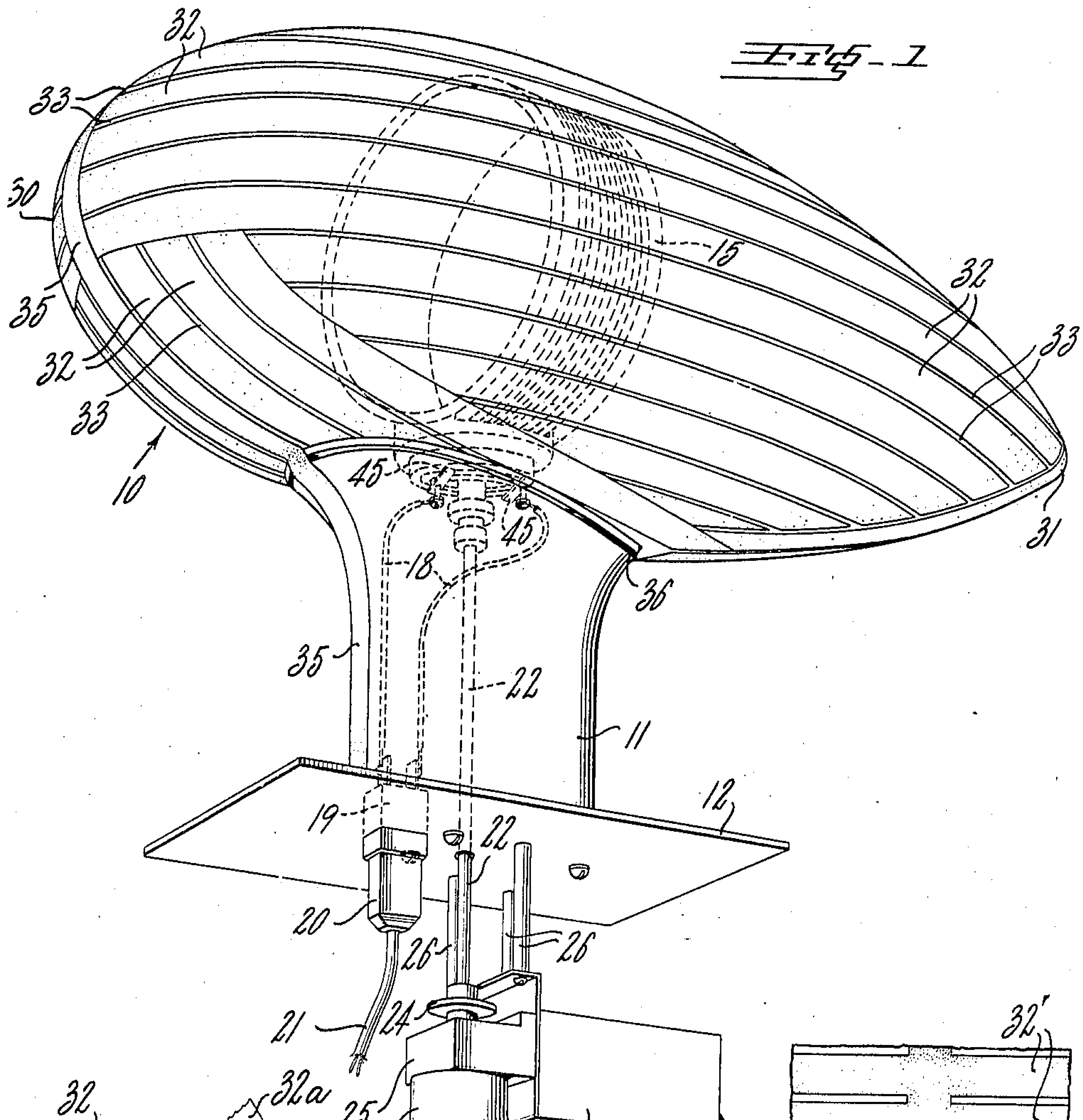

Fig. 1

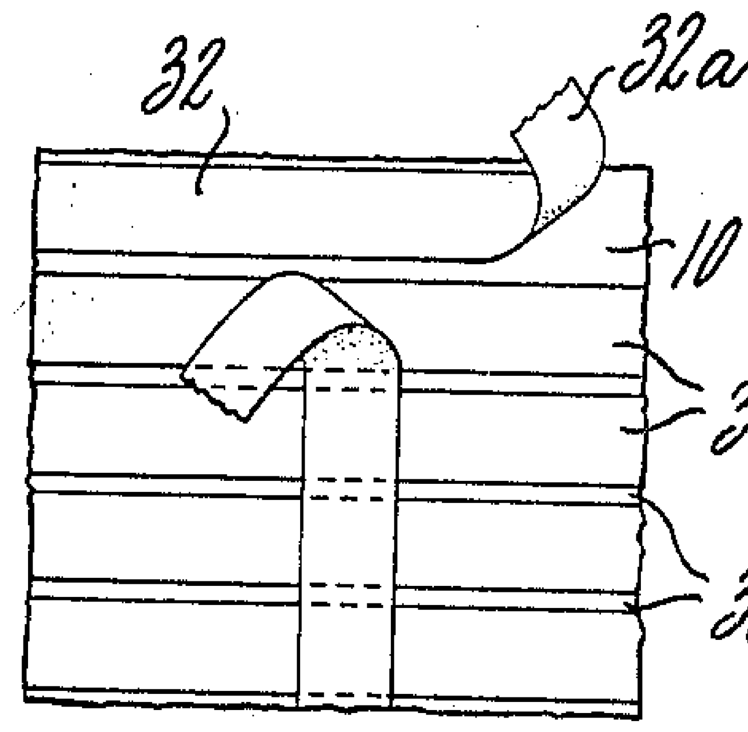

Fig. 2

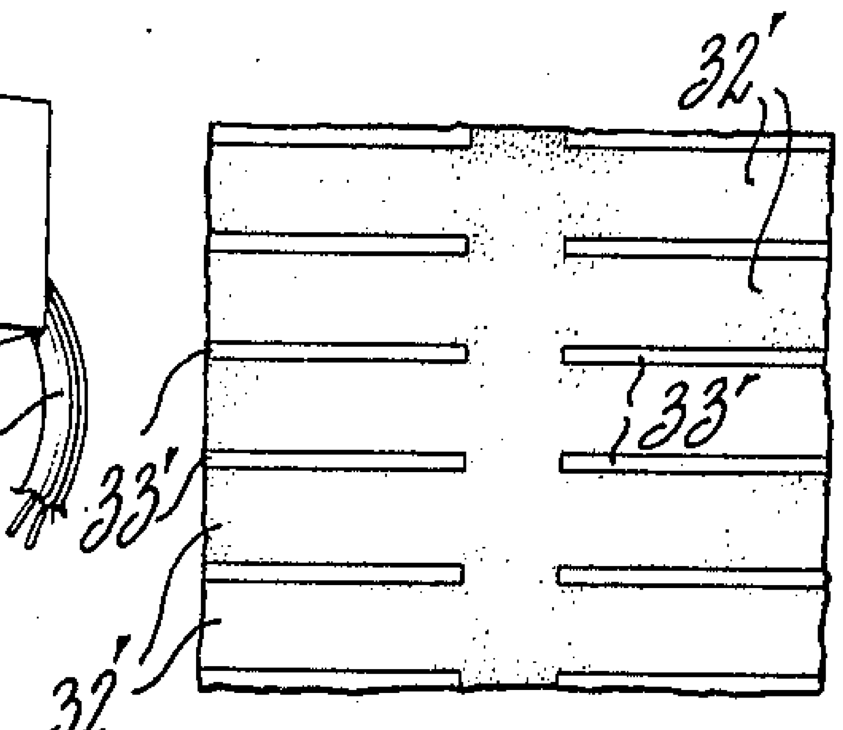

Fig. 3

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LOOP ANTENNA SYSTEM

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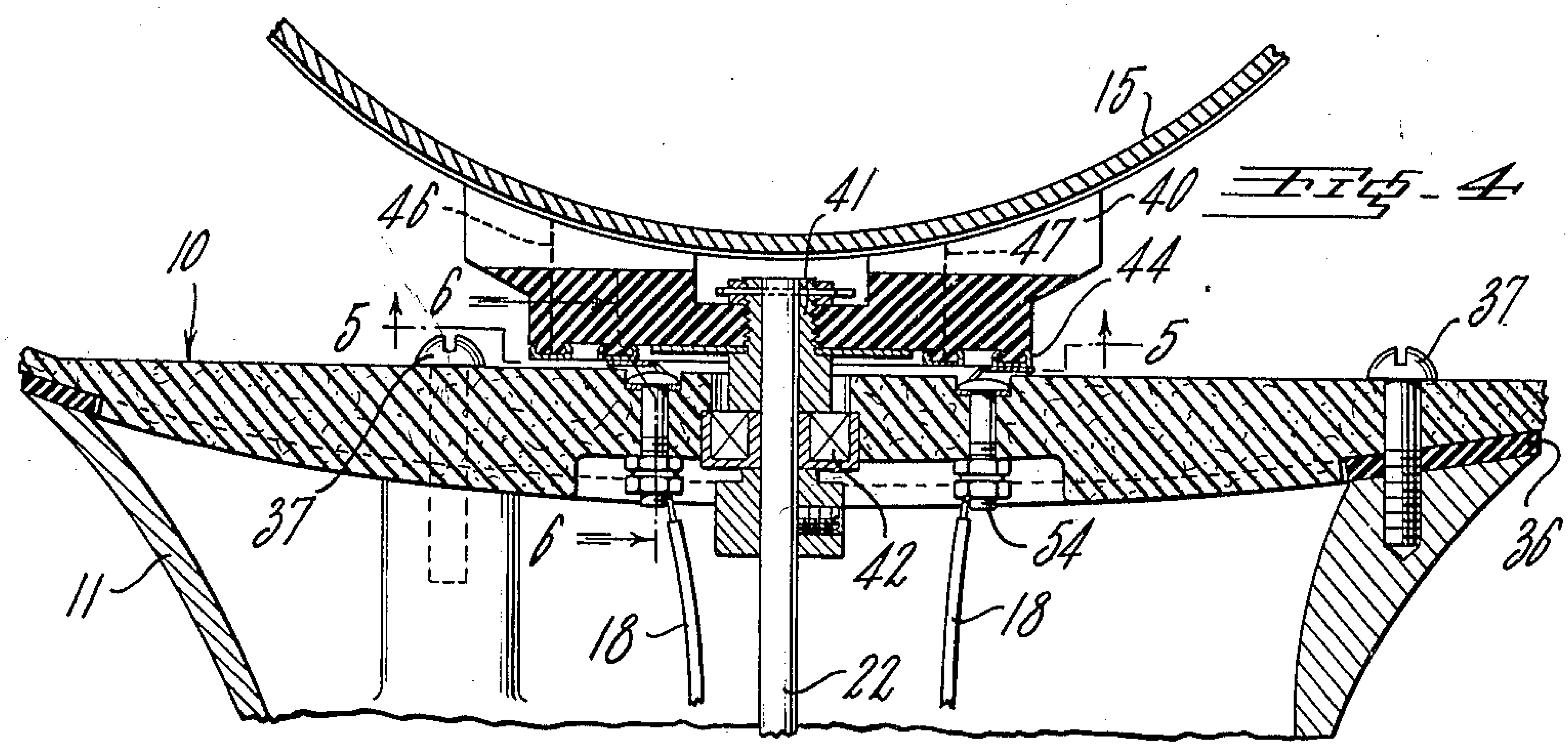

FIG. 4

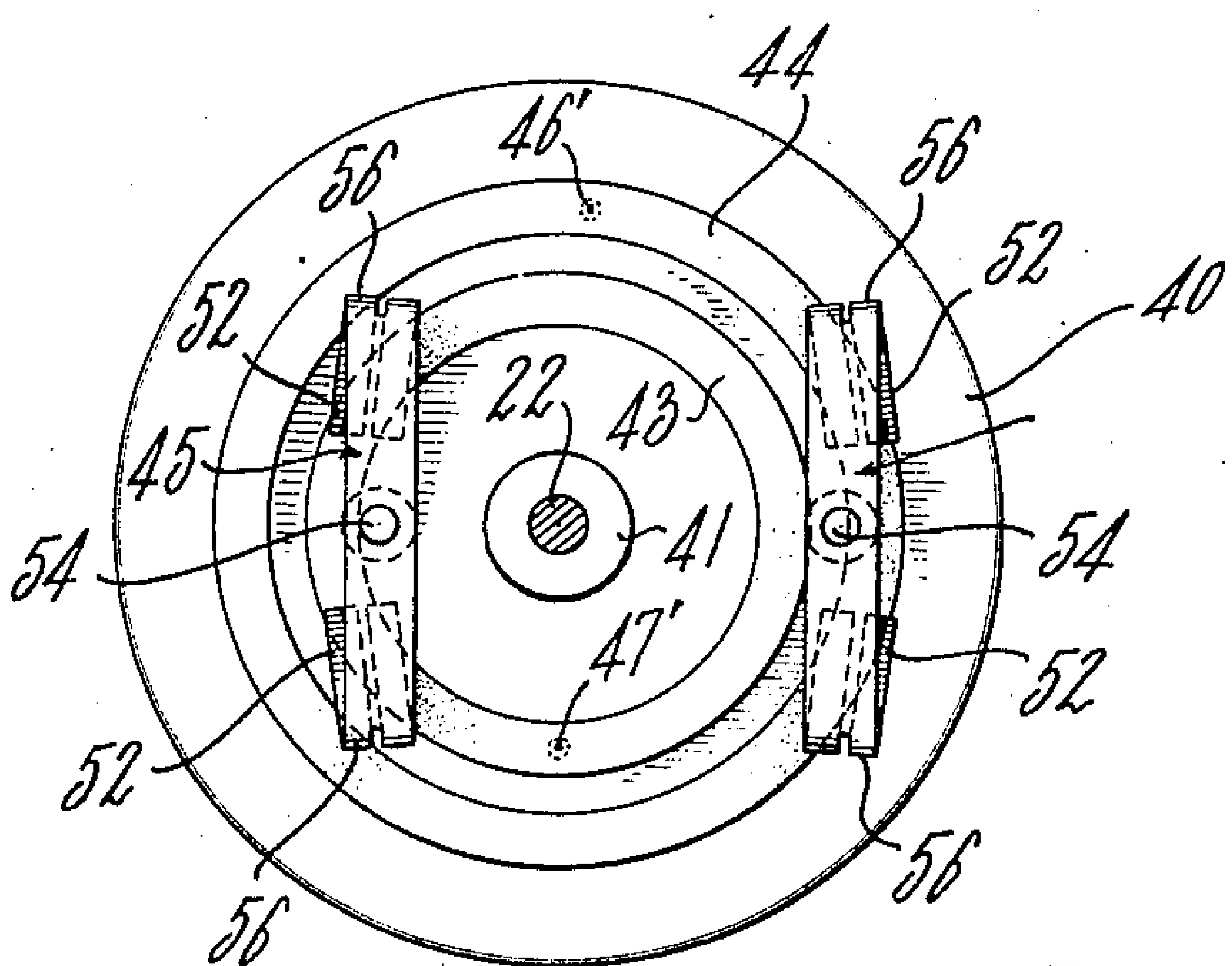

FIG. 5

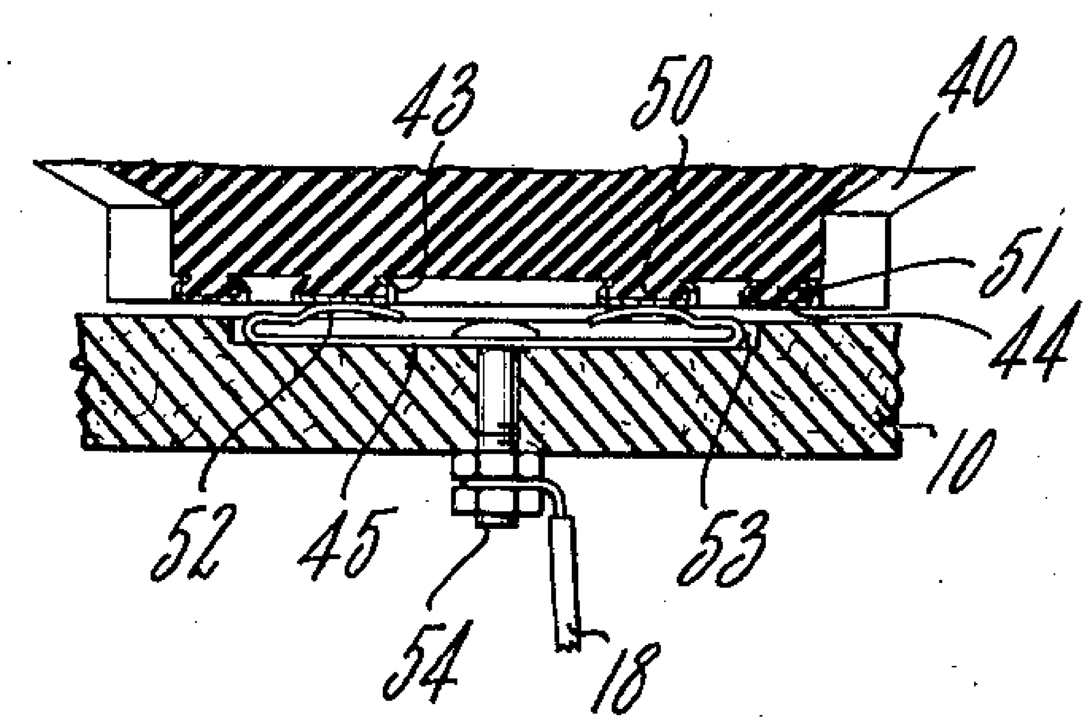

FIG. 6

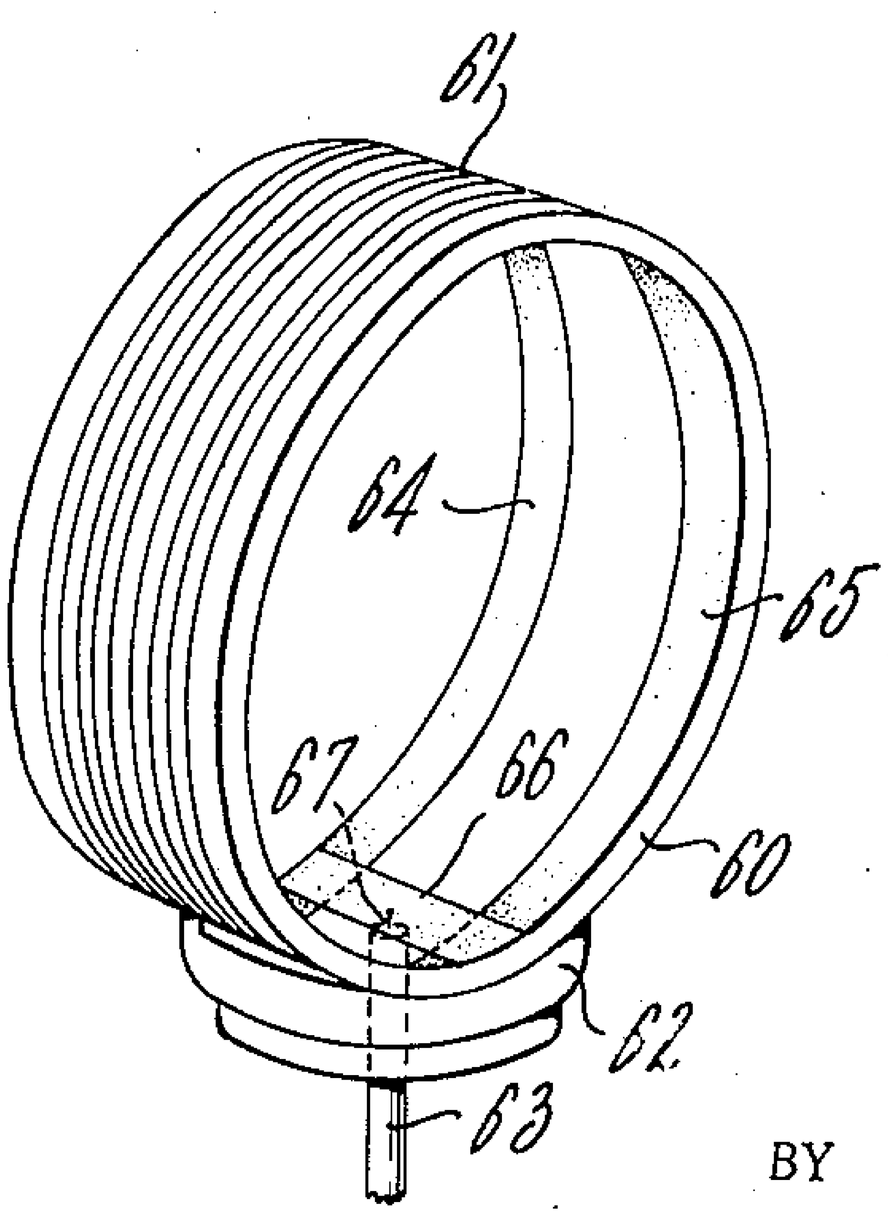

FIG. 8

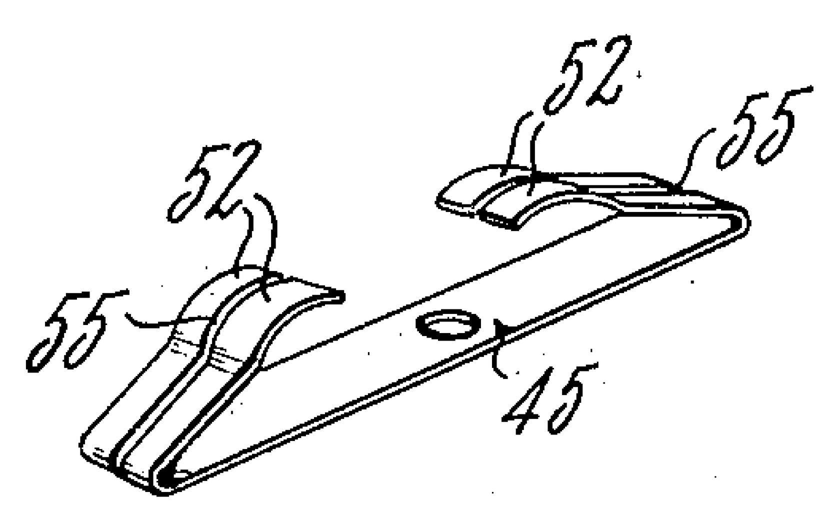

FIG. 7

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LOOP ANTENNA SYSTEM

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Application December 14, 1939, Serial No. 309,137

6 Claims. (Cl. 250—33)

This invention relates to radio antennae and more particularly relates to improvements in loop antenna constructions for aircraft direction finders.

A directional antenna for an aircraft direction finder is generally a loop coil mounted exterior of the aircraft. Streamline shells have been used about such loop coils to minimize the aerodynamic resistance presented by the antenna structure. In accordance with the present invention, I provide novel arrangements for electrostatically shielding the streamline shell for the loop antenna, to sharpen the directional reception by the loop, and to substantially eliminate electrostatic charges previously resulting from impinging dust particles, rain, fog, or snow as encountered during flight. The shell is made of composition or dielectric material. Spaced longitudinally arranged conducting layers are secured to the exterior of the shell, and aligned parallel to the aerodynamic currents around the shell when in flight. The conducting or metal foil layers are spaced to minimize eddy current losses, and are electrically interconnected to ground. The electrostatic charges are efficiently absorbed by the streamline conducting layers without inducing parasitic charges or signals in the loop antenna. Further details and advantages of the spaced longitudinal streamline conductive layers on the loop shell will be more fully set forth hereinafter.

Further, in accordance with the present invention, structural features are provided for mounting and strengthening the exposed streamline shell for withstanding large vibrational stresses it is generally subjected to in practice. I have found, through extensive development, that by constructing the section of the streamline shell adjacent the base on which it is secured of composition material containing fibrous matter placing a rubber gasket between the shell and its base, that the projecting shell will remain intact despite high wind and vibrational forces exerted on it. Other details for the directional antenna are provided with the present invention for simplifying its construction, assembly, and insuring foolproof efficient operation, particularly for automatic rotation in connection with automatic direction finding equipment.

It is accordingly an object of my present invention to provide a streamline directional antenna electrostatically shielded in a novel and effective manner.

Another object of my present invention is to provide novel electrostatic shielding for streamline antennae to effectively minimize static conditions encountered in high speed flight.

Still another object of my present invention is to provide a novel streamline directional antenna electrostatically shielded with spaced conducting layers aligned in the direction of streamlining thereon.

A further object of the present invention is to provide a novel vibration-proof mounting and arrangement for the streamline shell about a directional antenna mounted outside an aircraft.

Still a further object of the present invention is to provide a novel rotatable directional antenna of simplified mechanical and electrical construction.

These and further objects of my present invention will become further apparent in the following description of a preferred embodiment for the streamline directional antenna illustrated in the drawings in which:

Fig. 1 is a perspective view of the streamline shell with the streamline electrostatic shielding.

Figs. 2 and 3 illustrate preferred modes of electrostatically shielding the streamline shell.

Fig. 4 is an enlarged longitudinal cross-sectional view through the rotatable loop antenna structure, showing the preferred mode of mounting of the shell.

Fig. 5 is a horizontal view of the collector rings for the rotatable loop coil, taken along the line 5—5 of Fig. 4.

Fig. 6 is a cross-sectional view through the loop contactor assembly, taken along the line 6—6 of Fig. 4.

Fig. 7 is an enlarged perspective view of a spring contactor used for establishing electrical connection with the rotatable loop winding.

Fig. 8 is a perspective view of a modified arrangement for electrostatically shielding a loop coil.

Fig. 1 illustrates the streamline directional antenna, in perspective, comprising streamline shell 10 secured to base 11 mounted on base plate 12. A rotatable loop coil 15 is rotatably arranged within streamline shell 10, as shown in dotted lines. Loop coil 15, designed in accordance with principles well known in the radio art, serves as an antenna for a directional receiver for directionally intercepting radio waves. The ends of the winding of loop coil 15 are connected to collector rings coacting with contactors 45, 45 to which stationary leads 18, 18 are connected to conduct the intercepted signals to plug 19 attached to base plate 12. Coacting plug 20 connects loop cable 21 to plug 19 and the loop winding. Cable 21 leads to the directional receiver, not shown.

A shaft 22 mechanically connects loop coil 15 with motor 23, through coupling member 24 and reduction gearing contained within enclosure 25. The loop drive mechanism 23, 24, 25 is mounted onto base plate 12 through posts 26. Electrical cable 27 extends from motor 23 for connection to a control or directional system. Loop coil 15 may be automatically orientated when used with an automatic direction finding system. Such an automatic directional system is disclosed in my copending application, Serial Number 286,733 filed on July 27, 1939, entitled "Automatic radio direction indicator." It is to be understood that loop coil 15 may be rotated manually or incorporated in other directional systems. A position transmitter for indicating the orientation of loop coil 15 at a remote point is shown at 28. The illustrated position transmitter 28 is an electrical one, such as the Selsyn type.

The contour of streamline shell 10 is designed in accordance with well known aerodynamic principles. It is somewhat egg-shaped, tapering from blunt front portion 30 to narrow rear portion or tip 31. Loop coil 15 is mounted to freely rotate within shell 10. I prefer to construct streamline shell 10 of a plastic or composition material such as Bakelite, molded to the required streamline shape as illustrated. Shell 10 is molded in two or more sections and mechanically assembled in any suitable manner, to completely enclose loop coil 15.

Electrically conducting strips 32 are arranged over the surface of shell 10 to substantially cover it, as illustrated. Strips 32 are spaced from each other, forming intermediate spaces 33. Conducting strips 32 may be metal foil layers, pasted on shell 10 as indicated in Fig. 2, or formed by direct plating on the surface, as indicated at 32' in Fig. 3. I prefer to use foil layers ¾ of an inch wide, commercially known as "Metacel." The foil layers may be an alloy of aluminum or tin. The bottom surface contains paste for directly attaching the layers onto shell 10. The plated surface 32' may be constructed with any suitable metal plating such as silver, copper, zinc, or the like. Spaces 33' are arranged between the plated strips 32', corresponding to spaces 33 between the foil layers 32.

The spaced conducting layers 32 are electrically connected by an interconnecting strip 35 which extends across all the longitudinal strips 32 and below shell 10 along base 11 for connecting the layers 32 to ground potential. By the preferred construction, substantially the entire surface of streamline shell 10 is covered with a conducting layer having sufficient open regions to greatly minimize eddy current losses, and provide efficient electrostatic shielding for the contained loop 15. Grounding strip 35 places the whole conductive covering of the shell at ground potential for discharging any electrostatic potential which might otherwise accumulate on the shell. When the streamline shell is moved through the atmosphere at the high speeds encountered in flight, particles of dust, rain, fog, snow or the like impinge on the surface and would normally cause electrostatic discharges to be induced in the contained loop winding and greatly interfere with radio reception. The conducting strips place the shell as a whole substantially at ground potential to render such electrostatic effects harmless as far as directional radio reception is concerned.

An important feature of my present invention resides in arranging the conducting strips on the streamline shell in a direction conforming to the passage of the wind currents about the shell effective during flight conditions. The arrangement of strips 32 may be said to be streamline about the shell 10. By such arrangement, the wind currents which pass about the shell during flight always exert a pressure on layers 32 in a manner assisting them firmly in their position on the shell, rather than in any other direction to dislodge them. The disclosed electrostatic shielding is accordingly carried out in practice in an inexpensive manner. The conducting strips, such as "Metacel," are simply pasted on the shell along predetermined "streamlines" about the shell, and are insured against dislodgment despite the very high wind velocities passing about the shell during flight conditions since the wind presses them more firmly in place.

The arrangement of the conducting strips in the streamline direction on the shell also affords a useful electrical advantage aside from the mechanical advantage just described. The particles impinging about the shell are, in general, smoothly conducted to ground along the particular strip they impinge upon, without being interrupted by insulation spaces (corresponding to 33) if such spaces were in transverse alignment. The electrically shielded streamline shell of my invention is accordingly substantially lighter in weight than a corresponding metallic shell, and is far simpler and less expensive to build with a view to minimize eddy current losses, which is a rather difficult matter for a wholly metallic shell.

Fig. 4 is a longitudinal cross-sectional view through the region where shell 10 is mounted onto base 11. Gasket 36 is placed between base 11 and shell 10. Screws 37 secure shell 10 in position on base 11. A three or four screw mounting of the shell onto base 10 may be used. Rubber gasket 36 serves to properly adjust the shell onto base 11, and to absorb vibrational or shock displacements of the shell with respect to the rigid base 11. Bakelite or other suitable plastic material, as ordinarily molded, breaks down when subjected to the large vibrational stresses encountered during flight conditions or as determined on an experimental shake-table. Through extensive experimentation, I have found that a satisfactory solution against shell failure under vibrational stress is avoided when the section of shell 10 adjacent base 11 is molded with fibrous material. In practice, I construct shell 10 in two halves, joined along a central horizontal plane. The composition for molding the lower half sections comprises the usual plastic powder, such as Bakelite powder, admixed with shredded fibrous material, such as shredded fabric or canvas. The upper section need not be constituted with the fabric shreds since it is not subject to breakage under vibration as is the lower section.

Loop coil 15 is mounted on insulation block 40 through which drive shaft 22 centrally projects. Block 40 is secured to shaft 22 by a pin and threaded coupling member 41. A thrust roller bearing 42 may optionally be incorporated wtih the rotatable loop assembly, as shown. Connections are made to the winding of rotatable loop coil 15 through a novel and simplified contactor arrangement. Conducting collector rings 43 and 44 are arranged at the bottom face of mounting block 40, to coact with fixedly mounted contactors 45. Each end 46 and 47 of the loop coil is electrically connected to collector rings 43 and

44 respectively, at the points indicated at 46' and 47' in Fig. 5.

Figs. 5 and 6 illustrate the contactor arrangement of the present invention in more detail, being respectively views taken along lines 5—5 and 6—6 of Fig. 4. Thes contactor assembly of the present invention is a simplified means for effecting continuous electrical connection with the rotatable loop coil, with a view towards obtaining foolproof operation despite strenuous service conditions. The number of components of the contactor arrangement is reduced to a minimum, with the further advantage of minimizing its cost and maintenance.

The bottom face of circular block 40 is molded with two concentric annular projections 50 and 51. Annular projections 50 and 51 may, optionally, be shaped into the block 40 if it is first molded with a flat surface. Concentric annular projections 50, 51 are coated with a metallic surface, preferably by electroplating, forming collector rings 43 and 44 respectively. In the preferred embodiment, ring projections 50, 51 are silver-plated to form closely adherent metallic layers on the composition block 40, which may be of Bakelite. The silver-plated surfaces form well-wearing corrosion-resistant collector rings 43, 44 coacting with spring contactors 45, 45.

Contactors 45 are made of spring material, such as phosphor-bronze, and are constructed with their end portions 52 looped over and pressed against the associated annular collector ring 43 or 44. Contactors 45 are also silver-plated, to establish continuous efficient electrical connection with the loop winding through collector rings 43, 44. The spring pressure at contacting ends 52, inherent in the design and constructions of contactors 45, insures smooth electrical connection despite vibration and other stresses on the loop encountered in flight conditions, an important feature for radio directional reception. Contactors 45 are mounted in grooves 53 of shell 10 with bolts 54. Connection leads 18 establish electrical connection with contactors 45 through bolts 54.

Fig. 7 is an enlarged perspective view of contactor 45 before its assembly in the loop antenna. Ends 52 are extended in Fig. 7, indicating the spring pressure by them upon collector rings 43, 44 when assembled. Longitudinal slots 55 are made in ends 52 to insure smoother frictional contact and wide contacting area with collector rings 43, 44. Looped ends 52 of contactors 45 are bent at an angle with respect to the axis of the contactor, as indicated at 56, to effect a maximum contacting area between the ends 52 and circular rings 43, 44. The base of each contactor 45 is mounted slightly displaced with respect to collector rings 43, 44, so the contacting end portions 52 project at the angle of bending to coact with the collector rings over a relatively wide area. Angular bends 56 are similar for each of the contactors. The respective contactors for collector rings 43 and 44 are arranged so that bends 56 are in reverse positions, as shown in Fig. 5, for effective coaction with the collector rings of different diameters. The reverse angular orientation of the bent-over ends of the contactors permits a single design of the contactors for both rings.

When the rotatable loop antenna is mounted inside the body or fuselage of the aircraft, a streamline shell, corresponding to shell 10 of Fig. 1, is unnecessary. Fig. 8 illustrates in perspective, a loop antenna electrostatically shielded for such interior mounting. Rotatable loop 60 of Fig. 8 comprises loop winding 61 arranged about coil form 60, its connection ends projecting through circular block 62 on which loop 60 is mounted in a manner similar to those of the loop antenna of the previous modification. Shaft 63 is connected to block 62 for rotating the loop 60. Suitable electrical contacting means (not shown) are provided for establishing electrical connection with the ends of rotatable loop coil 61.

The inside edges of loop antenna 60 are lined with metallic strips 64, 65 in vertical planes substantially parallel to the effective plane of loop winding 61. Cross-over strip 66 connects circular strips 64, 65 to ground, such as through connection 67, shown in dotted lines, to metallic shaft 63. The vertical coil edge shielding by metallic strips 64, 65 substantially eliminates vertical antenna effect, and greatly sharpens the null signal position obtainable with the loop antenna in directional reception. Such direct shielding of loop 60 is unnecessary when a shell with a streamline electrostatic shielding as described in connection with Figs. 1, 2 and 3, is used. When the loop coil is freely mounted within the aircraft or aboard a vessel, or in a land station, the vertical edge shielding described in connection with Fig. 8 greatly sharpens the null reception therewith.

It is to be understood that modifications may be made in practicing the present invention without departing from the broader principles and scope thereof, and accordingly I do not intend to be limited except as set forth in the following claims.

What I claim is:

1. A streamline shell for a loop antenna, constructed of insulation material, and having shielding means comprising a plurality of conducting strips spacedly arranged along the outside surface of said shell in a direction substantially conforming with the streamline path of air currents around the shell and substantially covering the outside surface thereof, whereby impacting atmospheric charges are smoothly conducted past the shell.

2. A streamline shell for a loop antenna, constructed of insulation material, and having shielding means comprising a plurality of relatively narrow metal foil strips pasted on the outside surface of said shell in closely spaced relationship and aligned substantially along the normal streamline direction of air currents about the shell, and a conducting strip electrically interconnecting said spaced metallic strips to a unipotential electric condition also arranged in said normal streamline direction, whereby impacting atmospheric charges are smoothly conducted past the shell.

3. A streamline shell for a loop antenna, constructed of insulation material, and having shielding means comprising a plurality of spaced relatively narrow metallic layers plated on the exterior surface of the shell with a conducting region electrically interconnecting said layers to a unipotential condition, said layers being aligned substantially along the normal streamline direction of air currents about the shell, whereby impacting atmospheric charges are smoothly conducted past the shell.

4. A streamline shell for a radio antenna, constructed of insulation material, and having shielding means comprising a plurality of spaced conducting members arranged longitudinally along said shell in a direction substantially conforming

with the streamline path of air currents around the shell, and conducting means interconnecting said members to a unipotential condition, whereby impacting electrically charged particles are smoothly conducted past said shell.

5. In an electrical system including conducting means subject to capacitive coupling effects with adjacent conducting means, the combination with said conducting means of an electro-static shield comprising an insulating wall portion composed of a composition material having metallic coated sections covering the greater portion thereof, said sections being separated from one another, but connected at one end to a common conductor, and arranged to converge toward a common zone on said wall portion, said shield acting to substantially eliminate the capacitive coupling effects between said adjacent conducting means and said conducting means.

6. In antenna apparatus for a radio receiver, the combination of a coil, and an electro-static shield for said coil, said shield including an insulating wall portion having sections thereof coated with a metallic substance, said sections being separated from each other and adapted to cover the greater part of said wall portion, and being arranged to emanate from a common zone on said wall portion, with the converging ends of said sections being conductively connected at said common zone, said shield serving to reduce the capacitive coupling of said coil with any capacitance bodies adjacent said shield.

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