

Nov. 28, 1950

W. L. BARROW ET AL
DIRECTIVE ANTENNA STRUCTURE

2,531,455

Original Filed Feb. 4, 1942

2 Sheets-Sheet 1

FIG. 1

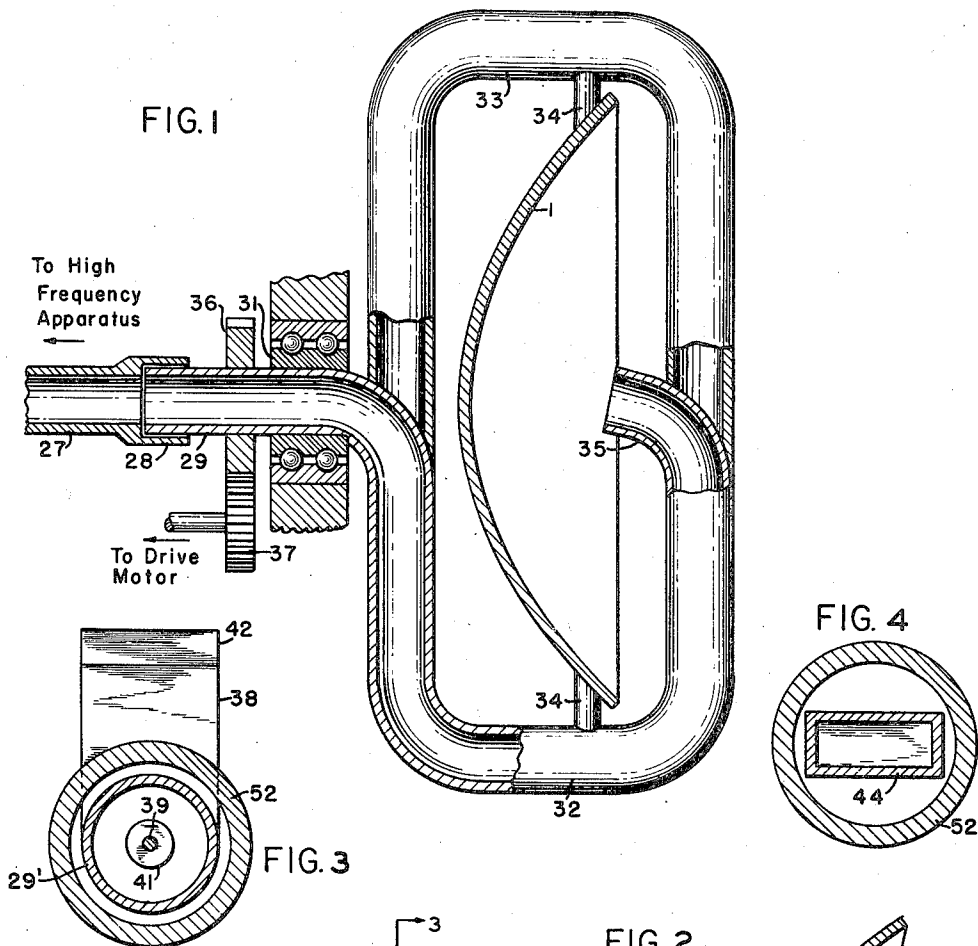


FIG. 3

FIG. 4

FIG. 2

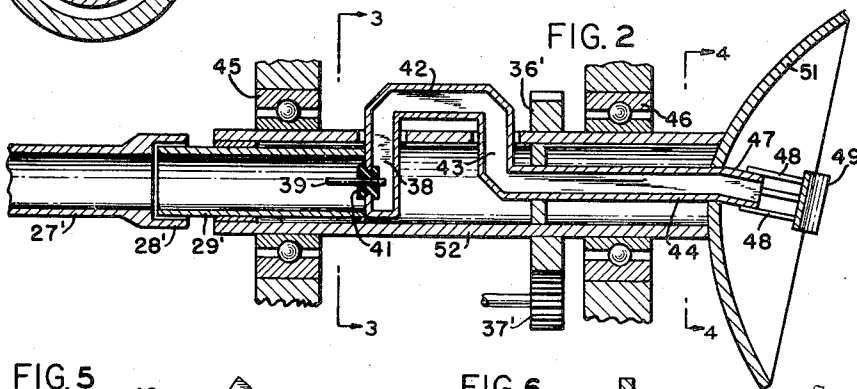


FIG. 5

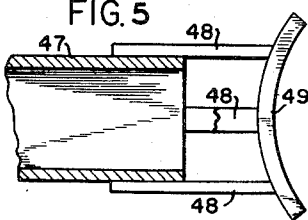
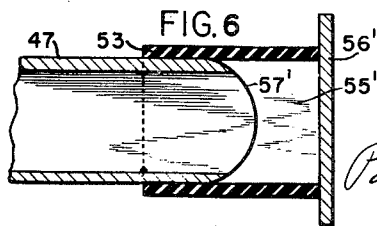


FIG. 6



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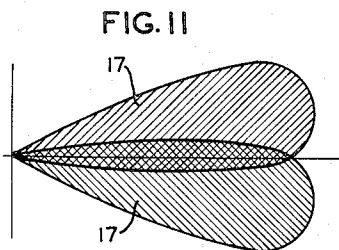
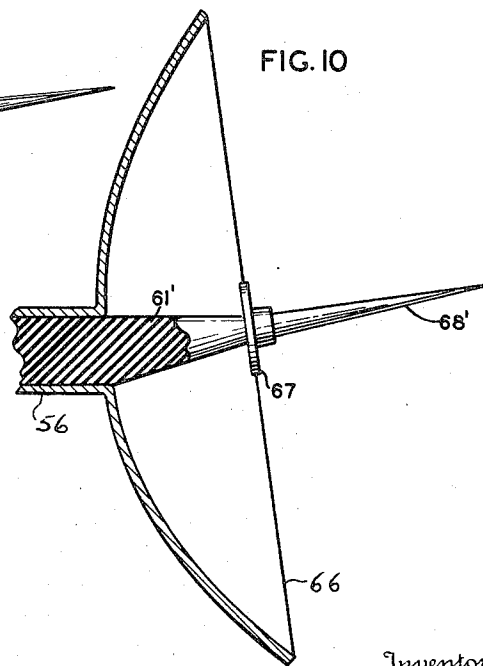
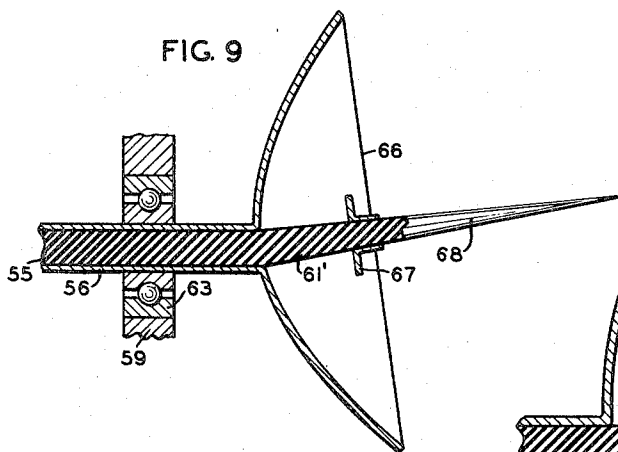
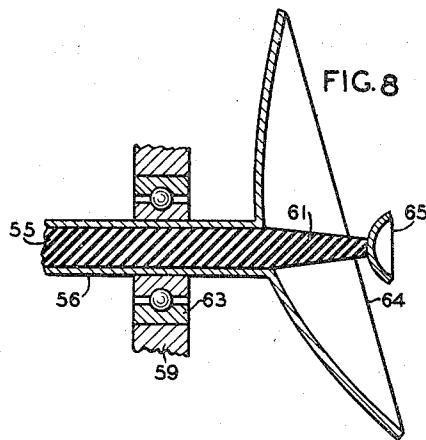
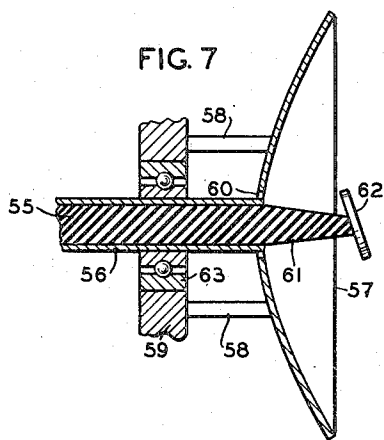
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DIRECTIVE ANTENNA STRUCTURE

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28 Claims. (Cl. 250—33.65)

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This invention relates, generally, to the directional reception or transmission of high frequency electromagnetic energy and the invention more particularly relates to a novel directive antenna structure having a series of differing zones of reception or transmission, said series being repeated in regular sequence. This application is a division of application Serial No. 429,494, filed February 4, 1942, filed conjointly by the present applicants and Robert J. Marshall.

Heretofore, directive antenna means have been employed for setting up a series of directed zones of transmission or reception, such antenna means comprising a radiating antenna and a cooperating eccentrically mounted parabolic or other reflector, such reflector being rotated to produce the desired space pattern. The rotation of these reflectors at high speeds is undesirable owing to the windage and to gyroscopic effects. Furthermore, such reflectors are usually supported in large diameter bearings where a wave guide is used to convey the energy to or from the antenna means, such large bearings having but a short life in use and tending to cause overheating and excessive wear of the relatively movable parts.

One object of the present invention is to provide a novel directive antenna structure adapted in use to establish a series of overlapping zones of electromagnetic radiation or reception, said series being repeated indefinitely.

Another object of the present invention is to provide a novel antenna structure comprising a reflector and wave guide means for supplying electromagnetic radiation into said reflector or receiving radiation therefrom.

Still another object of the present invention is to provide a novel directive antenna structure comprising a fixed reflector, wave guide means for conveying energy to or from said reflector, and motor-driven deflecting means cooperating with the mouth of said wave guide for producing a lobe of electromagnetic radiation or reception whose central axis continuously revolves defining the surface of revolution of a cone, the apex of such surface being centered at the antenna structure.

Another object of the present invention provides a novel antenna structure having a reflector and employing a rectangular wave guide for conveying energy to or from the reflector, said wave guide being rotatable with the reflector to produce continuously moving lobes of electromagnetic radiation or reception wherein the polarization changes with the angular movement of the wave guide and reflector.

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Other objects and advantages will become apparent from the specification, taken in connection with the accompanying drawings wherein the invention is embodied in concrete form.

In the drawings,

Fig. 1 is a sectional view of an antenna structure embodying principles of the present invention.

Fig. 2 is a view similar to Fig. 1 but of a modified structure.

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 2.

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 2.

Fig. 5 is a detail of a portion of the structure of Fig. 2.

Fig. 6 is a fragmentary sectional view of a slight modification of the structure of Fig. 2.

Figs. 7, 8, 9 and 10 are sectional views showing additional modifications.

Fig. 11 is a diagrammatic view of the lobe of radiated or received energy in two successive positions.

Similar characters of reference are used in all of the above figures to indicate corresponding parts.

Generally speaking, the invention comprises a reflector 1 of the parabolic type, mounted relative to a wave guide so that electromagnetic waves discharged from the mouth or end of the guide enter the cavity of the parabolic reflector preferably adjacent to its axis. Deflecting means, such as an eccentric nozzle or plate, preferably is rotatable with respect to the reflector axis to provide a movable lobe of electromagnetic energy. However, the reflector also may be made rotatable, either concentric with the axis of rotation or otherwise.

In Fig. 1 the reflector 1 is carried by a looped wave guide 32 which has a complementary dummy portion 33 for balancing the rotatable structure shown as being driven by gearing 36, 37 attached to the stub portion 29 of guide 32. The stub portion communicates with a guide 27 extending to the high frequency transmitter or receiver. Stub portion 29 is shown carried by bearing 31. It will be noted that mouth 35 of loop 32 is directed at an angle with respect to the reflector 1 to give the lobe of electromagnetic reception or transmission, inclination with respect to the axis of rotation as shown in Fig. 11 and thus serves as energy deflecting means directing electromagnetic energy between guide 27 or 29 and reflector 1. If desired, the reflector 1 could be tilted instead of the mouth portion 35

and the same result obtained. Reflector 1 is shown supported from guide means 32, 33 by struts 34.

Thus, where the antenna structure is used as a radiator, energy leaving guide 27 and loop 32 is directed by deflector 35 so as to strike the reflector 1 and then is projected substantially as a lobe such as the lobe 17 shown in Fig. 11. As the motor for gears 36 and 37 revolves, this lobe also revolves, its longitudinal axis describing the surface of a right circular cone. On the other hand, if the antenna structure is used as a receiver it will have a revolving zone of electromagnetic reception which at any instant will have the form as shown at 17, but which will revolve as indicated in Fig. 11.

In the structure of Fig. 2, an eccentrically mounted reflector 51 and connected wave guide 44 are shown as rotatable. The reflector and guide are shown supported by a tubular member 52 mounted on bearings 45 and 46, which tubular member is rotated by gearing 36', 37'. The wave guide 44 is rectangular, as shown in Fig. 4, and is coupled to the circular guide portion 29' via a coupling element or rod 39 shown projecting both into the guide 29' and into the portion 38 of guide 44, the portion 38 extending at right-angles to the circular guide 29' in order to facilitate the transmission of energy therebetween. In order that the rotation of rectangular guide 44 shall not modulate the output of circular guide 29', the electromagnetic energy traversing guide 29' should have a longitudinal electric component. Wave guide portion 38 communicates with the remaining portion of the wave guide portion 44 via off-set portion 42 and a radial portion 43. The rotating circular guide 29' communicates with a stationary circular guide 27'. The mouth portion 47 of rectangular guide 44 is shown deflected so as to extend substantially coaxial with the axis of reflector 51 and is provided with a deflector 49 in the form of a convex curved plate as better shown in Fig. 5, this plate being supported by struts 48 preferably of dielectric material from the mouth portion 47. Deflector 49 serves to spread the output of guide 44 substantially uniformly over the walls of reflector 51 to produce the pattern shown in Fig. 11 as the reflector and antenna structure are revolved. Owing to the fact that rectangular guide 44 is used and to the fact that the same is revolved, the plane of polarization of the emitted lobe will revolve also. Such plane of polarization will shift in the operation of the structure of Fig. 1 due to the rotation of the member 32.

In Fig. 6 the end portion 47 of the long sides of the guide is shown rounded at 57', preferably about substantially a circular arc to improve the wave front, the radiation striking the flat plate 55' that is shown carried by an insulating box member 53 which plate is just slightly larger than the longer side of the rectangular guide. If desired, this plate could be carried by arms as in Fig. 5. The action of the structure of Fig. 6 is very similar to that of Fig. 5.

In Fig. 7 the wave guide 56 is shown as containing a solid dielectric 55 as of polystyrene or other low-loss dielectric. The guide casing or metal portion 56 of guide 55-56 terminates in the aperture 60 provided in the reflector 57, which reflector is mounted rigidly as by struts 58 upon a supporting member 59. The dielectric 55 projects beyond the aperture 60 and is tapered as indicated at 61 and terminates in an inclined metal plate or other deflector 62 that

is carried by the end of this dielectric tapered portion 61. The guide 56 is rotatably mounted in a bearing 63. In operation, the guide 56 revolves and energy escapes from the tapered portion 61 of the dielectric in the manner of an end fire antenna, and after reflection from the plate 62, strikes the parabolic reflector 57 to produce a zone of radiation that revolves with its axis defining the conical surface of a right-circular cone as illustrated in Fig. 11.

In this structure of Fig. 8 the parabolic reflector 64 has its main axis extending at an angle to the axis of the guide 55-56 and is attached fixedly to the guide casing 56. The tapered portion 61 of the dielectric 55 carries a semi-spherical reflector plate 65 at a point to one side of the focus of reflector 64. As the reflector 64 and guide 55-56 are revolved within bearing 63, the pattern of Fig. 11 is again produced.

In the structure of Fig. 9 both the axis of the parabolic reflector 66 and that of the tapered portion 61' of the dielectric 55 are inclined with respect to guide 55-56. Tapered portion 61' is shown carrying a reflector plate or deflector 67 in the form of a sleeve mounted thereon, and portion 61' projects through this reflector plate as shown at 68 to produce an end fire array so that the energy produced by the radiating system has the form shown in Fig. 11, the energy being supplied not only from the portion 63 but also as reflected by plate 67 and reflector 66. The degree of taper of the tapered portion 61' will determine the amount of radiation taking place along the taper.

In Fig. 10, portion 61' is shown tapered to a greater extent than portion 68' so that the radiation along 61' per unit of length will be greater than that along 68' per unit of length. Thus, it is possible to obtain a lobe having varying intensity of field throughout its cross-section, such intensity being controlled at will by the configuration of the tapered portions 61' and 68'.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A directive antenna structure comprising a concave reflector; an air-filled metallic conductor having a mouth terminus for conveying electromagnetic energy to or from said reflector; and deflector means positioned in front of said terminus for transferring energy between said terminus and said reflector, said terminus, deflector and reflector being angulated at an acute angle with respect to the axis of said conductor.

2. A directive antenna structure comprising a concave reflector, a hollow wave guide communicating with the concave side of said reflector, said guide being open ended to terminate in a mouth, deflector means positioned in front of the mouth of said wave guide and supported thereby at an acute angle to the axis of said wave guide for transferring energy between said wave guide and said reflector, said deflector means being small compared to said reflector, and means for rotating said deflector means for producing a rotating directivity characteristic for said antenna structure.

3. A directive antenna structure comprising a concave reflector, a rectangular wave guide com-

municating with the concave side of said reflector, and cylindrical deflector means mechanically coupled to said reflector positioned in front of the mouth of said wave guide and supported thereby for transferring energy between said guide and said reflector and having its axis parallel to one of the sides of said wave guide.

4. A directive antenna structure comprising a reflector, a wave guide for conveying electromagnetic energy to or from said reflector, and energy deflecting means coupling said wave guide to said reflector, said deflecting means being inclined at an acute angle to the axis of said wave guide and separated therefrom for producing a directivity characteristic for said antenna angularly disposed of said axis and being small in size as compared to said reflector.

5. A directive antenna structure comprising a reflector, a hollow wave guide for conveying electromagnetic energy, said guide being open ended to terminate in a mouth, and deflector means separated from and positioned relative to said wave guide at an acute angle to the axis thereof for transferring energy between said wave guide and said reflector, said deflector means being supported by said wave guide and being small in size with respect to said reflector and being rotatable for producing a revolving lobe of electromagnetic energy.

6. A directive antenna structure comprising a reflector, a wave guide for conveying electromagnetic energy to or from said reflector, and electromagnetic energy deflector means supported by said wave guide being small in size as compared to said reflector for transferring energy between said wave guide and said reflector, said deflector means being inclined at a fixed acute angle to the axis of said wave guide and being rotatable about said wave guide axis for producing a revolving electromagnetic energy directivity characteristic.

7. A high frequency directive antenna system comprising, a parabolic reflector, a hollow wave guide projecting through said reflector substantially at the axis thereof, said guide being open ended to terminate in a mouth, a deflector plate being small in size with respect to said reflector positioned in front of the mouth of said wave guide and inclined at an acute angle relative to said guide, and means for rotating said deflector plate to render said antenna structure successively sensitive to differing zones of electromagnetic reception.

8. In a directive antenna structure comprising, a rotatable wave guide having a looped portion carrying a parabolic reflector, said looped portion having its mouth terminating in front of and extending at an angle with respect to the axis of said reflector, and means for rotating said wave guide.

9. A high frequency directive antenna structure comprising, a parabolic reflector, means for rotating said reflector about an axis extending at an angle to the axis of said reflector, a wave guide rotatable with said reflector and having an emitting portion extending substantially coincident with the axis of said reflector, and a deflector plate positioned in front of said portion of said wave guide supported thereby and rotatable therewith.

10. A high frequency directive antenna structure comprising an axially symmetrical concave reflector, means for rotating said reflector about an axis angularly disposed to the axis of symmetry of said reflector, a wave guide rotatable

with said reflector and having an emitting portion extending substantially coincident with the axis of said reflector, and a deflecting plate supported by said wave guide positioned in front of said portion and rotatable therewith.

11. A high frequency directive antenna structure as defined in claim 5 wherein said wave guide is rectangular, and wherein a circular wave guide is provided communicating with said rectangular wave guide, and coupling means interconnecting said wave guides, said coupling means comprising a rod projecting into both said rectangular and circular wave guides.

12. A radiating antenna structure comprising, a substantially parabolic reflector, a wave guide projecting through said reflector substantially at the axis thereof and having an open mouth at the front of said reflector, and a deflector being small in size compared to said reflector positioned in front of said wave guide mouth and supported thereby so as to transfer energy from said wave guide to said parabolic reflector, said deflector having the form of a flat plate disposed at an acute angle to the axis of said wave guide.

13. A directive antenna system comprising a generally paraboloidal reflector, a wave guide extending through said reflector and communicating therewith, a deflector member comprising a conduit adjacent to the discharge end of said wave guide and extending at an angle to the axis of said guide, means for rotating said conduit, and a plate positioned in front of said conduit for transferring energy between said conduit and said paraboloidal reflector.

14. A directive antenna system comprising a concave reflector, a wave guide extending through said reflector, and communicating therewith, a deflector means adjacent to and separated from the discharge end of said wave guide and extending at an acute angle to the axis of said guide, said deflector means being small in size compared to said reflector, and means for rotating said deflector means to produce a revolving directivity characteristic for said antenna system.

15. A directive antenna system comprising a reflector, a wave guide for conveying electromagnetic energy to or from said reflector, and coupling means between said wave guide and said reflector, said coupling means comprising deflector means separated from said guide being disposed adjacent to said reflector and extending at an acute angle to the axis of said guide, said deflector means being small in size compared to said reflector and rotatable for producing a rotating directivity characteristic for said antenna system.

16. A directive antenna structure, comprising a parabolic reflector, a wave guide for conveying a beam of electromagnetic energy, and an energy deflecting member operatively connected between said wave guide and said reflector at an acute angle to said wave guide, said deflecting member being small in comparison to said reflector and being supported by said wave guide for recurrently moving through a predetermined path to produce a movable lobe of electromagnetic energy.

17. A directive antenna structure comprising a parabolic reflector adapted to radiate a lobe of radiant energy, a wave guide located substantially at the axis of said reflector for conveying electromagnetic energy, and energy deflecting means being small in size compared to said reflector adapted to direct said energy from said wave guide onto said reflector and being sepa-

rated from said wave guide, both said reflector and said deflecting means being eccentrically disposed relative to and rotatable about the axis of said wave guide.

18. A directive antenna structure comprising a reflector, a wave guide for conveying electromagnetic energy to or from said reflector, and electromagnetic energy deflecting means separated from said guide adapted to direct electromagnetic energy between said wave guide and said reflector, said deflecting means being small in size compared to said reflector, both said reflector and said deflecting means being disposed at an acute angle relative to and movable relative to the axis of said wave guide.

19. In an antenna structure, a wave guide comprising a hollow conduit adapted to conduct electromagnetic waves, said guide having a mouth at one end for discharging said waves, said conduit having longitudinal walls rounded in convex fashion at said end to improve the wave front of the discharged waves.

20. A directive antenna structure comprising a concave reflector, a rectangular wave guide having a mouth projecting through said reflector toward the concave side thereof, one opposite pair of sides of said wave guide being rounded at the end of said mouth to improve the wave front of the waves discharged thereby.

21. In an antenna structure, a wave guide adapted to conduct electromagnetic waves comprising a conduit having substantially parallel side walls, one pair of said walls being longer than the other pair, whereby the electric lines of force extend transversely of said longer sides, said longer sides being rounded at the discharge end of said guide about a substantially semi-circular arc to improve the wave front of the discharged waves.

22. A directive antenna structure comprising, a reflector, a hollow rotatable wave guide for conveying electromagnetic energy, and deflector means positioned at an acute angle relative to said wave guide and supported thereby for transferring energy between said wave guide and said reflector, said deflector means being small compared to said reflector and said deflector means and said wave guide being rotatable for producing a revolving lobe of electromagnetic energy.

23. A radiating antenna structure comprising, a substantially parabolic reflector, a rotatable wave guide projecting through said reflector substantially at the axis thereof and having an open mouth at the front of said reflector, and a deflector supported by said guide positioned in front of said wave guide mouth at an acute angle to the axis of said wave guide, said deflector having the form of a semi-cylindrical plate presenting its convex surface towards said wave guide mouth, and being small compared to said reflector.

24. In combination, an air-filled metallic wave guide having a longitudinal axis and a transverse

antenna aperture at one end, and means for revolving said axis about a line included in the plane of and forming an acute angle with said axis.

25. In a directive antenna structure having a substantially parabolic reflector, a wave guide section having an open end and an axis acutely angularly disposed relative to the axis of said reflector, said wave guide section being rotatable about said reflector axis.

26. In a directive antenna structure having a concave reflector having an axis, a wave guide section having an open end facing said reflector and acutely angularly disposed relative to the axis of said reflector, said wave guide section being rotatable to produce a conically rotatable directivity characteristic.

27. High frequency apparatus comprising a hollow wave guide of circular cross-section, a rectangular hollow wave guide, said circular cross-section wave guide having an axis intersecting the axis of said rectangular wave guide and passing through the interior thereof, and means for intercoupling said wave guides for transfer therebetween of microwave energy, said coupling means comprising a rod extending along the axis of said circular cross-section wave guide and into the interior of said rectangular wave guide, said rod being terminated in said circular cross-section wave guide.

28. High frequency apparatus as defined in claim 27, wherein said rod is perpendicular to the parallel walls of said rectangular wave guide having the greater cross sectional dimensions thereof.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,931,980	Clavier	Oct. 24, 1933
2,083,242	Runge	June 8, 1937
2,115,789	Schmid	May 3, 1938
2,173,897	Clavier	Sept. 26, 1939
2,206,923	Southworth	July 9, 1940
2,220,840	Metcalf	Nov. 5, 1940
2,255,042	Barrow	Sept. 9, 1941
2,342,721	Boerner	Feb. 29, 1944
2,370,053	Lindenblad	Feb. 20, 1945

FOREIGN PATENTS

Number	Country	Date
841,036	France	Jan. 28, 1939
450,484	Great Britain	July 20, 1936

OTHER REFERENCES

Proceedings of the I. R. E., vol. 27, No. 12, December 1939, pages 769 and 779.