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Anderson et al.

[54] **COMBINED SCAN AND TRACK ANTENNAS**

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[52] **U.S. Cl.** **343/761,** 343/725, 343/757, 343/756, 343/777

[51] **Int. Cl.** **H01q 3/12**

[58] **Field of Search**......343/757, 758, 761, 779, 839, 343/840, 837, 762, 893, 725, 835

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[57] **ABSTRACT**

Combined scan and track antennas are disclosed, each comprising a reflector and a feed thereto in which the track reflector and its feed and the feed to the scan reflector are all fixed with respect to each other and the scan reflector rolls in such a manner that a line through the center of the spherical feed antenna and the fixed feed point therefor always is perpendicular to a point on the surface of the spherical reflector through which it extends.

11 Claims, 3 Drawing Figures

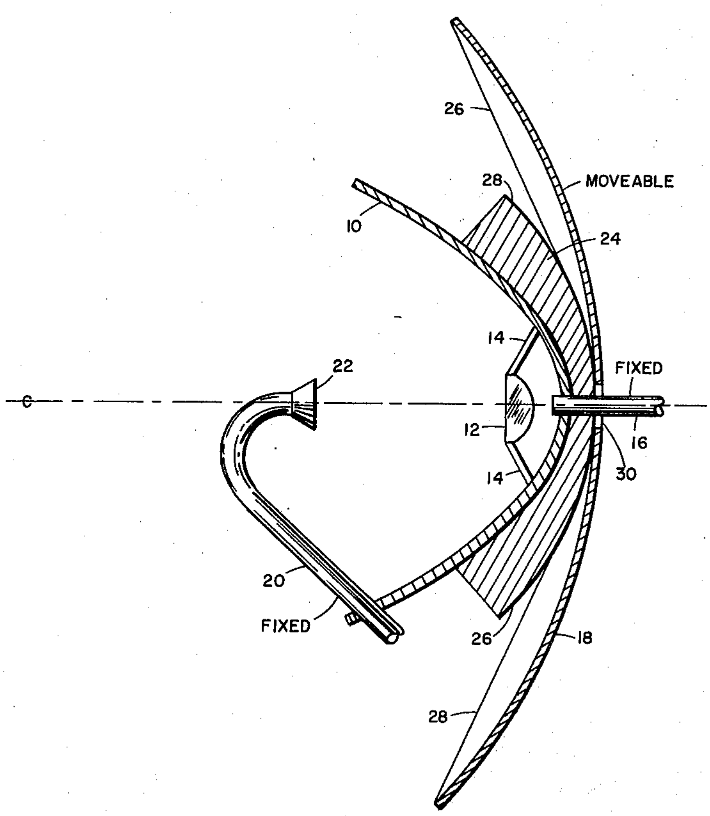

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Fig. 1

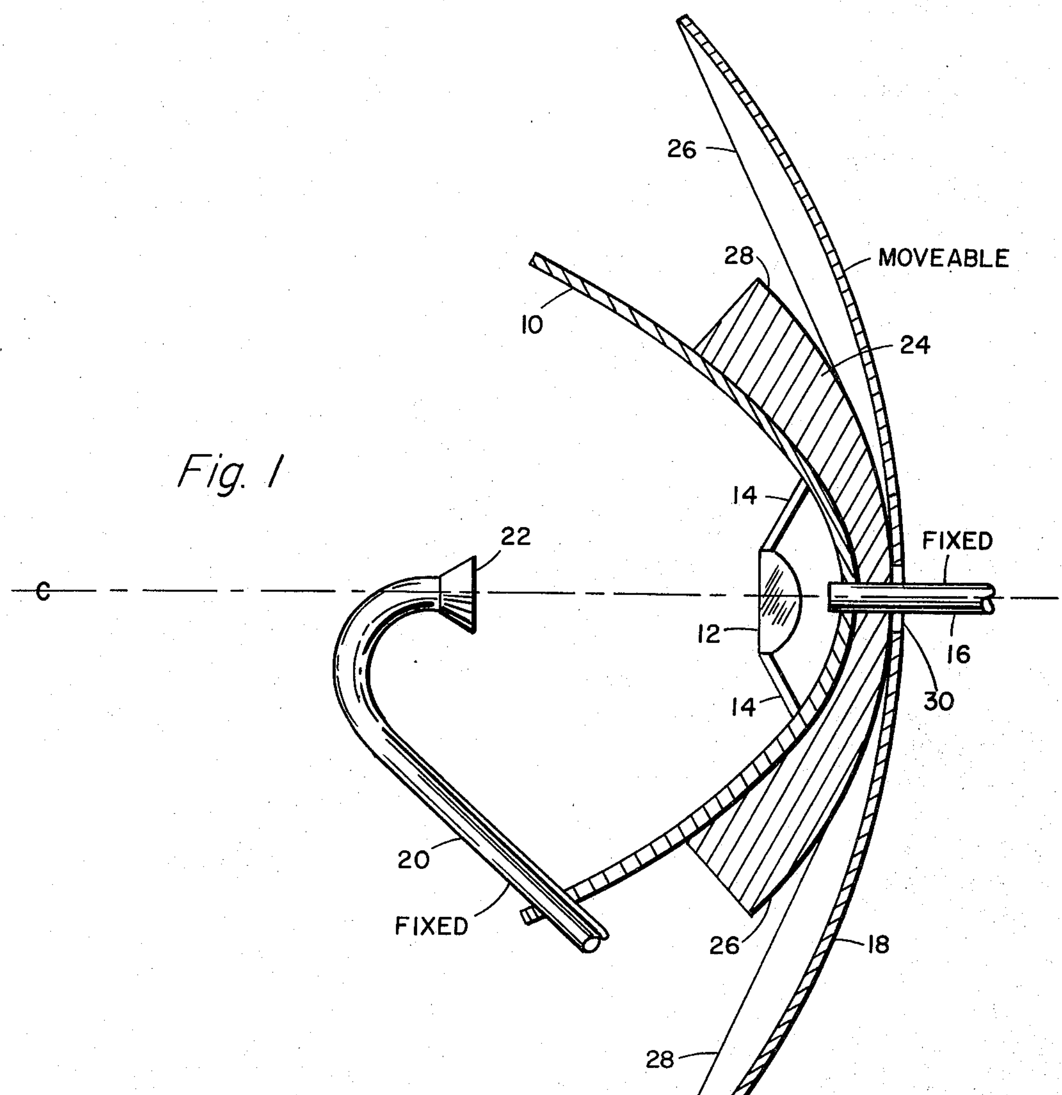

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Fig. 2

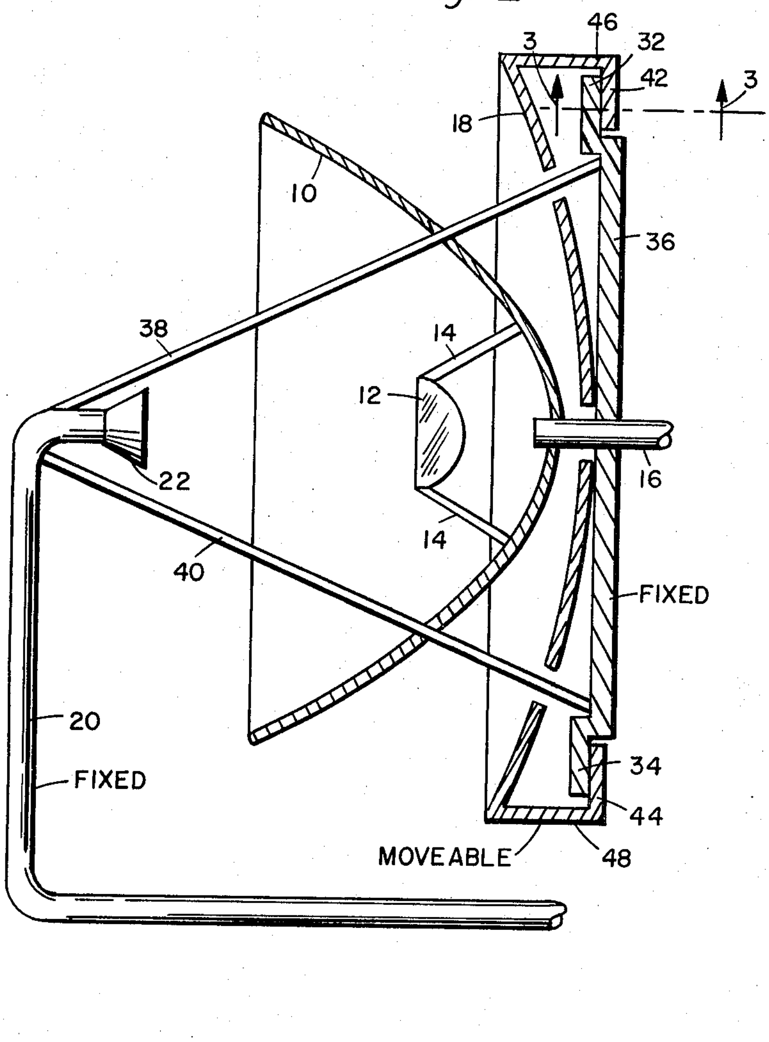
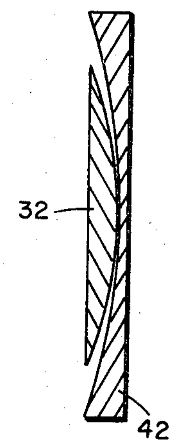


Fig. 3



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COMBINED SCAN AND TRACK ANTENNAS

BACKGROUND

This invention concerns itself with a combined scan and track antenna.

It is known to transmit a radio wave in a scanning manner and to pick up the waves reflected from an object by a tracking antenna. The scanning antenna may involve moving parts which may move in a manner which is different than a manner of moving the tracking antenna, in the process of tracking the object which may be illuminated by the scan antenna. When the scan and track antennas are both mounted on a vehicle such as an airplane, it may be advantageous to fix the track antenna to the vehicle and point the vehicle at the object. To save room and to make sure that the object is in the area that is scanned, the scan antenna should also be mounted on the vehicle and should be placed as nearly coincident with the positioning of the track antenna as is possible. It is known to place two grid type antenna reflectors one inside the other and with the grids properly oriented with respect to each other and with appropriate polarization of the feeds thereto, to provide antenna patterns produced by the two antennas which are essentially independent. Therefore, one of these two antennas may be used as a scan antenna and the other thereof may be used to track an object in the same area. While the two reflectors are usually parabolic, they can be either both parabolic or both spherical or one thereof can be parabolic and the other can be spherical. For feeding a spherical reflector, the feed or focus point is at a point one half way from the surface of the reflector to the center of the sphere of which it is a part. For a spherical scanning reflector to provide scanning, the reflector being stationary, the feed point must move in a sphere which is concentric with the spherical reflector and which has a radius equal to one half of the radius of the spherical reflector, this concentric sphere being called a focus sphere of the spherical reflector. Several ways are known to accomplish this result, one of which is to hinge a wave guide feed means at the center of the spherical reflector, the end of the wave guide pointing towards the spherical reflector and the length of the wave guide from the hinge point to its end being about equal to one half the radius of the spherical reflector. This requires much space in front of the spherical reflector and furthermore the end of the feed means does not move in the focus sphere but in an approximation thereof. Another known manner in which this moving of the feed means in a focus sphere is attempted comprises the use of a complicated hinged feed line having several, three for example, hinged joints in the feed wave guide, which causes the mouth of the wave guide to move more nearly in the focus sphere. This known method requires complicated hinged feed line means and complicated means to operate the feed line to cause proper scanning.

It is an object of this invention to provide an improved combined scan and track antenna.

It is a further object of this invention to provide a combined scan and track antenna which is simpler and easier to make than known combined scan and track antennas.

It is still a further object of this invention to provide combined scan and track antennas involving a minimum number of moving parts.

SUMMARY

In accordance with this invention, the track antenna includes a reflector and a feed means which are fixed with respect to each other and in which the scan antenna includes a scan reflector and a feed means therefor and in which the feed means to the scan reflector is fixed with respect to the track antenna and in which the scan reflector of the scan antenna rolls on a guide surface which is fixed with respect to the track reflector in such a manner that the feed for the scan reflector is always the distance of one half the radius of the scan reflector from the scan reflector and also directs a beam on a line through the center of the feed for the scan reflector which is perpendicular to the surface of the scan reflector. That is, while the scan reflector is rolling, the fixed feed means for the scan reflector is always at a focus point for the rolling scan reflector.

DESCRIPTION

The invention may be better understood upon reading the following description in connection with the accompanying drawing in which

FIG. 1 illustrates a combined scan and track antenna which embodies the invention,

FIG. 2 illustrates a modification of the antenna of FIG. 1 and

FIG. 3 is a fragmentary sectional view of FIG. 2 on line 3—3 thereof.

In FIG. 1, the track antenna comprises a parabolic reflector **10** and a feed or pick up means therefor comprising a Cassegranian reflector **12** held in position at the focus of the parabolic reflector **10** as by studs **14**. A fixed wave guide **16** extends through the vertex of the parabolic reflector **10** and ends so as to radiate energy in the direction of the reflector **12** or to receive energy from the reflector **12**. The reflector **12** reflects the energy in a direction of the reflector **10** or reflects energy from the reflector **10** into the wave guide **16**. The reflectors **10** and **12** may be made of wire mesh and the feed from the wave guide **16**, or to it, is polarized in a desired manner so as to prevent interference with the radiation of the scan antenna which will be described. The antenna comprising the elements **10**, **12**, **14** and **16**, and the manner of making it out of wire mesh and of polarizing the feed thereto is well known, whereby no further explanation thereof need be provided.

The scan antenna comprises a spherical reflector **18** which is movable with respect to the track antenna and a feed therefor, comprising a wave guide **20** ending in a horn **22**, which are fixed with respect to the track antenna. The end of the horn **22** is at the focus, that is at a distance equal to one half the radius of the spherical reflector **18** from the spherical reflector **18**. The reflector **18** may be a solid reflector and the feed by and to the horn **22** is also polarized in such a manner that the scan and track antennas operate substantially independently of each other.

As is stated above, the reflector **18** is movable in that it rolls on the outer surface of a guide **24**. The guide **24** is fixed to the back of the reflector **10**, whereby the side adjacent thereto conforms to the reflector **10** in shape. The side of the guide **24** adjacent the movable reflector **18** is spherical in shape and has a radius equal to one half the radius of the spherical reflector **18**. So that the guide 24 should not shield the reflector 18 from any wave that is travelling towards or away from the reflector 18, the guide 24 should be made of a nonconductive material. Means may be provided to cause the guide 24 and the reflector 18 to roll with respect to each other without slipping. This means may take any known form as meshing teeth (not shown) in the contacting portion of the reflector 18 and the guide 24. Or straps 26 and 28 may be provided, the strap 26 being fastened to the top of the reflector 18 as viewed in the figure and to the bottom of the guide 24, the strap 28 being fastened between the bottom of the reflector 18 and the top of the guide 24. Since the straps 26 and 28 are very thin, there are shown, for convenience, as lines. The straps should not be of conductive material. A hole 30 is formed in the reflector 18 to clear the feed wave guide 16 as the reflector 18 rolls on the guide 24. It will be seen that as the reflector 18 rolls on the guide 24, the center C of the spherical reflector 18 moves but the focus point at the horn 22 does not move and a line can be drawn from any position of the center C through the fixed focus point at the horn 22 that will be a radius of the reflector 18. This is due to the fact that the contact of the spherical reflector 18 and the spherical guide 24 is always at a tangent plane to the two spheres and a line perpendicular to the tangent plane to the two spheres is a radius of both of the spheres. Since all the radii of the sphere 24 passes through the point 22, the line through the point of contact of the reflector 18 and the guide 24 which is the radius of the guide 24 is also a radius of the reflector 18. Therefore, in every position of the spherical reflector 18, the point 22 is on a radius thereof and is at a distance equal to one half the distance to the center of the spherical antenna 18, that is, as the reflector 18 rolls, the horn 22 is always at a focus point of the reflector 18 and yet the wave reflected by the reflector is directed in different directions by the rolling of the reflector 18. Furthermore, there is nothing physical beyond the wave guide 20 in the direction towards the center C, whereby the described structure extends only to the wave guide 20 and the described structure is smaller than known combined scan and track antennas which extend beyond the focus point 22.

As described, the surface of the guide 24 adjacent the antenna 18 is spherical as is the facing surface of the antenna reflector 18. If desired the surface of the guide 24 away from the reflector 10 may be cylindrical instead of spherical and the reflector 18 may also be cylindrical, resulting in a planar scan rather than the possible multi-directional scan where the contacting surfaces of the guide 24 and the reflector 18 are both spherical.

As noted, in the device of Fig. 1, the guide 24 and the straps 26 and 28 should not be of conductive material since they may shield the reflector 18 when made of conductive material. As shown in Fig. 2, the roll guides 32 and 34 may be behind the reflector 18.

In Fig. 2, elements are given the same reference characters as similar elements of Fig. 1. A fixed frame 36 is provided on which the fixed wave guide 20 and the horn 22 and the fixed parabolic reflector 10 may be positioned as by struts 38 and 40. The roll guides 32 and 34 are identical and are integrally fixed to the frame 36. The shape of one thereof is shown in Fig. 3. The roll guide 32 is in the shape of a segment of a cylinder having a radius equal to one half the radius of the spherical reflector 18. The rolling means 42 and 44 are identical and are cylindrically concave and have a radius equal to the radius of the spherical reflector 10. The shape of the rolling means 42 and its relation to the rolling guide 32 are shown in Fig. 3. The rolling means are fixed to support bars 46 and 48 which support the spherical reflector 18. As the rolling means 42 and 44 roll on the roll guides 32 and 34 respectively, the reflector 18 moves in a manner as to keep its focus point at the mouth of the antenna horn 22, however waves are scanned in a direction above and below a line through the horn 22 and the wave guide 16. It is noted that the roll guides 32 and 34 and the roll means 42 and 44 are behind both reflectors 10 and 18, whereby they can be made of metal. The roll guides 32 and 34 are convex and the roll means 42 and 44 are concave, however, if desired they may all be convex and still give the reflector 18 the proper motion.

What is claimed is:

1. Combined antenna means for radiating waves in the same area comprising

- a first and a second reflector rollable relative to each other,
- respective feed means for said reflectors, said first reflector and both said feed means being fixed with respect to each other, and
- means for rolling said second reflector with respect to said first reflector.

2. The invention of claim 1 in which said second reflector is spherical in shape and its respective feed means is positioned to radiate energy in a direction of said second reflector from the focus point of said second reflector.

3. The invention of claim 2 in which said means for rolling includes a rolling guide having a spherical surface which has half the radius of the second antenna.

4. The invention of claim 3 in which said rolling guide fits on said first reflector in a manner to present its spherical surface to said second reflector.

5. The invention of claim 4 in which means are provided to prevent slipping of the second reflector and the rolling guides.

6. The invention of claim 5 in which said first reflector is of parabolic shape.

7. The invention of claim 1 in which said second reflector is cylindrical in shape and said means for rolling said second antenna with respect to said first antenna is also cylindrical in shape.

8. The invention of claim 1 in which said second reflector is spherical in shape and said means for rolling said second antenna with respect to said first antenna comprises a pair of means having contacting cylindrical surfaces.

9. The invention of claim 8 in which one of said contacting cylindrical surfaces is concave.

10. The invention of claim 8 in which at least one of said contacting surfaces is convex.

11. The invention of claim 8 in which said contacting surfaces are located in the same direction from both reflectors.

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