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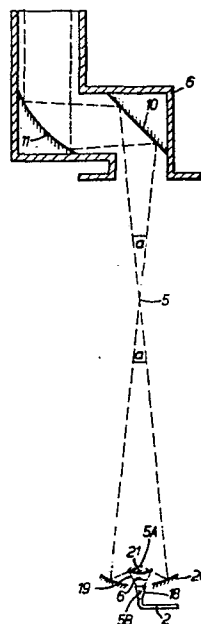
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Beam waveguide feed for antenna.

In microwave communication systems it is common practice to use a beam waveguide to transmit energy between a waveguide (2) connected to transmitting and receiving equipment located at ground level and a main antenna reflector (not shown in Figure 3) mounted above ground level. Hitherto the waveguide (2) has terminated in a very large, accurately machined, horn which is necessary to produce a beam having a small angle of divergence suitable for entry into the beam waveguide (6).

The present invention proposes that this large (and very expensive) horn be replaced by a relatively small horn (18) which produces a beam having a relatively wide angle of divergence. By using a concave reflector (22) and a sub-reflector (21) in Cassegrain configuration this widely diverging beam is converted into a more nearly parallel (or a totally parallel) beam which enters the beam waveguide (6) as illustrated.



Beam waveguide feed for Antenna

This invention relates to apparatus for feeding electromagnetic signals, particularly in the microwave and radio frequency areas of the spectrum between, on the one hand a reflector belonging to an antenna and, on the other hand, transmitting and/or receiving equipment for delivering signals to or receiving them from the antenna.

Particularly when large reflectors are required, such as is normal for satellite communication systems, it is necessary for practical reasons that the transmitting and/or receiving equipment be at ground level whilst the reflector be raised above ground level. An ordinary waveguide provided with rotating joints can be used for feeding energy between the equipment on the ground and the reflector but such waveguides are inefficient in that much of the energy is lost during transmission along them. It is therefore generally preferred to use what is known as a "beam waveguide" which is defined for the purpose of this Specification as an arrangement of reflectors designed to direct radiation along a desired path.

A typical known apparatus of the type described above is shown very schematically in Figure 1 of the accompanying drawings. Referring to Figure 1 there is shown a building 1 which houses microwave signal detecting and generating equipment 1A. Microwave energy passes from 1A along a short waveguide 2 which terminates in a large corrugated radiating horn 3. This emits a beam 4 of radiation which diverges from point 5 inside the mouth of the horn with an angle of divergance (a).

The diverging beam 4 enters a beam waveguide 6 mounted on a support structure 7 which has wheels 8 riding on a circular track 9. The support structure 7 and the beam waveguide 6 can thus be rotated about a vertical axis X-X. The means for effecting such rotation is not illustrated in the drawing.

The beam waveguide 6 has a lower tubular portion containing a flat reflector 10 from which the diverging beam 4 is reflected to a parabolic reflector 11. The latter has its focus at or near point 5 and therefore produces an essentially parallel beam which is directed to another parabolic reflector 12. The reflector 12 brings the beam to a focus at point 13 after reflection from a flat reflector 14. The beam, now diverging again, is scattered from a sub-reflector 15 to a main reflector 16 from where the signals are transmitted into the atmosphere or into space if the apparatus is located in an extra terrestrial position.

The main reflector 16 has support arms 17 pivotted about a horizontal axis Y-Y to the support structure 7. The beam waveguide 6 is divided as indicated at 6A into upper and lower parts so as to enable the upper part to rotate with the reflector 16 about the axis Y-Y. The means for rotating the reflector 16 about the horizontal axis Y-Y is not shown in the drawing. By selecting the appropriate positions of rotation about the axes X-X and Y-Y the reflector 16 can be made to point in any desired direction.

In arrangements such as shown in Figure 1 the horn 3 needs to radiate most of the energy within a narrow angle (a), so that an acceptable proportion of the energy is incident upon reflectors 10 and 11. In order to achieve a small angle (a) the horn must be very large, possibly several metres high. The horn is therefore very expensive, particularly if, as is usually the case, the horn is internally corrugated along its entire length.

This invention provides apparatus for transmitting or receiving electromagnetic signals comprising a path for the signals extending: from a signal generator or detector to a member located in front of a concave reflector; from the said member to the concave reflector;

from the concave reflector, past opposite sides of the said member to a beam waveguide; and from the beam waveguide to a main reflector.

5 The concave reflector provided by this invention enables a widely diverging beam, from for example a small horn, to be converted into a beam having a smaller angle of divergance, such as would be obtained from a large horn. The cost of the conventional large horn is thus substantially eliminated at the expense of a relatively
10 inexpensive concave reflector. The concave reflector can be designed to give a beam having as small an angle of divergance as may be required or even a parallel beam or a converging beam. The invention therefore makes it possible in cases to eliminate the need for concave
15 reflectors in the beam waveguide thus further reducing the cost of the system.

The aforementioned comments with regard to the angle of divergance of the beam refer to the system when operating as a transmitter. Similar comments of course
20 apply to the apparatus when operating as a receiver in which case the aforementioned angle of divergance will be the angle of convergance.

The said "member" can be a relatively small horn positioned in front of the concave reflector and directed
25 towards the latter. However, such a horn requires a waveguide feed which, because of its necessary cross-sectional area, obstructs to a significant extent the path between the concave reflector and the beam waveguide. It is therefore preferred that the said "member" be a
30 sub-reflector positioned axially in front of the concave reflector and arranged so that the said path passes through an aperture in the centre of the concave reflector between the sub-reflector and a horn or equivalent member located behind the concave reflector.

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A sub-reflector as described above can be supported on relatively slender supports which do not present any significant obstacle to the passage of radiation along the aforementioned path.

An example of how the invention may be performed will now be described with reference to Figures 2,3 and 4 of the accompanying drawings in which:-

Figure 2 is a schematic vertical cross-section through apparatus constructed in accordance with the invention;

Figure 3 is similar to Figure 2 but shows a modification; and

Figure 4 is a more detailed view of part of the apparatus shown in Figure 3.

Referring firstly to Figure 2, this apparatus has components 1,1A,2,6,7,8,9,10,11,12,14,15,16 and 17 identical to those shown in Figure 1. Of these only components 10 and 11 and part of component 6 are shown in Figure 2. The large horn 3 of Figure 1 is replaced, in Figure 2, by a small horn 18 which emits, or receives, a beam 19 whose angle of divergance, or convergance, is denoted by the letter (b). This angle (b) is much greater than the corresponding angle (a) of Figure 1 because of the smaller horn size. The beam 19 passes through a central aperture in a concave reflector 20 behind which the horn 18 is situated. The beam is then reflected from a sub-reflector 21 onto the front of the concave reflector 20.

The concave reflector 20 is elliptical in section having one focus at the point 5, which is the same as the point 5 shown in Figure 1; and its other focus at a point 5A.

The convex reflector 21 is hyperbolic in section, having one focus at 5A and its other focus at 5B inside the mouth of the horn 18. Accordingly, the beam

eflected from the reflector 20 is brought to a focus at point 5. The angle of convergance and divergance at point 5 is chosen to be equal to the angle (a) of Figure 1 so that after passing point 5 the beam behaves exactly as described with reference to Figure 1. The apparatus depicted in Figure 2 can thus be used as a direct replacement for the large horn 3 of Figure 1 without the need arising for any other modifications to the equipment.

Figure 3 shows an apparatus similar to that of Figure 2 but modified by the replacement of the elliptical reflector 20 by a parabolic reflector 22 having its focus at the point 5A. This produces a parallel beam which is directed into the beam waveguide 6. Since the beam is parallel there is no need for curved reflectors in the beam waveguide. Thus the reflectors 11 and 12 of Figure 1 can be replaced by planar reflectors such as shown at 11A.

In order to avoid any reduction in efficiency of the system by obstruction of the beam by the sub-reflector 21, the latter is preferably shaped so that it directs no radiation, or a relatively low intensity of radiation to the central portion of the reflector 22. This is illustrated in Figure 4 where regions of the beam having maximum intensity values are shown by the shaded areas. From Figure 4 it is apparent that the sub-reflector 21 is effective to shape the beam 4 into an annular configuration which is incident on the part 23 of the reflector 22 but not to a substantial extent on the central part of this reflector. As a consequence the sub-reflector 21 does not, to a substantial extent, obstruct energy flowing between the concave reflector 22 and the beam waveguide.

CLAIMS:

1. Apparatus for transmitting or receiving electromagnetic signals comprising a path for the signals extending: from a signal generator or detector to a member located in front of a concave reflector; from the said member to the concave reflector and past opposite sides of the said member to a beam waveguide; and from the beam waveguide to a main reflector.
2. Apparatus according to claim 1 in which the said member is a sub-reflector and in which that part of the path which extends from the transmitter or receiver to the sub-reflector passes through an aperture in the concave reflector to a sub-reflector and thence to the said concave reflector.
3. Apparatus according to claim 2 in which the said part of the path includes a horn located behind the concave reflector and pointing through the aperture towards the sub-reflector.
4. Apparatus according to claim 2 or 3 in which the sub-reflector is shaped so that the said path extends past opposite sides of the sub-reflector but is not to a substantial extent intercepted thereby.

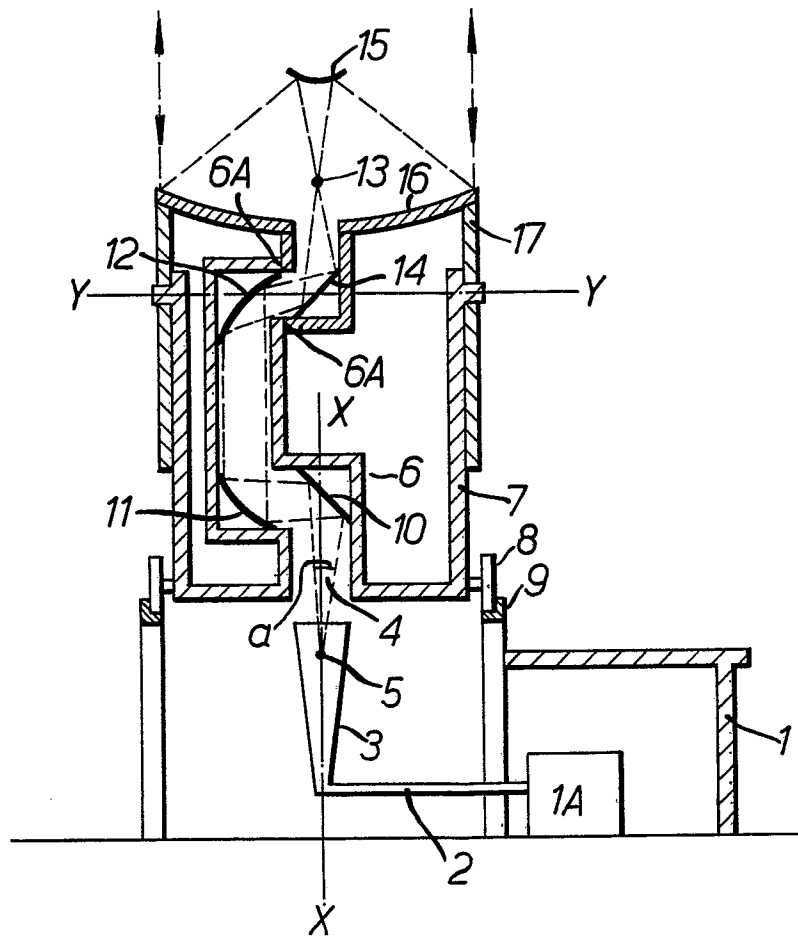


FIG. 1.

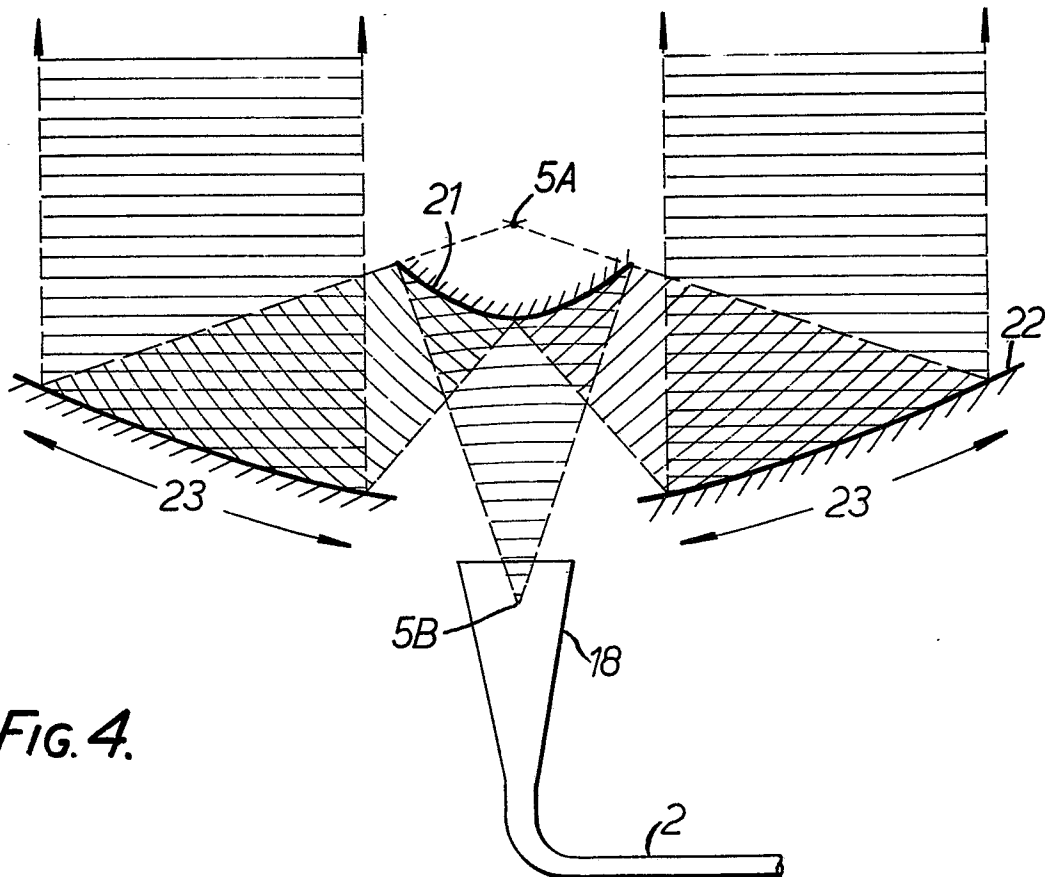


FIG. 4.

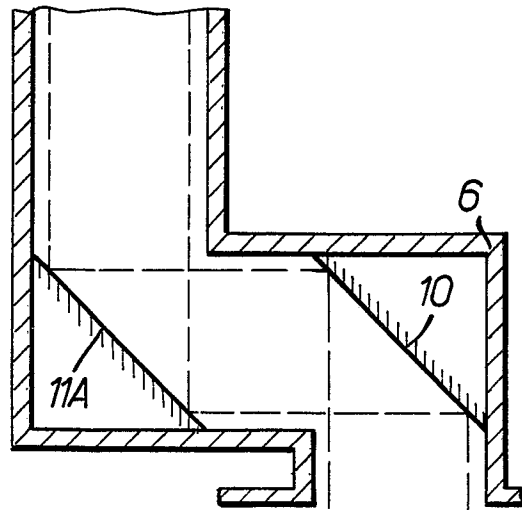
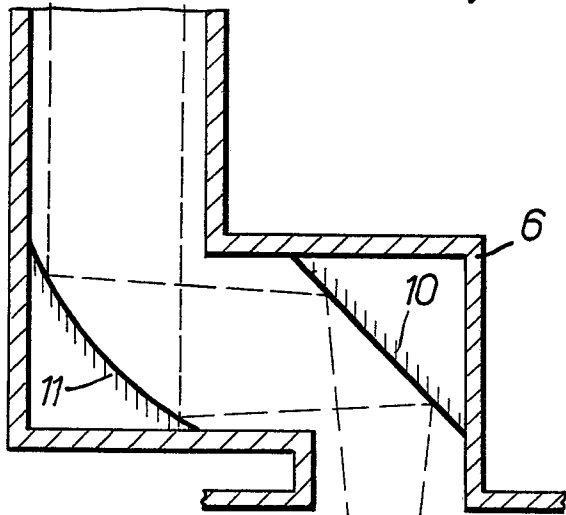


FIG. 2.

FIG. 3.

