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## (54) Antenna reconfigurable with respect to frequency, coverage and polarisation.

(57) Antenna to be reconfigured as to frequency, covering, polarization or function (table 1), mainly consisting in a system for the generation of a primary beam (B) and optionally of an optics (A) which alone can effect, in succession, missions which are different as to frequency bands and/or polarization and/or covering (i.e. as to form and/or width of the irradiated beam). Said antenna can effect an automatic following which may be present in one or in all of the missions.

The simultaneous working at two different frequencies may be carried out by the use of a sistem for the generation of the primary beam having a dichroic reflecting surface.

The invention may be used in civilian and military fields. It may further be used in movable and/or in stationary sistems and in space sistems.

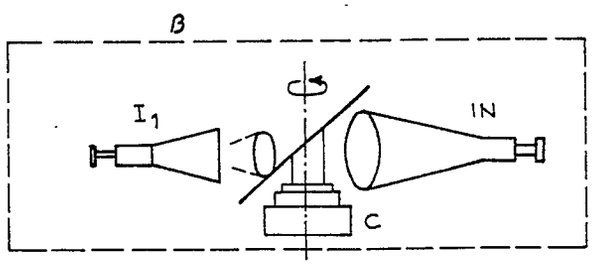


FIG. 6

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# Antenna to be reconfigured as to frequency, covering and polarization

The present invention relates to an antenna which may be reconfigured as to frequency, as to polarization, as to covering, i.e. which is able to change, in a control led manner, the operation frequency, the polarization, the form and the width of the irradiated beam and which can carry out the automatic following, when necessary.

Because of the flexibility, the simplicity and the compactedness of the reconfiguration sistem, the invention is superior than other sistems which can achieve the same objects.

The invention mainly consists in a sistem of a rotating mirror which makes it possible to select the illuminator which is the most suitable for the requested mission (e.g. see table 5).

The rotating mirror may be plane or curved, depending on the field of application. For some applications, e.g. the illustration system of an onset antenna with a double reflector, it is useful to employ as a mirror part of an ellipsoid having a focus Ei (i between 1 and N) which coincides with the phase centre of the active illuminator Ii (i between 1 and N) and the second focus EN + 1 on the optics axis, as illustrated on table 3.

The illuminators may be simple or complex, as for instance bands of sources having beam forming nets.

The antenna according to the invention consists of a unit for the generation of the commutable primary beam B which is to be considered the most significant part of the invention, and of the optics A which may be omitted in some applications and which is to be considered optional.

The sistem in question makes it possible to obtain, with a relatively compact unit, N missions which usually would require N separate antennas.

The usual automatic following tecnologies may be present where necessary.

In some applications, the reflecting surface 10 (table 2) of the unit for the generation of the primary beam may be a dichroic surface 10A (table 2) instead of a totally reflecting surface, or a reflecting surface having a form which is different from a plane (table 3).

The commutable primary generator B (table 2) consists of so many illuminating units, from I1 to In, as there are the types or type families of beams which should be generated, and of a commutation unit C.

The commutation unit itself consists of a reflecting surface (totally or selectively reflecting) at radio-frequency, of an actuator and of a supporting system.

The actuator has a motor device ("stepper" or direct current d.c or any other movement generator including manual operation), a system for the movement transmission (e.g. a revolution reduction unit with play compensation, or a crank mechanism etc.) and, optionally, a system to detect the action position of the reflecting suface (optical encoder, "syncro", inductosyn R , potentiometer system, notches and release system, etc.).

In case the commutable primary generator is provided with a selectively reflecting surface, said generator allows continuous operation with a different choice between the commutable Ns.

In the scheme of said commutable primary generator are evident three points which have to be observed in order to assure a correct operation (see table 4):

a. The mirror has to rotate around the axis Z of the illuminator, equivalent to the originary optics.

b. The locus of the axes Hi (i between 1 and n) of the single illuminators Ii (i between 1 and n) is a cone having:

- an axis that coincides with the axis Z of the equivalent illuminator
- an apex V determined by the intersection of the axis Z of the illuminator equivalent with the plane (10,10A or 10B) of the reflecting surface
- semiaperture equal to the double of the angle between the normal line N in the apex V of the reflecting surface and the axis Z of the equivalent illuminator.

c. The illuminators Ii (i between 1 and n) must have the phase centres Ei (i between 1 and n) equally spaced from the apex V of the cone as defined in point b, by a distance equal to the distance between the focus Fe of the optics and the intersection V of the reflecting surface with the axis Z of the equivalent illuminator.

The invention will now be described with reference to some of its preferred and not limiting embodiments (table 1) and to the tables of which table 2 is the most significant.

Table 1 illustrates the antenna according to the present invention in which:

Figure 1 shows the antenna with a direct radiation of the primary beam. B is the system for the production of the primary beam explained in figure 6 in which I1 ... In indicate the n illuminators (primary sources) and C indicates the commutation unit, explained in table 2.

Figure 2 shows a reflector antenna of the single offset type in which S1 means the reflecting surface.

Figure 3 shows a double reflector antenna of the onset-cassegrain type in which S2 and S3 are the reflecting surfaces.

Figure 4 shows a double reflector antenna of the offset type in which S4 and S5 are the reflecting surfaces.

Figure 5 refers to an antenna having a plurality of reflectors of the beam - waveguide type where S6 and Sm are the reflecting surfaces.
(A means the optics and appears in figures 2 to 5).

Figure 6 is a schematic illustration of the system for the production or formation of the primary beam.

Table 2 illustrates two diagrams of the commutable generator as explained in the following:

Figure 7 is a schematic illustration of a commutable primary generator in case a totally reflecting surface 10 is used. It is shown a commutation unit C in which 20 indicates the support for the reflecting surface that, because of its structure, enables the rotation, 30 is the system for the transmission of motion, 40 means the system for generating the motion, and 50 indicates the system for detecting the position of the reflecting surface which may occupy various positions, e.g. 50A, or which may be totally absent (optional).

Figure 8 illustrates schematically the commutable primary generator in case of a dichroic reflecting surface. Said dichroic surface is indicted at 10A, and F means an illuminator which is able to always illuminate the optics A, because the dichroic surface will be transparent at its operation frequency. In this configuration the illuminators I1 ... In must work at such a frequency that the dichroic surface is reflecting.

Table 3 shows schematically the antenna in case the commutable primary generator is provided with a reflecting surface 10B made up of part of an ellipsoid having one focus in point (En + 1) and the other focus, at any one time, in the phase centre (Ei, i between 1 and n) of the activated illuminator. When the position of the reflecting surface is changed over towards one of the illuminators, the combined primary source will be activated.

Table 4 indicates the position the commutable illuminators have to occupy.

Figure 9 shows the axis Z of the illuminator, which is equivalent with the phase centre that coincides with the focus of the originary optics Fe.

Figure 10 schematically indicates the position of the phase centres of the commutable illuminators. V is the intersection of Z with the reflecting surface of the commutable generator (10 or 10A or 10B). N is the normal line through V of the surface 10 or 10A or 10B, $\beta$ is the angle between Z and N and is the semiaperture of the cone, locus of the axes of the single commutable illuminators.

Table 5 is a pictorial illustration indicating an offset antenna having a primary generator commutable into five positions, two of them are shown.

The present invention allows the selection of the illuminator which is most suitable for the requested mission. Only one antenna having a plurality of selectionable illuminators can satisfy, in succession, different missions. If requested, the single illuminators may be designed such that an automatic following of the antenna is possible, adopting usual technologies.

In case of the configuration illustrated in figure 3, point EN + 1 is the virtual source of the illuminator; in such a way, the diameter requested for the bore in surface S3 serving for locking the optics is reduced.

The invention is superior to usual solutions because it does not burden the complexity of the illuminator since it is, on the contrary, based on different and dedicated units, each of them relatively simple. Classic examples of application are multifrequency antennas and antennas having a reconfigurable covering in order to allow the adaption to the telecommunication requirements, the optimization for different orbital positions of a satellite, etc.

## Claims

1. Antenna to be reconfigured as to frequency, covering, polarization and mission, provided with a system to generate a commutable primary beam, made up of a plurality of illuminators, characterized in the presence of a totally or partially reflecting surface that effects the commutation between the various illuminators available, such that in one single antenna are associated different functions for frequency and/or covering and/or polarization and/or automatic following and/or mission target, e.g. in the field of telecommunication, radar, radiometry, radioastronomy, direction finding.

2. Antenna as claimed in claim 1, wherein said antenna is provided with a commutation unit (B) made up of n illuminators conveniently positioned, and with a commutation unit (C) made up of a surface (10) totally reflecting at radiofrequency, a support (20) for the surface such that said surface may rotate around the axis of propagation of the desired primary beam, a system (30) for the transmission of motion from a motor (40) to said surface (10), and optionally a system (50) for detecting of the actual position of the reflecting surface.

3. Antenna as claimed in claim 2, wherein the surface (10A) of the commutation unit (C) is selectively reflecting at radiofrequency, such that the

(n + 1)st illuminator (F) may always be active, the surface (10A) being transparent at the radiation of said illuminator.

4. Antenna as claimed in claim 2 or 3, having said commutation unit for the primary beam, provided with reflecting surfaces which are different from a plane, e.g. part of an ellipsoid.

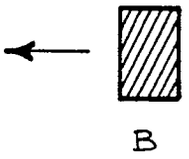



FIG.1

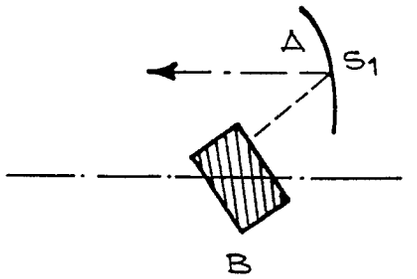



FIG.2

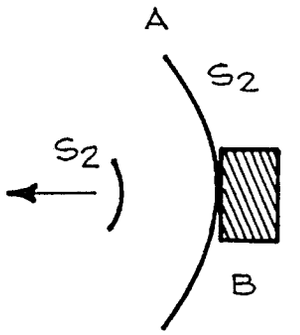



FIG.3

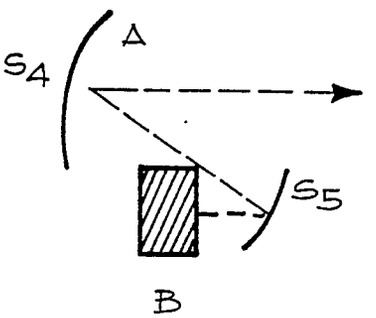



FIG. 4

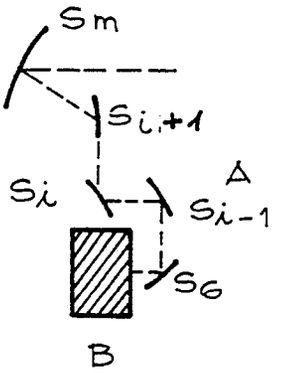



FIG.5

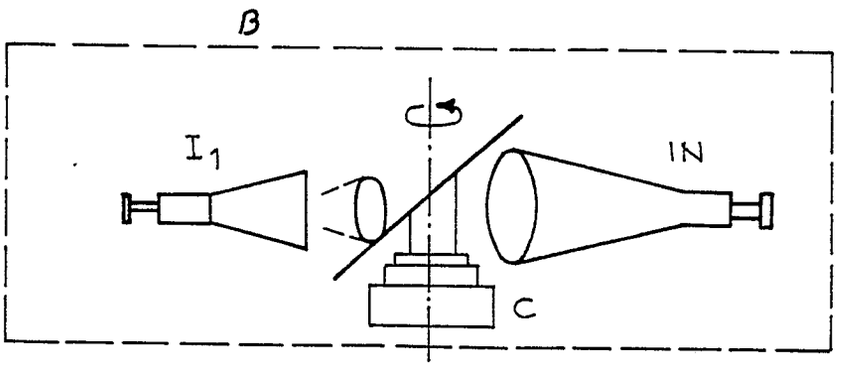



FIG. 6

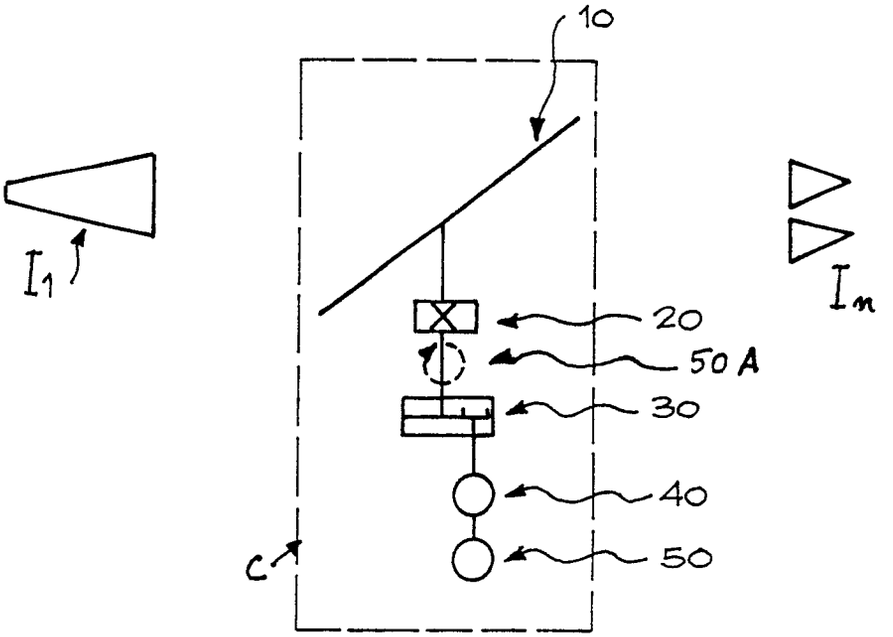



FIG.7

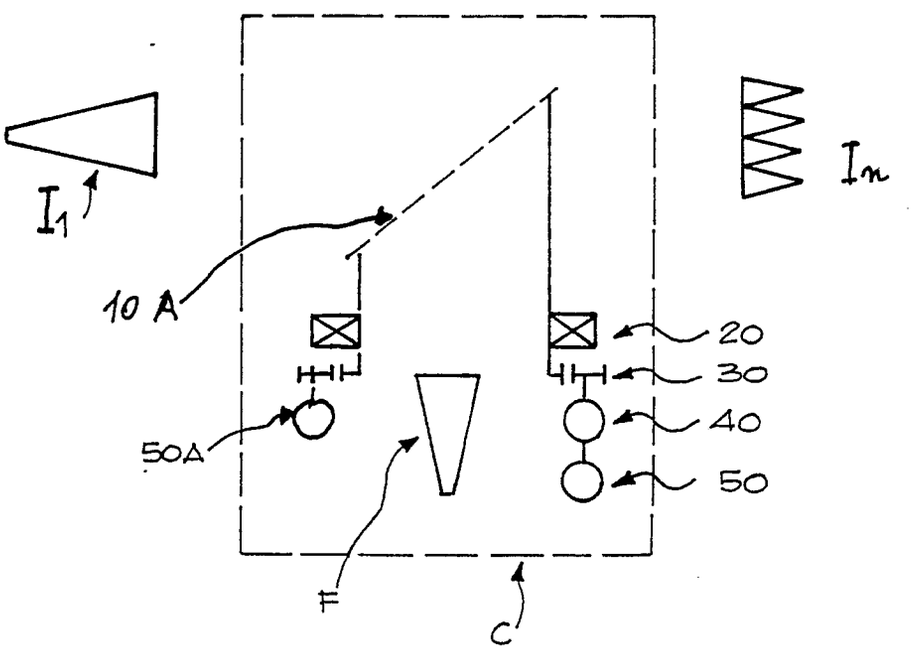
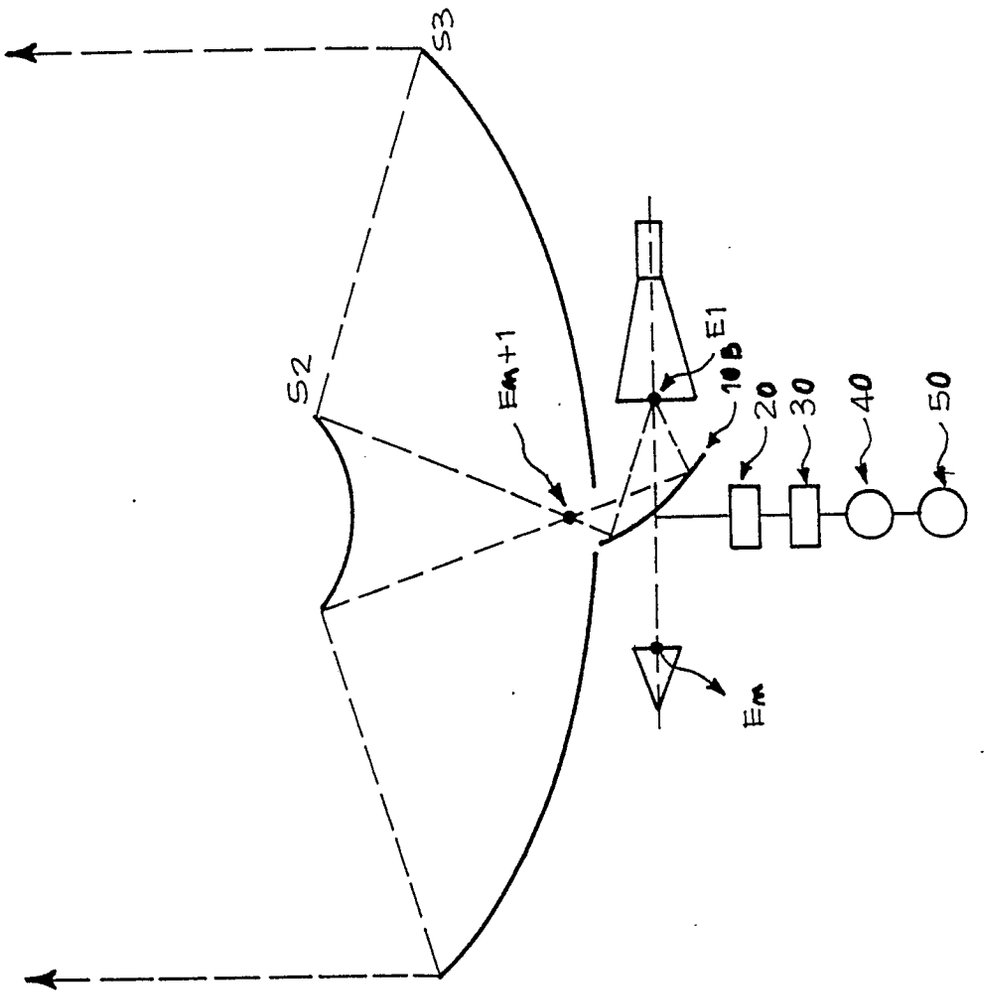



FIG.8


S3
S2
Em+1
E1
10
20
30
40
50
Em

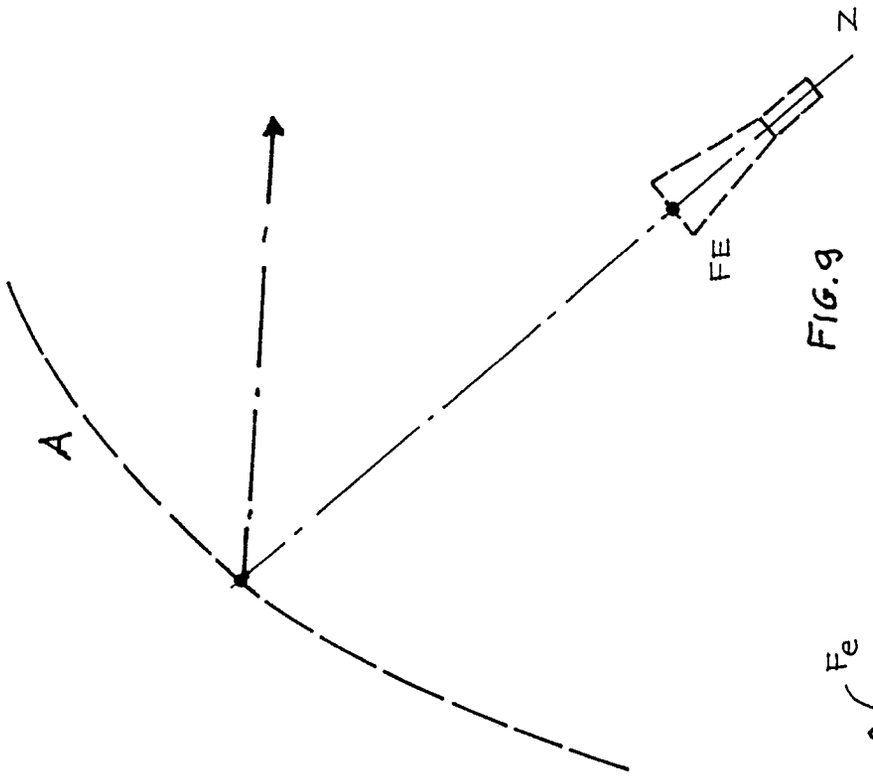



FIG.9

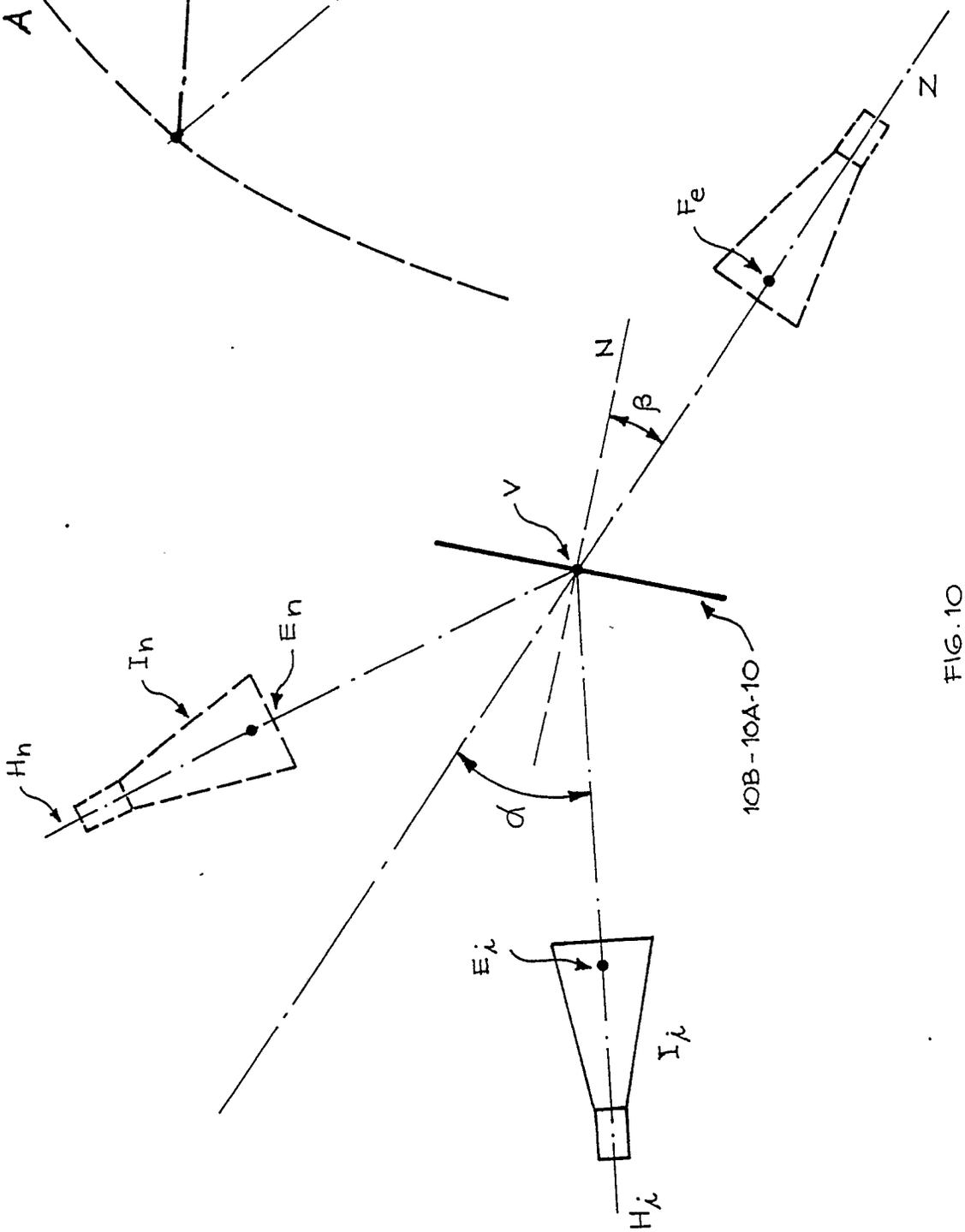



FIG.10