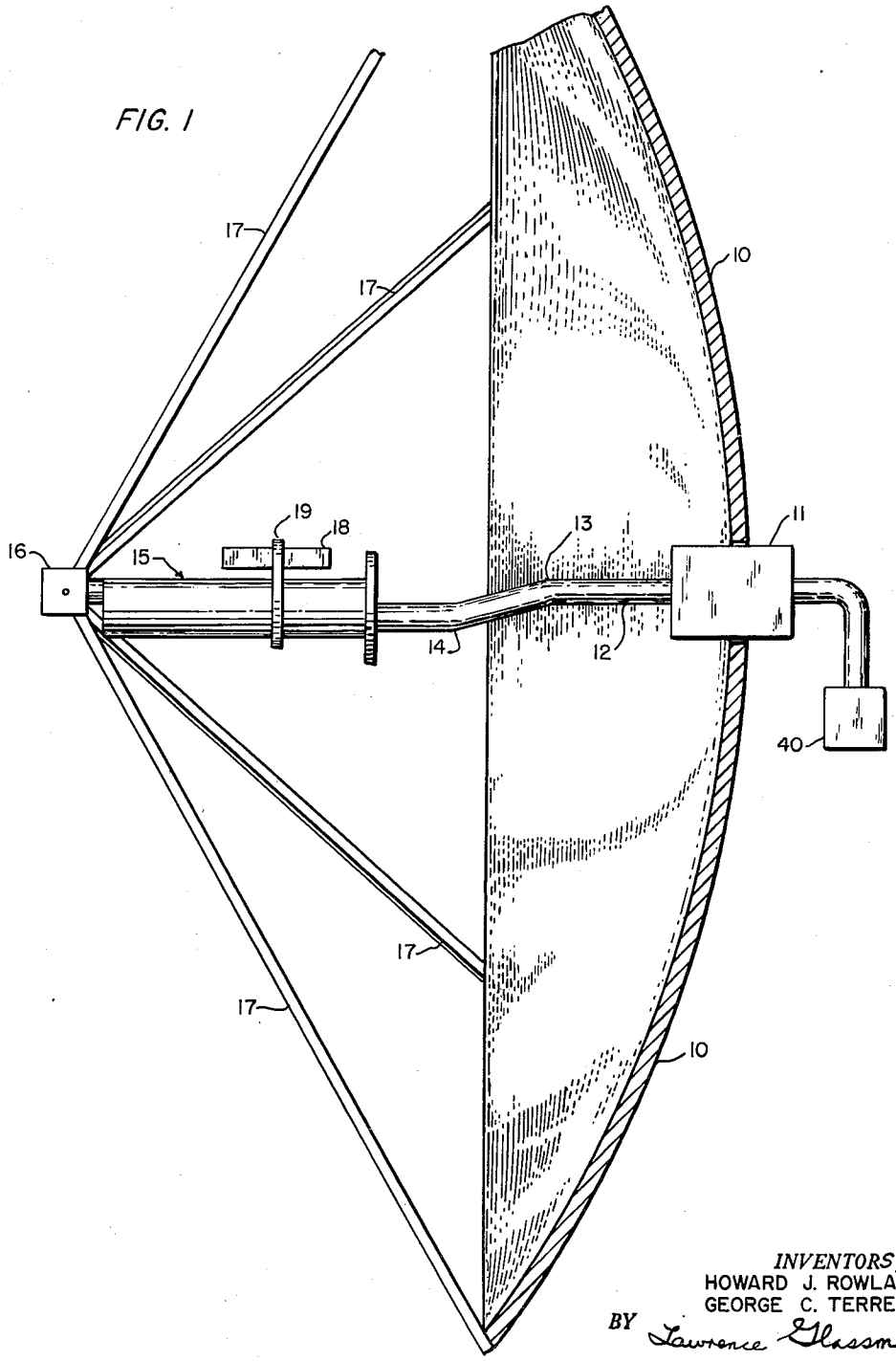
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FIG. 1



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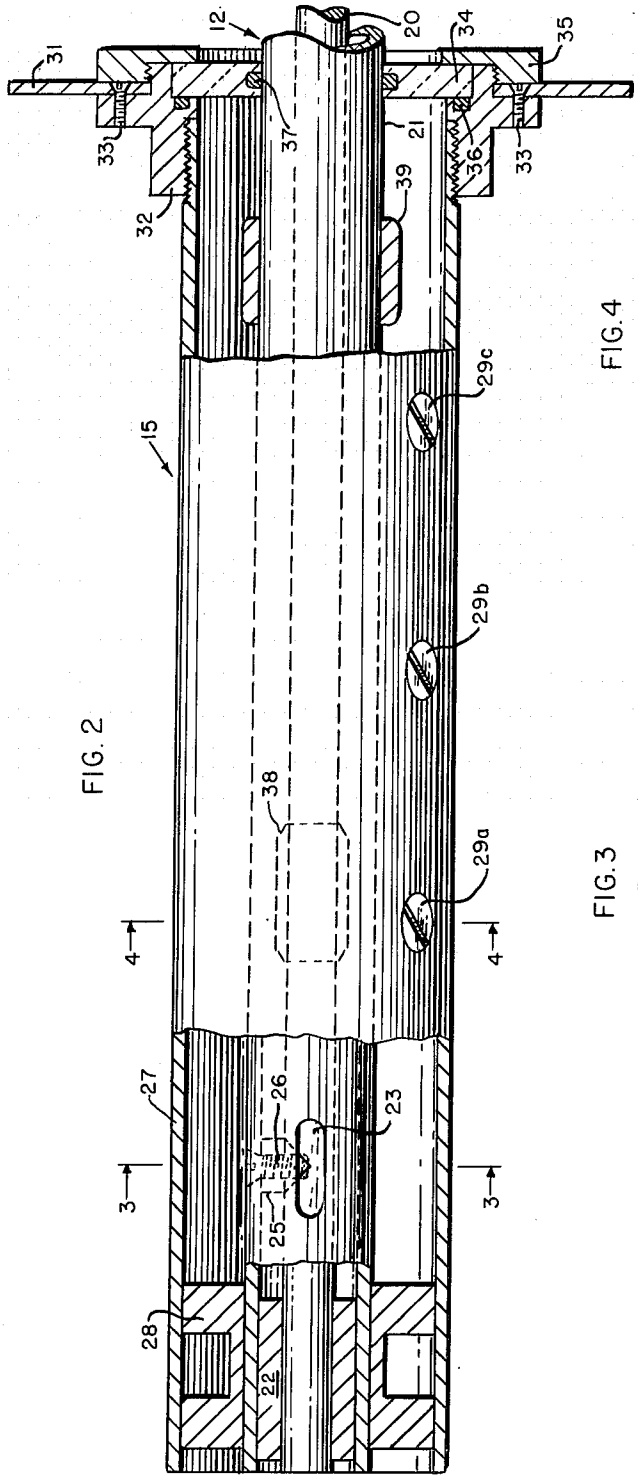


FIG. 2

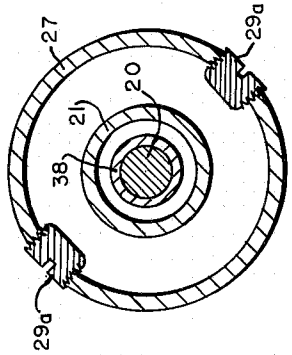


FIG. 4

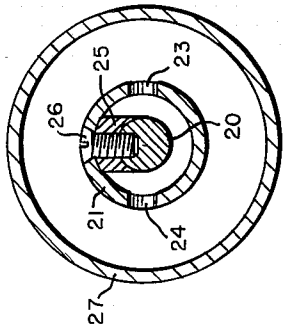


FIG. 3

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Patented Nov. 16, 1954

2,694,778

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Application May 29, 1953, Serial No. 358,294

9 Claims. (Cl. 250—33.65)

Our invention relates to a radio antenna fed from a coaxial line which is capable of radiating a circularly polarized wave. The use of an antenna fed from a coaxial line is well known. For example, one well known radio object locating system employs a dipole fed from a coaxial line to illuminate a paraboloidal reflector. The dipole is offset from the axis of the reflector and revolved to produce a conical beam in a well known manner. However, this system radiates a linearly polarized wave. In many applications in communications and radio object locating systems a circularly polarized wave is more suitable.

Accordingly, it is an object of our invention to provide an antenna which will radiate a circularly polarized wave.

Another object of our invention is to provide an antenna which will radiate circularly polarized wave and which may be readily energized from a coaxial line.

Still another object of our invention is to provide an antenna in which the polarization of the wave may be readily adjusted to a linear polarization, a circular polarization or elliptical polarization.

A still further object of our invention is to provide an antenna which is adapted to be located near the axis of a reflector and revolved to produce a conical beam.

Briefly, the antenna of our invention comprises a short section of coaxial line short circuited at one end and closed by a dielectric window at the other end. The inner conductor of this line is also the outer conductor of a coaxial line connected to the source of energy. The outer, larger line is energized by means of slots in the inner conductor (which is the outer conductor of the feed line). Polarization is changed from linear to circular by means of several pairs of lumped susceptances.

For a more complete understanding of the invention reference may be made to the accompanying drawing in which Figure 1 is a schematic view of the antenna of our invention used to illuminate a paraboloidal reflector; Figure 2 is a view partly in elevation and partly in section showing the antenna in more detail; Figure 3 is a view in section taken along the line 3—3 of Figure 2; and Figure 4 is a view in section taken along the line 4—4 of Figure 2.

Figure 1 shows a portion of a section of paraboloidal reflector **10**. At the vortex of the reflector is an assembly **11** including a motor and suitable rotating joints for rotating a coaxial feed line **12**. Coaxial line **12** is bent at points **13** and **14** and supports the antenna, generally indicated by the numeral **15**, at a location slightly offset from the axis of the reflector. The antenna **15** is supported at its other end by bearing housing **16** which is in turn supported from the rim of the reflector **10** by means of a plurality of guy rods **17**. Since the antenna is to be rotated and is offset from the axis of rotation, it is counterweighted by means of a weight **18** secured to the antenna by a bracket **19**. When the motor in assembly **11** in energized, antenna **15** will revolve about the axis of the reflector to produce a conical beam.

Referring now to Figure 2, coaxial line **12** consists of an inner conductor **20** and an outer conductor **21**. These conductors are short circuited at the end of line **12** by means of a hollow cylindrical plug **22**. At a distance of the order of a quarter of a wavelength from the end of plug **22**, outer conductor **21** is provided with two diametrically opposite slots **23** and **24** (also shown in Figure 3). At the same distance from the plug **22** the inner conductor **20** is connected to outer conductor **21** by means of a shorting stub **25** which is at right angles to a line

connecting slots **23** and **24**. This stub **25** may be secured to outer conductor **21** by any suitable means such as a machine screw **26**. Spaced from and surrounding outer conductor **21** is a tubular conductor **27**. Conductor **27** is mounted so as to be rotatable about its axis and may be fastened in any desired angular position. Conductor **27** comprises the outer conductor of a second coaxial line of which the inner conductor is conductor **21**. This outer coaxial line is short circuited by means of a hollow cylindrical plug **28**, located approximately opposite to plug **22**, at a point on the order of a quarter of the air wavelength from the center line of slots **23** and **24**. Plug **28** serves also to position conductor **27** concentrically about conductor **21** while allowing conductor **27** to be rotated about its axis. Conductor **27** is provided with a pair of metallic rod-like elements **29***a* which protrude into the space between conductors **21** and **27**. Elements **29***a* may be threaded into conductor **27** and constitute adjustable lumped susceptances. As best shown in Figure 4, members **29***a* are opposite to each other, and when adjusted for circular polarization, a line connecting them makes an angle of 45° with shorting stub **25**. Another pair of lumped susceptances **29***b* is located at an axial distance of approximately a quarter of a guide wavelength from pair **29***a* and lies in the same longitudinal plane. A further pair of susceptances **29***c* is located approximately a quarter of a guide wavelength from the second pair **29***b* and is in the same longitudinal plane. At the open end of conductor **27**, there is a circular metallic plate **31**, which may be secured to member **27** by any suitable means. As illustrated in Figure 2 this means may comprise a nut **32** threaded on conductor **27** and a plurality of machine screws **33** threaded into nut **32**. The space between outer conductor **27** and inner conductor **21** is closed by means of dielectric window **34** which may be secured by means of a nut **35** threaded onto nut **32**. Window **34** aids in positioning conductor **27** concentrically about conductor **21**. A gasket **37** may be located between window **34** and conductor **21** and another gasket **36** may be placed between window **34** and nut **32**. These gaskets make the seal between conductors **21** and **27** air tight so that the entire antenna and feed line may be pressurized, if desired.

In operation, coaxial line **12** is energized from any suitable source such as the source **40** shown in Figure 1 so as to propagate a wave in the TEM mode. Slots **23** and **24** together with shorting stub **25** cause the outer coaxial line consisting of members **21** and **27** to be excited in the TE_{11} mode. The discontinuity presented by slots **23** and **24** and shorting stub **25** may be compensated for by means of a transformer **38** surrounding inner conductor **20** approximately one half wavelength from the slots. The linearly polarized TE_{11} wave in the outer coaxial line may be thought of as consisting of two components at right angles to each other. For circular polarization, susceptances **29***a*, **29***b* and **29***c* are placed at an angle of 45° to stub **25** so as to retard the phase of one component while leaving the phase of the other component unchanged.

It has been found that three pairs of susceptances placed as previously described and properly adjusted are sufficient to retard one component of the wave by 90°. As a result the two components are 90° apart in space and also 90° apart in phase. A circularly polarized wave is therefore produced and radiated through window **34**. The change in impedance due to window **34** may be compensated for by means of a transformer comprising a metallic band **39** placed around conductor **21**.

Figure 4 shows conductor **27** and susceptances **29***a*, **29***b* and **29***c* angularly positioned so as to resolve the linearly polarized wave into two components. If conductor **27** be positioned so that the susceptances **29***a*, **29***b* and **29***c* are parallel to shorting stub **25**, the linearly polarized wave will be uniformly retarded and a linearly polarized wave will be radiated. If the angle between the susceptances and shorting stub **25** is between 0° and 45°, an elliptically polarized wave will be radiated. At one of the 45° positions a right hand circularly polarized wave will be produced, while at the other 45° position, a left hand circularly polarized wave will be produced.

While a specific embodiment of the invention has been

described, it is obvious that numerous modifications can be made within the scope of the invention.

What we claim as our invention is:

1. An antenna for radiating a circularly polarized wave comprising: a coaxial line including inner and outer conductors, said outer conductor being terminated at the point at which energy is to be radiated; means for exciting said line to propagate a linearly polarized wave; and means within said coaxial line for changing the polarization from linear to circular.

2. An antenna for radiating a circularly polarized wave comprising: a coaxial line including inner and outer conductors, said outer conductor being terminated at the point at which energy is to be radiated; means for exciting said line to propagate a linearly polarized wave; and a plurality of pairs of diametrically opposite rod-like elements, constituting lumped susceptances, adjustably secured to the inner surface of the outer conductor of said coaxial line for changing the polarization from linear to circular.

3. An antenna according to claim 2 further comprising a metallic reflector surrounding said outer conductor at its termination.

4. An antenna according to claim 3 further comprising a dielectric window for closing the space between said inner and outer conductors in the plane of the termination of said outer conductor.

5. An antenna for radiating a circularly polarized wave comprising: an open ended, hollow, conductive tube; a coaxial feed line extending into said tube on its center line and terminating at one end of said tube; a first cylindrical plug for short circuiting said tube to the outer conductor of said coaxial line at said one end of said tube; a second cylindrical plug for short circuiting the end of said coaxial line; a pair of slots in the outer conductor of said coaxial line located approximately one quarter of a wavelength from said second plug; and means on said conductive tube for changing the wave from a linear to a circular polarization, whereby a circularly polarized wave will be radiated from the other end of said tube.

6. An antenna according to claim 5 in which the means for changing the polarization comprises a plurality of pairs of metallic rod-like elements, constituting lumped susceptances, adjustably secured to the inner surface of said conductive tube.

7. An antenna according to claim 6 further comprising a metallic reflector surrounding said other end of said tube.

8. Apparatus for exciting a circularly polarized wave in a coaxial line comprising a first coaxial line in which the TEM mode is propagated; a second coaxial line concentric with said first line in which the inner conductor of said second line is the outer conductor of said first line; slot means in the outer conductor of said first line for exciting a linearly polarized wave in second line; and a plurality of lumped susceptances on the inner surface of the outer conductor of said second line for changing the polarization from linear to circular.

9. Apparatus for exciting the TE_{11} mode in a coaxial line comprising a first coaxial line in which the TEM mode is propagated; a second coaxial line concentric with said first line in which the inner conductor of said second line is the outer conductor of said first line; a pair of diametrically opposite slots in the outer conductor of said first line; a shorting stub in the same axial plane as said slots and at right angles to said slots for connecting the inner and outer conductors of said first line; means for short circuiting said first line approximately one quarter of a wavelength from said slots; and means for short circuiting said second line approximately one quarter of the air wavelength from said slots.

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