

Aug. 30, 1949.

J. H. IRVING

2,480,189

ANTENNA SYSTEM

Filed Oct. 30, 1944

FIG-2

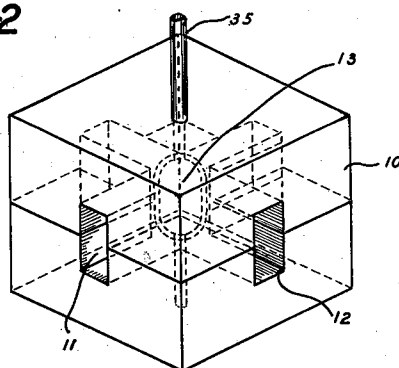


FIG-3

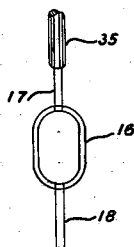
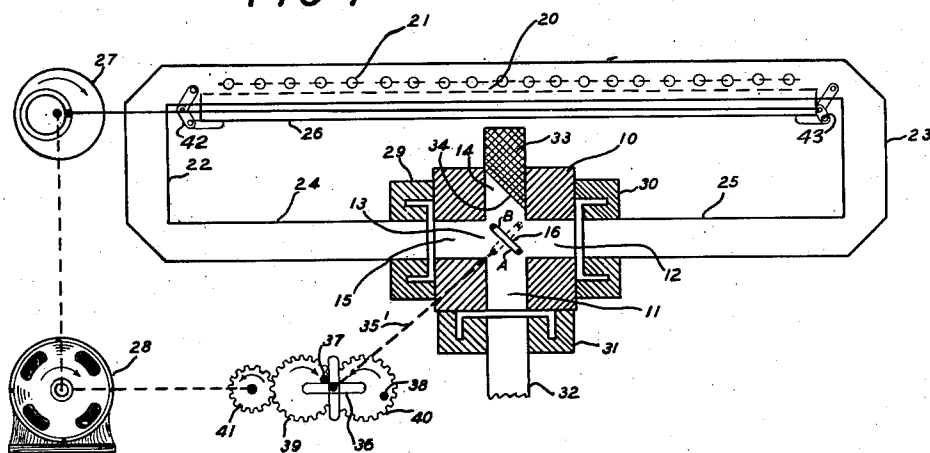


FIG-1



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2,480,189

ANTENNA SYSTEM

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6 Claims. (Cl. 250—33.63)

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The present invention relates to a switch assembly for high frequency energy currents which is particularly adapted to operate in connection with an electrically scanning antenna system of the kind having a variable-width wave guide with a series of dipoles aligned along its length, which is disclosed in the application of Luis W. Alvarez, Serial No. 509,790, filed November 10, 1943.

In such a system, electrical scanning is achieved by varying the wide dimension of the variable-width wave guide. The range through which such scanning is possible may be practically doubled by scanning with the transmitter energy fed first from one end of the wave guide and then from the opposite end of the wave guide.

It is one of the objects of the present invention to provide an antenna system having such an increased scanning range. The foregoing is achieved by providing means for switching energy into alternate ends of the wave guide associated with the antenna elements.

It is also an object of this invention to provide a switch adaptable for switching high frequency currents into alternate paths whenever such switching action is found desirable.

It is a further object of this invention to provide a reflector member which is adapted to oscillate from one position to another and thereby reflect energy from a feed wave guide to either of two oppositely disposed wave guides without presenting its plane perpendicular to the feed guide, thus obviating the possibility of reflecting energy back into the feed wave guide.

It is still another object of this invention to provide means whereby the terminal energy remaining at the distant end of an antenna array is directed into an absorbing medium.

These and other objects attained by the present invention will be more apparent from the following description, which while particularly directed to an antenna system of the kind referred to, is understood not to be limited to such a system.

In the drawings:

Fig. 1 is a diagrammatic showing of an antenna system illustrating one application of the invention and a sectional view of the switch assembly portion of the present invention;

Fig. 2 is an isometric view of the housing assembly or connecting block housing the switch portion of the invention; and

Fig. 3 is an elevation detail of the reflecting member used in the assembly of Figs. 1 and 2.

Referring to the drawings, the present switch in its simplest form consists of a resonant ring

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pivotaly mounted in a wave guide crossing. A crossing is formed by housing member or coupling block 10 which in its simplest form consists preferably of a generally cube-shaped member within which are intersecting wave guide channels 11 and 12, here shown as intersecting at right angles but which may intersect at any angle to form a region 13 within the housing member 10. The housing member or block 10 may be of any suitable material such as brass or copper and may be made in any suitable shape or fashion, such as in two parts as shown in Fig. 2.

It will be noted that the intersection or crossing of the wave guide channels 11 and 12 with their extensions 14 and 15 is an "electrical plane" crossing; thus the junction point between the two parts of the housing member or block 10 (when a two-part block is used) does not form a discontinuity in the current carrying wave guide walls.

Disposed within region 13 is an energy reflecting member 16 which may have bearing pins 17 and 18 journaled in suitable apertures in block 10. Thus member 16 is pivoted on an axis perpendicular to the axes of the wave guide channels 11, 12, 14 and 15 and located substantially at the center of the crossing or region 13.

The member 16 may consist of a resonant ring or loop or even a solid sheet of conducting metal, such as copper, and may be round or rectangular (or it may have some other shape, or indeed a resonant structure in some other shape which is not a ring at all, may be used), but in the rectangular wave guide system shown it is convenient to provide a resonant ring of generally rectangular form, as shown. The dimensions of the member 16 should be such as to resonate at the frequency of operation of the antenna or other system.

The member 16, as shown end-on in Fig. 1, is adapted to be rotated 90° to assume one of two positions, so that high frequency energy supplied through one of the channels, for example channel 11, may be reflected into channel 15, as shown, or into channel 12 when the reflecting member 16 is in the dotted line position. Also, member 16 is adapted to serve a second purpose by reflecting terminal energy into an absorbing medium. Thus when member 16 is in its solid line position, its surface A reflects the main feed energy into channel 15 and its surface B reflects remaining terminal energy from channel 12 into a channel 14 leading to an absorbing material as hereinafter more fully described. Similar ac-

tion takes place when the member 16 is in the dotted line position.

Referring particularly to Fig. 1, a wave guide 20 is shown upon which a series of aligned dipoles 21 are mounted. Wave guide 20 may have side sections 22 and 23 and elongated portions 24 and 25 forming a generally closed system.

Means are provided for varying the width of wave guide 20 as generally indicated at 26, such means may comprise a movable wall section 26 which is moved by the action of a cam mechanism 72 and toggles 42, 43, by a cam mechanism 27, driven by motor 28, or in any other suitable manner. Wall 26 and associated elements co-operate to accomplish the electrical scanning above referred to.

Wave guide portions 24 and 25 are preferably coupled together by means of the coupling block or switch housing member 10 described herein. Wave guide sections 24 and 25 are adapted to fit on opposite sides of block 10 so that their axes are co-linear with the axes of wave guide channels 15 and 12, respectively, and may be coupled thereto by choke flange coupling members 29 and 30 described and claimed in detail in the copending application of Winfield W. Salisbury, Serial No. 489,844, filed June 5, 1943, now Patent No. 2,451,876, issued October 19, 1948. The wave guide channel 11 in the block 10 may be coupled by coupling 31 to a feed wave guide section 32 for supplying high frequency to the system. Channel 14 may be terminated, as shown, by an energy absorbing section 33 having suitable material therein packed for absorbing radiant energy. Material 33 may be of some high resistance material such as carbon particles or sawdust, and may desirably be disposed in such manner as to provide a tapering or slant surface 34, as shown.

Reflector 16 has the property of not only acting upon the main incident energy supplied from wave guide section 32 but also acting upon the unused energy that has already passed through the radiating system proper. Thus, as shown in full lines, reflector 16 operates on energy coming into guide section 32 by diverting it to wave guide 24 and thence through wave guide section 22 and 20. Whatever energy remains after having passed through the length of section 20, continues on to wave guide section 23 and then 25 and is then reflected by the same member 16 into absorbing material 33. Material 33 merely functions as a load for absorbing undesired energy, it being essential that radiation from member 33 back to reflecting loop 16 be reduced to a minimum. Actually, because of the comparatively small amount of energy left to be handled by material 33, some reflection may be tolerated without undue harm.

It should be noted that reflecting member 16 is never in a plane perpendicular to the axis of feed guide 32 so that reflection back into the oscillator portion of the transmitter does not occur, thus avoiding adverse effect on the stability of the oscillator. To avoid this difficulty, reflector 16 is oscillated back and forth from one position to another and back again without going through the objectionable position referred to above. Thus, in operating the reflector 16, the turning motion carries the reflector through the position in which the plane of the reflector is aligned with the direction of the feed guide 32 and not through the position in which the plane of the reflector is at right angles to the direction of the feed guide 32. Thus as shown in Fig. 1

with the reflector 16 in the position indicated by solid lines, the plane surface A is shown diagonally with reference to the feed guide 32. The turning motion, in a clockwise direction from the solid line position to the dotted line position, then presents the surface B diagonally relative to the direction of the feed guide 32. The reverse turning motion, in a counterclockwise direction, again places the member 16 in the solid line position. It will be obvious that this oscillatory motion of 90° does not permit the plane or reflecting surface A or B to be positioned perpendicularly to the direction of the feed guide 32.

A simple form for obtaining this movement is shown diagrammatically. Thus reflecting member 16 may have a driving rod 35 coupled as indicated at 35' to a cross-shaped member 36. Cross-shaped member 36 is adapted to be moved by pins 37 and 38 carried by gears 39 and 40 driven by a suitable motor 28. Gears 39 and 40 are driven through a gear 41 at half motor speed (for timing or synchronizing with the means indicated generally at 26 and 27 herein mentioned for providing variation in the width of the wave guide.) It is clear that by virtue of this movement reflector 16 may be timed so that it will be moved quickly back and forth over a 90° range and then left undisturbed during a scanning operation until the necessity for moving again arises. Suitable damping means may be provided to limit rotation of member 16.

As will be apparent from the foregoing description, the present invention contemplates an effective means for increasing the electrical scan of an antenna by feeding the transmitter energy first into one end and then into the other end of the antenna array, and this is accomplished in synchronism with the changing wave guide dimension.

While preferred embodiments of the present invention have been illustrated and described, it will be understood that these are capable of variation, modification, improvement and combination without departing from the spirit of the invention. Therefore, it is not desired that the scope of the invention be limited to the precise details set forth.

What is claimed is:

1. An apparatus for switching currents of high frequency energy comprising, in combination, two oppositely disposed wave guides, two additional oppositely disposed wave guides angularly related to said first oppositely disposed wave guides, said wave guides meeting to form a junction region, a reversing switch comprising an energy reflecting member pivotally mounted in said junction region on an axis perpendicular to the axes of said wave guides, and means to oscillate said reflecting member so that said member acts to reflect energy from one of said first oppositely disposed wave guides alternately into either one of said angularly related oppositely disposed wave guides, and simultaneously alternately to reflect energy from one of said angularly related wave guides into the other of said first oppositely disposed wave guides.

2. In a directional scanning antenna having a variable width wave guide and radiating elements disposed along said wave guide and energized thereby; means for directing high frequency energy along said variable width wave guide in alternate directions comprising a feed wave guide, a pair of branch wave guides perpendicularly intersecting said feed wave guide at a point and connected to opposite ends of said variable width

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wave guide, a resonant member centrally pivoted within said intersection, said resonant member having two substantially parallel faces, said feed wave guide being terminated beyond said intersection in an energy absorbent material, means for rotating said member through an arc whereby said energy is alternately reflected by one of said faces into each of said branch guides, unradiated energy is reflected by the other of said faces into said energy absorber, and no energy is reflected back into said feed wave guide.

3. In a directional scanning antenna having a variable width wave guide and radiating elements disposed along said wave guide and energized thereby, means for directing high frequency energy along said wave guide in alternate directions comprising a feed wave guide, a pair of branch wave guides perpendicularly intersecting said feed wave guide and connected to opposite ends of said variable width wave guide, a resonant member pivotally disposed within said intersection, said resonant member having two substantially parallel faces, said feed wave guide being terminated beyond said intersection in an energy absorbent material, means for oscillating said member through an arc substantially 45° to either side of the longitudinal axis of said feed wave guide, whereby said energy is alternately reflected by one of said faces into each of said branch guides, unradiated energy is reflected by the other of said faces into said energy absorber and no energy is reflected back into said feed wave guide.

4. In a directional scanning antenna system having a main wave guide and radiating elements longitudinally disposed along said wave guide and energized thereby, means for directing high frequency energy along said main wave guide in alternate directions comprising a feed wave guide, a plurality of branch wave guides perpendicularly intersecting said feed wave guide at a point, said branch guides being electrically connected to opposite ends of said main wave guide, said feed wave guide being terminated beyond said intersection in an energy absorbent material, and means for directing energy propagated along said feed wave guide alternately into each of said branch wave guides and for directing

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the unused portion of said energy into said absorbent material.

5. In an antenna system having a feed wave guide and branch wave guides, a connecting section comprising a block having two intersecting passages therethrough defining a portion of said feed wave guide and said branch wave guides, said feed guide portion being terminated in an energy absorbent material, means pivotally mounted within said intersection for reflecting the electromagnetic energy propagated along said feed wave guide alternately into each of said branch wave guides and reflecting the energy propagated along said branch wave guides towards said reflecting means into said absorbent material.

6. In a scanning antenna system having a variable width wave guide, and radiating elements disposed longitudinally along said wave guide and energized thereby and in which the electromagnetic beam of said antenna is shifted angularly by varying the width of said wave guide; means for increasing the angle through which said beam can be shifted comprising a feed wave guide, a pair of branch wave guides intersecting said feed wave guide at a point, said branch guides being electrically connected to opposite ends of said variable width wave guide, said feed wave guide being terminated beyond said intersection in an energy absorbent material, and means for reflecting energy propagated along said feed wave guide alternately into each of said branch wave guides and for reflecting the unradiated portion of said energy into said absorbent material.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,129,712	Southworth	Sept. 13, 1938
2,396,044	Fox	Mar. 5, 1946
2,415,242	Hershberger	Feb. 4, 1947
2,423,130	Tyrrell	July 1, 1947
2,423,508	Leck	July 8, 1947
2,452,202	Lindenblad	Oct. 26, 1948

Certificate of Correction

Patent No. 2,480,189

August 30, 1949

JACK H. IRVING

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 3, lines 11 and 12, for "mechanism 72" read *mechanism 27*; column 6, line 10, for "ror" read *for*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of April, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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