July 12, 1960 L. D. STROM 2,945,193

ROTARY WAVEGUIDE JOINT AND SWITCHING STRUCTURE

Filed Feb. 2, 1954 5 Sheets-Sheet 1

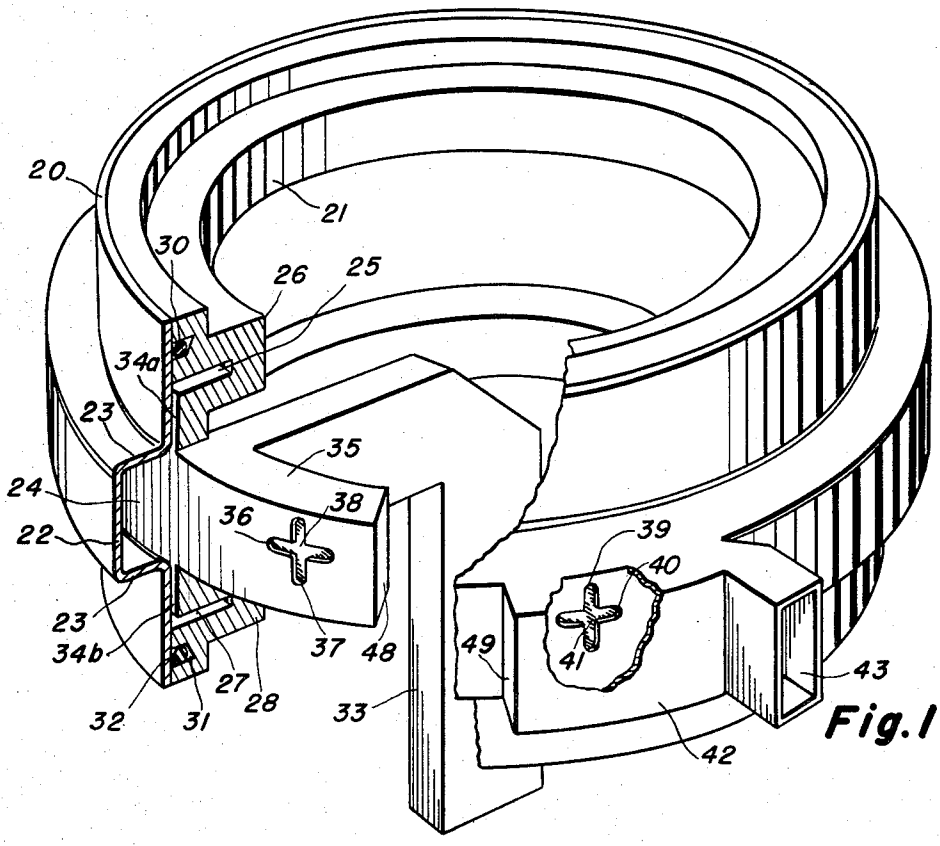


Fig. 1

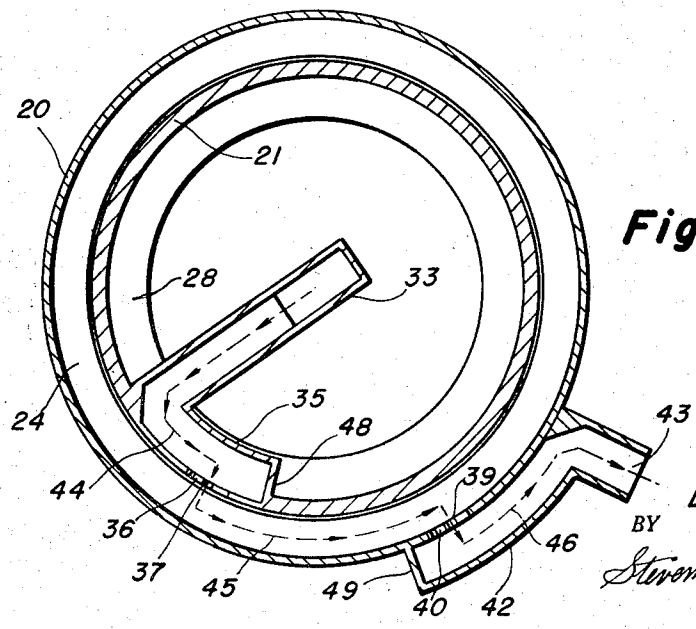


Fig. 2

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Filed Feb. 2, 1954 5 Sheets-Sheet 2

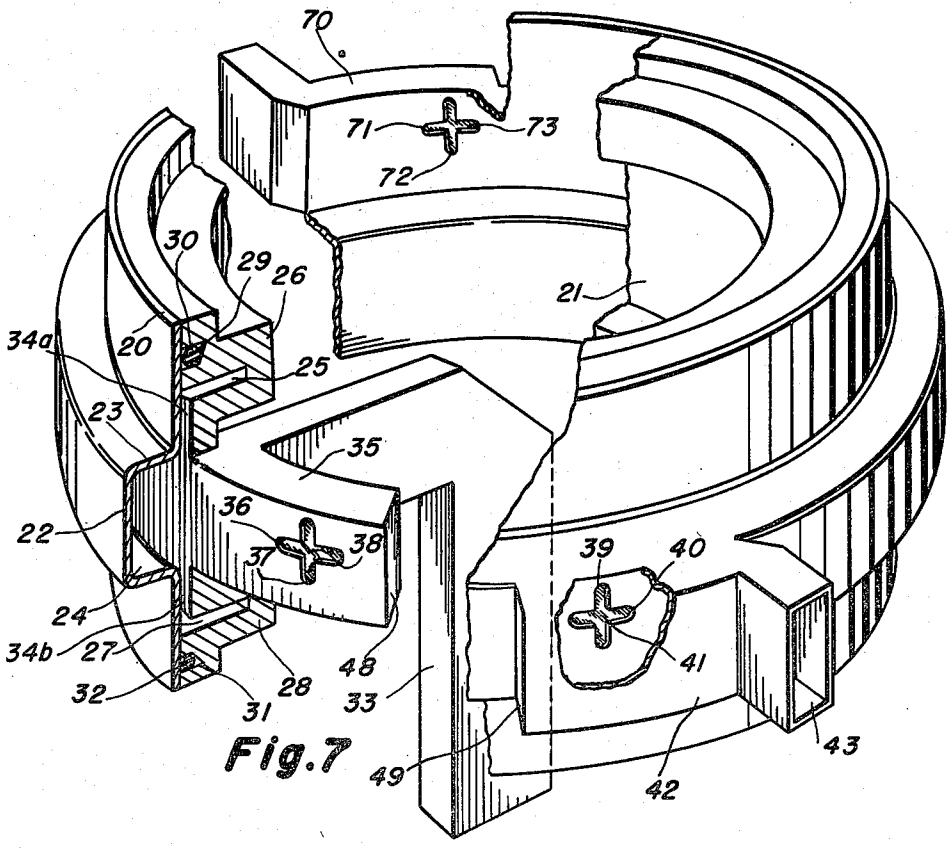


Fig.7

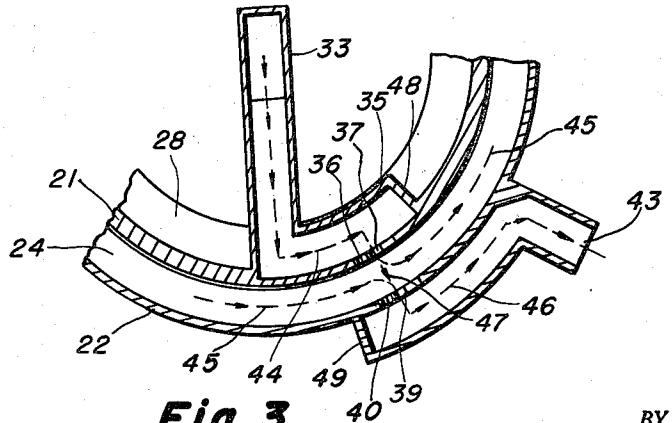


Fig.3

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ROTARY WAVEGUIDE JOINT AND SWITCHING STRUCTURE

Filed Feb. 2, 1954 5 Sheets-Sheet 3

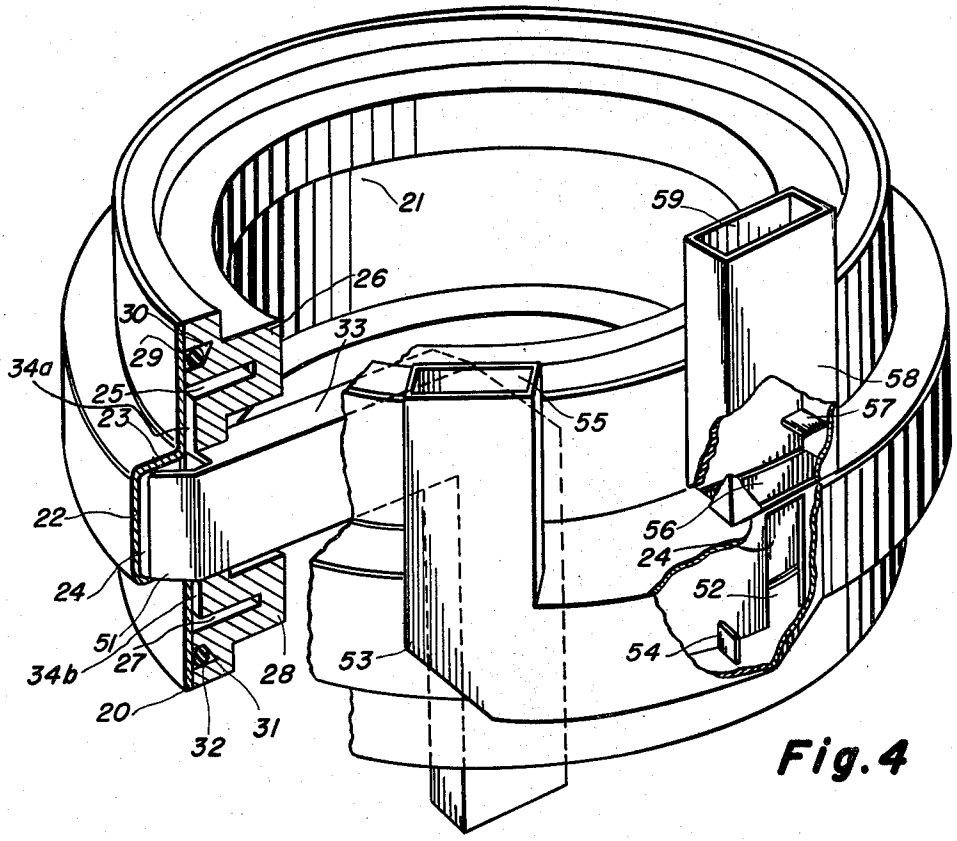


Fig. 4

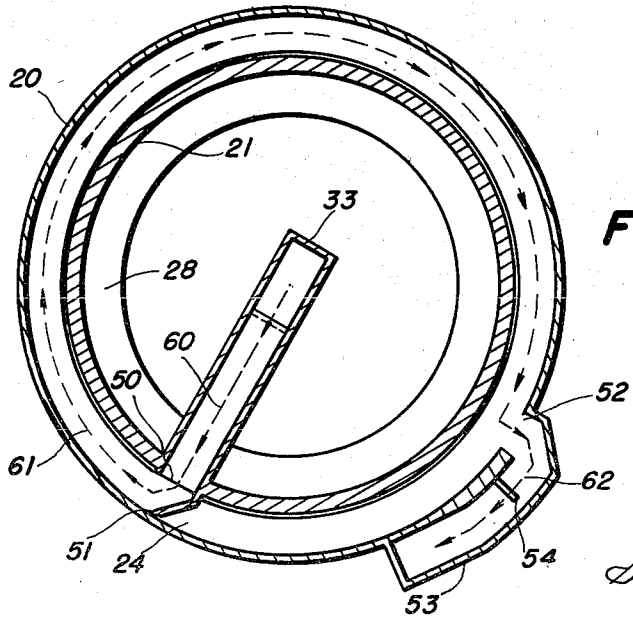


Fig. 5

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ROTARY WAVEGUIDE JOINT AND SWITCHING STRUCTURE

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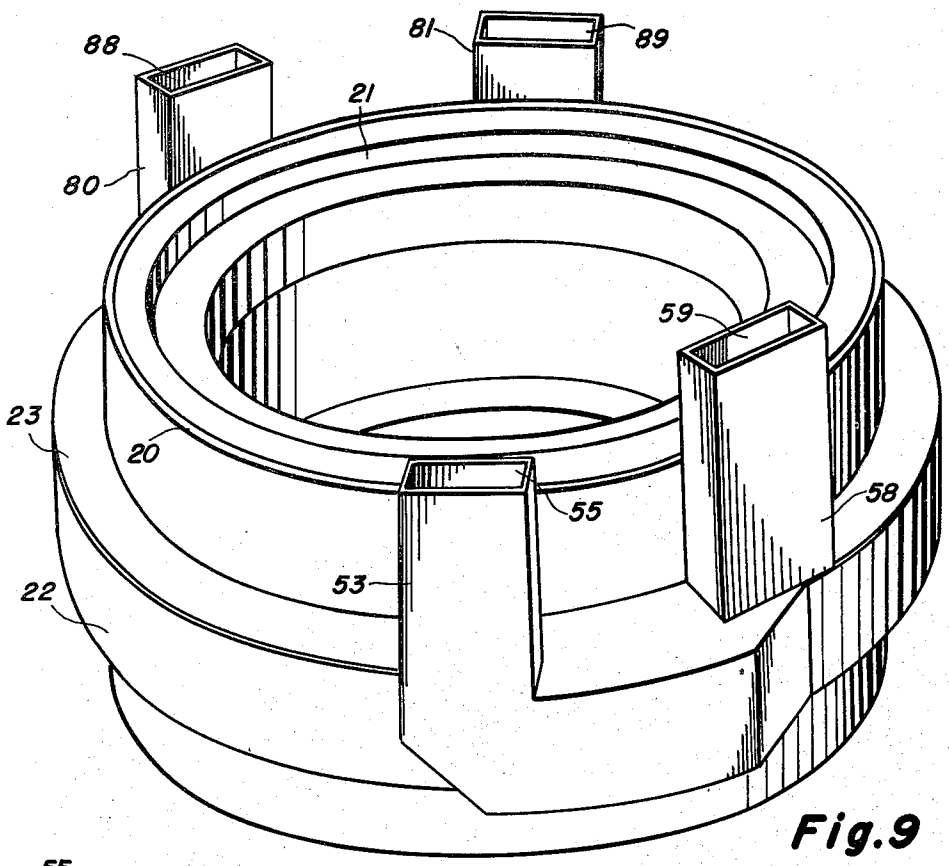


Fig.9

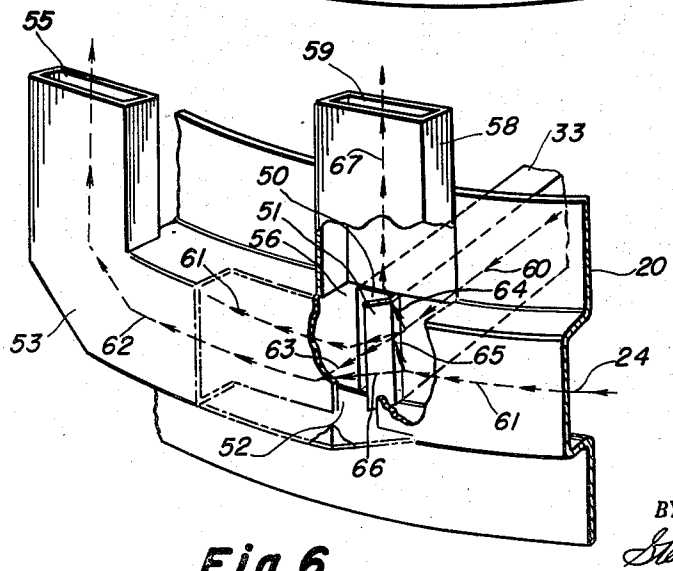


Fig.6

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ROTARY WAVEGUIDE JOINT AND SWITCHING STRUCTURE

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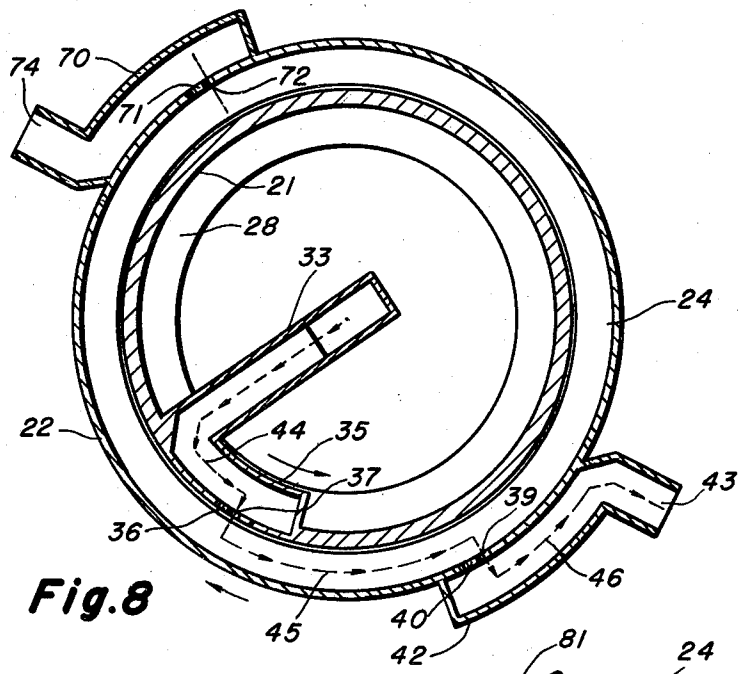


Fig.8

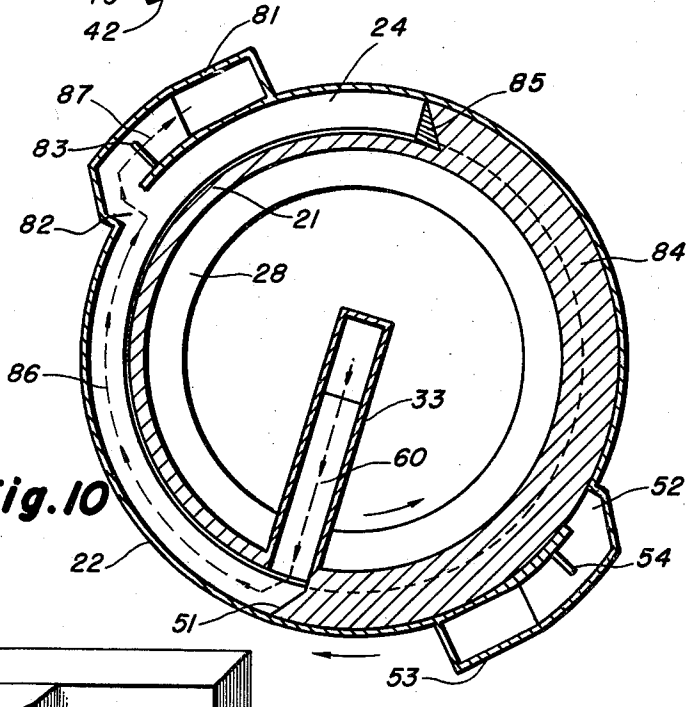


Fig.10

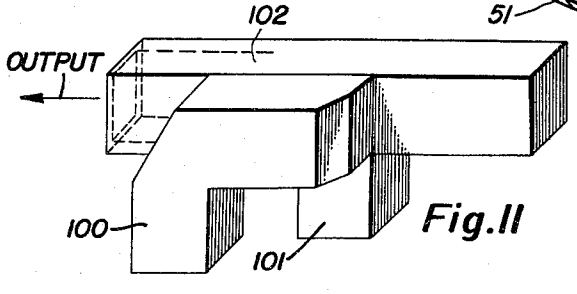


Fig.11

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United States Patent Office 2,945,193 Patented July 12, 1960

2,945,193

ROTARY WAVEGUIDE JOINT AND SWITCHING STRUCTURE

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Filed Feb. 2, 1954, Ser. No. 407,685

17 Claims. (Cl. 333—7)

This invention relates to a rotary joint and switching structure and more specifically, to a rotary joint of the rectangular waveguide type so constructed as to transfer R.-F. power to an antenna rotating through 360 degrees, or to switch R.-F. power alternately to more than one antenna feed while maintaining 360 degrees rotation of the antenna array.

It will be appreciated that rotary waveguide joints as such are not new. Prior art joints have been developed using the circular TM_{10} mode and the rectangular TE_{10} mode. One of this latter type of joints was disclosed in a Naval Research Laboratory Report in 1951 by Breetz and embodied in Patent No. 2,595,186 issued April 29, 1952, to Breetz. The rotary joint in the referred to report consists of a rectangular waveguide bent in the E-plane to form a complete circle with the waveguide split along the narrow wall to permit relative motion between the respective sections. Waveguides connected into the opposite and facing wide sides of the waveguide sections form the power input and output for the joint with the input guide connected to the inner section and the output guide to the outer section. At the junction points of the input and output guides to their respective sections of the circular guide are sets of fingers extending into the guide and directed at such an angle as to make E-plane bends for the feed lines to and from the rotary joint. The fingers in the E-plane bend are set at approximately a 45-degree angle with the tangent to the circumference of the circle where the fingers enter the ring and serve to direct the path of the wave from the input guide through the rotary joint and to the output guide. These fingers attached to the relatively rotating sections are arranged to interleave thus permitting 360-degree rotation.

Although it is essential to direct the path of the input wave, yet it is undesirable for several reasons to direct the wave path by using sets of interleaving fingers. The practical difficulty of fixing the fingers to the input and output sections because of the relatively small dimensions of the waveguide constitutes a disadvantage of this apparatus. Further, the difficulty in setting the fingers parallel to each other to avoid interference in the interleaving position constitutes another disadvantage. Other and more serious disadvantages stem from the probability of resonance between the fingers and the breakdown of the relatively short air path between each finger. As these short air paths break down under load, arcing takes place causing undesirable reflections into the input arm. This necessarily means that when fingers are used to direct the path of the wave from the input guide to the output guide, the rotary joint is inherently limited to a low amount of power that can be transferred through the joint.

Accordingly, it is a principal object of this invention to provide an apparatus that will avoid the low power transfer limitations of previously known rotary waveguide joints by utilizing devices which have directional characteristics of themselves without the necessity of using power limiting devices such as interleaving fingers to accomplish wave path directivity.

It is another object of this invention to provide an apparatus that will avoid construction difficulties present with prior devices and one which will be simpler and more easily constructed.

It is a further object of this invention to provide a structure which can be easily adapted for switching the input power between two or more antennas.

It is still another object of this invention to provide a small, compact structure suitable for stacking one joint upon another with colinear axes of rotation for feeding an array of antennas without interference between the various feed arms to the antennas.

Other and further objects of the invention as well as the characteristics of the structure necessary to accomplish the above enumerated objects will become apparent from the following discussion. For this purpose, the discussion is referenced to the following drawings in which:

Figure 1 is a partially broken-away perspective view of the preferred embodiment of the invention showing a directional coupler as the directive device;

Figure 2 is a cross-sectional view of Figure 1 taken in a radial plane passing symmetrically through the device showing the wave path as directed by the input and output directional couplers;

Figure 3 is a view similar to Figure 2 illustrating the wave paths at the cross-over position;

Figure 4 is a perspective view partially broken away showing the use of hydrid T's as a modification of the invention;

Figure 5 is a cross-sectional view of Figure 4 taken in a radial plane passing symmetrically through the device illustrating the wave path around the rotary joint to the E-arm of the hybrid T;

Figure 6 is a perspective view of the device shown in Figure 4 showing the wave paths into the E and H-arms of the hybrid T at the cross-over point;

Figure 7 is a partially broken-away perspective view of a directional coupler switching arrangement according to another modification of the invention;

Figure 8 is a cross-sectional view of Figure 7 taken in a radial plane passing symmetrically through the device;

Figure 9 is a perspective view of a hybrid T switching arrangement according to a further embodiment of the invention; and

Figure 10 is a cross-sectional view of Figure 9 taken in a radial plane passing symmetrically through the device.

Referring now to the various figures, it can be seen that the basic structure of the rotary joint is identical for all embodiments of the present invention with the differences between the several embodiments being in the means for accomplishing wave path directivity. Basically, the rotary joint consists of a rotor 20 and a stator 21. Rotor 20 is a cylindrical annulus in shape with a raised area around its mid-portion which forms three sides of a waveguide 24. The wide side of waveguide 24 is designated by the number 22 and the narrow sides by the number 23, all an integral part of rotor 20. The closure of waveguide 24 is effected by the side wall of stator 21 when the stator is in position within rotor 20. Stator 21 is also a cylindrical annular structure, however, it is further formed with two inwardly extending circular annular sections 26 and 28 located toward the upper and lower ends of the stator 21 respectively. A slot 25 is cut into section 26 to a depth equal to a quarter wave length at the operating frequency of the system and is connected with the main guide 24 by means of another

quarter wave length passage 34*a* formed between the rotor and stator. Thus, slot 25 is located at a quarter wave length above waveguide 24 and acts as a choke to prevent the loss of R.-F. power.

From transmission line theory, the voltage is a maximum and the current is essentially zero at a point located at a quarter wave length from a short circuit in a transmission line. Consequently, an impedance approaching infinity is possible at the junction of slots 25 and 34*a*. This high impedance is in turn transformed through a quarter wave length section 34*a*, resulting in an effective short circuit at the junction of slot 34*a* and waveguide 24. It should be recognized that passage 34*a* is formed as a result of reducing the diameter of stator 21 to avoid metal-to-metal contact with rotor 20 and is as narrow as possible. In like manner, a quarter wave length slot 27 is formed in the lower section 28 and is connected by quarter wave length passage 34*b* with the lower side of waveguide 24.

Although not shown, it is necessary for the stator and rotor sections to be maintained in their relative positions by means of a suitable bearing arrangement. This can be accomplished by using stator 21 as the inner race and attaching cover plates to either end of rotor 20 to serve as the outer races of a ball bearing movement. The rotary joint is not restricted to the above designation of rotor and stator sections because the construction of the joint allows either to be used as the rotating or stationary section. Further, if the rotary joint is to be used in a pressurized system, O seal rings can be provided for this purpose. Sealing means is shown in Figure 1 and consists of O seal ring 30 in groove 29 and O seal ring 32 in groove 31, located at the upper and lower ends of stator 21 respectively.

In the operation of the embodiment shown in Figure 1, wave path directivity is accomplished by means of directional couplers. The R.-F. power is fed from input guide 33 into a directional coupler 35, which fits into an opening provided in the side wall of stator 21. Two mutually perpendicular slots 36 and 37 are formed into the wall of directional coupler 35 facing the circular waveguide 24. These slots 36 and 37 are each resonant at the operating frequency of the system and, consequently, tend to effect practically a 100 percent transfer of power from the coupler into the waveguide 24. A high dielectric strength plug 38 that does not materially reduce the transfer of power is inserted into the opening provided by the mutually perpendicular slots 36 and 37. It may be desirable also to insert a plug of highly absorbent material, commonly termed "lossy" material in the art, into directional coupler 35 at the terminal indicated by the numeral 48.

A directional coupler 42 is fixed to an opening cut into the wide face 22 of the circular waveguide 24 and serves as the power output from the rotary joint. Directional coupler 42 has two mutually perpendicular slots 39 and 40 filled with a high dielectric strength plug 41 in the same manner as directional coupler 35. It can be seen that the plugs 38 and 41 are important in increasing the power transmission characteristics of the rotary joint since without the use of such material, breakdown across the slot gaps would occur at a lower power rating. The output of directional coupler 42 is fed to an antenna by means of a waveguide (not shown) connected to opening 43.

A directional coupler may be defined as a device which, when inserted in a transmission line with waves traveling in both directions, delivers to a pair of terminals located in an auxiliary transmission line a voltage which is largely a function of the amplitude of the wave going in one preferred direction, and relatively independent of the wave going in the opposite direction. In Figure 2, the path of the wave delivered by input guide 33 to directional coupler 35 is indicated by path 44. The wave, on arriving at slots 36 and 37, is directionally coupled into the waveguide 24 where it travels in the direction indicated by path 45 as the preferred direction until it reaches the coupling slots 39 and 40 in directional coupler 42. Slots 39 and 40 directionally couple the wave into coupler 42 where the wave takes the path indicated by numeral 46 to the outlet 43 of the coupler.

It is obvious that if there is relative movement between rotor 20 and stator 21, path 45 will change in length until the slots 36 and 37 have rotated relatively to a point directly opposite slots 39 and 40 as shown in Figure 3. This varying path length makes no difference until the slots in the two couplers are directly opposite and reach what is termed the cross-over point. When this point is reached, the R.-F. power splits and a portion follows path 45 around the circumference of the ring joint while a portion follows path 47 directly across to directional coupler 42 and recombines with the wave following the path 45. In order to avoid a recombination of the waves following paths 45 and 47 in an out-of-phase relation with an attendant rapid change in the phase of the output wave relative to the input wave, the length of path 45 must differ from the length of the path 47 only by some multiple of a wave length. The effect of the cross-over position on the directed and reflected waves can be minimized by a proper design of the rotary joint path lengths.

In Figure 4, the structure of the rotary joint is identical to that shown in Figure 1 with the exception of the input and output directional devices. The directional coupler at the input in Figure 1 is replaced in Figure 4 by a miter corner 51 extending into the waveguide 24 at an angle of 45 degrees. The effectiveness of the mitered corner may be increased by a folded choke (not shown). At the output, the directional coupler of Figure 1 is replaced by a hybrid T consisting of an E-plane arm 53 fed through opening 52 in the wide face 22 of circular guide 24 and H-plane arm 58 fed through opening 56 in the narrow wall 23 of the circular waveguide 24. The hybrid T is a four-arm device consisting of two colinear arms, which in this instance is provided by the waveguide 24, and the E-plane and H-plane side arms 53 and 58 respectively.

The hybrid T, a well known device in the waveguide art, has the special property when power is applied at one terminal of transmitting with certain prescribed amplitude and phase relationships to a second and third terminal but not to the fourth. Thus, in Figure 5, as R.-F. power is applied to the input arm 33, it propagates along path 60 of the input arm and is directed into waveguide 24 by the miter corner 51. This energy travels path 61 around the circular guide until it reaches the openings 52 and 56 into the E and H-arms of the hybrid T. The power splits at this point and divides equally between the arms, the power following path 62 into the E-arm while the path of the wave into the H-arm is not shown in Figure 5. In order that the hybrid T may be most useful, the input arms should have no reflections when non-reflecting terminations are placed on the asymmetrical arms. Therefore, matching elements can be provided in the E-plane and the H-plane arms to produce reflections that cancel the reflections from the junction. These matching elements are provided by iris 54 in E-arm 53 and iris 57 in H-arm 58 as shown in Figure 4. The arms of the T-junction will then be reflectionless when the colinear arms are terminated with reflectionless loads.

From the above description of the hybrid T, it is apparent that the wave amplitude in arms 53 and 58 is half the amplitude of the original wave and it is further known from the waveguide art that the waves have certain phase relation with each other. The phase relation between the waves in a hybrid varies depending upon the structure of the hybrid, but for the hybrid T the waves in the asymmetrical arms are 180 degrees out-of-phase when excited by one of the colinear arms. By taking advan-

tage of the law of reciprocity governing hybrid T's, the waves in the E and H-arms may be recombined in a second hybrid T (Figure 11) to deliver the total power of the original wave to the antenna. The phase and amplitude relation of the rotary joint output arms are preserved and the E-arm 53 is connected to the E-arm 100 of the second hybrid T and the H-arm 58 to the H-arm 101. It is evident that since in the second hybrid T all particulars of the energy flow in the first hybrid T are reversed, all of the power must flow out of the colinear arm 102 corresponding to the original input arm. Thus, by the use of another hybrid T the power contained in arms 53 and 58 of the hybrid T can be recombined and the power of the original wave transmitted to the antenna.

The use of the hybrid T-junction in the output of the rotary joint is subject to the same objection at the cross-over position as when directional couplers are used. The cross-over position of the rotary joint using the hybrid T is shown in Figure 6. Wave 60 is applied through the input guide 33 and upon reaching the opening 50 into waveguide 24 divides into three paths with one component 64 being directed by miter corner 51 upward into H-arm 58, another component 63 into E-arm 53 and the third component around the circular guide 24 along path 61. The wave traveling path 61 on completing its path around the circumference of the rotary joint splits into the two components 65 and 66. Component 65 is directed upward through opening 56 into H-arm 58 and combines with component 64 to take path 67 out of the opening 54. Component 66 is directed through opening 52 to combine with component 63, which then propagates along path 62 in E-arms 53 and out of the opening 55. On the recombination of the wave components in each respective arm, the wave components must travel path lengths of a wave length or multiples of a wave length to avoid arriving in an out-of-phase relation with the consequent reflection of energy back toward the input. Although it is more difficult in actual practice to provide path lengths of multiples of wave lengths when the hybrid T is used as the directive device, it is possible to design a rotary joint using hybrid T's with a minimum amount of out-of-phase recombination due to the wave path lengths.

Referring now to Figures 7 and 8, the basic rotary waveguide joint of Figure 1 is converted into a switching structure by the addition of another directional coupler 70 into the wide face 22 of circular guide 24. Directional coupler 70 is identical in all respects to directional couplers 35 and 42 and utilizes two mutually perpendicular coupling slots 71 and 72. A high dielectric strength plug 73 is inserted in the coupler wall opening formed by the slots 71 and 72. Since the output directional couplers are located on diametrically opposite sides of the rotary joint, it can be seen that each coupler will transfer power during each half revolution of the rotary joint. Thus, with the input waveguide 33 located in the position shown in Figure 8, the input wave propagates along path 44 and is directionally coupled by coupler 35 into the circular waveguide 24 and along path 45. As the wave reaches the coupling slots 39 and 40 in output directional coupler 42, the wave is directionally coupled along path 46. The directional coupler 42 thus couples the input wave to its antenna until the input coupler has moved relative to the output coupler 42 and is directly opposite. After the cross-over point has been reached, the wave propagating along path 45 will be coupled into directional coupler 70 by the slots 72 and 73 and directional coupler 42 will receive no power until immediately after the cross-over point of directional coupler 70 has been reached. Due to the properties of the directional coupler, it can be seen that other couplers can be added to waveguide 24 to provide additional outputs to antenna feeds. Insofar as the directional coupler fails to couple 100 percent of the incident wave, some power will propagate to the nominally off arm. This extraneous coupling can be eliminated with a metallic plug 84 as will be discussed in the description of the hybrid T joint of Figure 10. It is also evident that the mitered corner 51 of the plug 84 may be used to provide wave directivity and eliminate directional coupler 35 of Figure 7.

In Figures 9 and 10, the structure of Figure 4 is modified to provide a switching structure utilizing two hybrid T's. In like manner to the directional couplers of Figure 7, the hybrid T's are located diametrically opposite from each other on the circular waveguide 24 with arm 80 representing the H-arm and arm 81 of the E-arm of the second output hybrid T. The path direction control of the rotary joint used as a switching structure differs somewhat from the structure used with a single output. The cross-section view of Figure 10 illustrates the internal construction of the switching structure and shows in addition to the miter corner 51 a solid plug 84 backing up the miter corner and extending through an arc length of 180 degrees. The back-up plug 84 terminates in a plug 85 composed of a highly attenuative "lossy" material. Figure 10 also shows the iris 83 located in E-arm 81 to cancel any reflections from the junction. Plug 84 may be omitted if minor coupling to the non-energized arm can be allowed, however, mitered corner 51 will still be required to direct the wave along path 86.

With the input arm 33 located as shown in Figure 10, the wave path 60 propagating through the input guide 33 is directed by the miter corner and back-up plug along the path 86 until it reaches the opening 82 into E-arm 81. Since the characteristic of hybrid T's is that a wave propagated into one colinear arm does not enter the other colinear arm but divides between the side arms, the wave following path 86 will be directed along path 87 into E-arm 81 and upward into arm 80 not shown in this view. Should any waves propagate past the openings into the E and H-arms of the hybrid T, the "lossy" plug 85 will absorb such energy and avoid reflections. When input arm 33 has rotated until the miter corner 51 has reached the cross-over point of the hybrid T containing E-arm 53, the input into opposite output hybrid T will be closed from the input wave by means of the plug 84. Thus, the input wave will be transmitted to the E and H-arms, 53 and 58 respectively, until input arm 33 has rotated relatively a sufficient amount to uncover the second output hybrid T and close the first output hybrid T to the input waves. Should it be desired to add additional outputs, the arc length of the back-up plug will be increased until only the arc length path between outputs remains uncovered. Thus, if three output hybrids are used, the back-up plug 84 would extend an arc length of 240 degrees and if four output hybrids were used, the back-up plug 84 would extend for 270 degrees around the circumference of the circle.

Although this invention relates to a rotary joint suitable for 360 degrees rotation with the necessary wave path directivity, there are many instances in which movement through only a segment of a circle is required. It is evident that the rotary joint described above can be modified to provide wave path directivity for those applications requiring relative movement between the input and output guides through any number of degrees less than 360 degrees since it is also suitable for complete rotation.

Although the present invention has been described with reference to specific embodiments for both a rotary joint and a switching structure, nevertheless, various modifications obvious to one skilled in the art that would satisfactorily serve the teachings of this invention are within the spirit, scope, and contemplation of the present invention.

What is claimed is:

1. A rotary waveguide joint of the type wherein high frequency energy is coupled from at least one input wave-

guide to at least one other relatively rotatable output waveguide, said joint comprising a first annular wall member, a second annular wall member which is rotatable with respect to the first annular wall member and which is placed coaxially with and in close concentric proximity to said first annular wall member to form a substantially enclosed annular waveguide cavity, means adapted to direct energy from said input waveguide into said annular waveguide, at least one opening in said annular waveguide, and means adapted to direct energy from said annular waveguide into said output waveguide, said directing means being characterized by a structural arrangement lying wholly outside said annular waveguide and communicating with said at least one opening.

2. A rotary waveguide joint of the type wherein high frequency energy is coupled from at least one input waveguide to at least one other relatively rotatable output waveguide, said joint comprising a first annular wall member, a second annular wall member which is rotatable with respect to the first annular wall member and which is placed coaxially with and in close concentric proximity to said first annular wall member to form a substantially enclosed annular waveguide cavity, a directional coupler arranged to receive high frequency energy from said input waveguide and having a wall in common with said annular waveguide and two mutually perpendicular slots formed in said common wall with each slot resonant at the intended operating frequency of the joint whereby substantially complete transfer of energy can be effected from said coupler into said annular waveguide, and means adapted to direct energy from said annular waveguide into said output waveguide.

3. A joint as defined in claim 2 wherein said means adapted to direct energy from said annular waveguide includes a directional coupler adapted to pass energy into said output waveguide and having a wall in common with said annular waveguide and two mutually perpendicular slots formed in said common wall with each resonant at the intended operating frequency of the joint whereby substantially complete transfer of energy can be effected from said annular waveguide into said coupler.

4. A joint as defined in claim 3 wherein a high dielectric strength plug is fitted into said mutually perpendicular slots.

5. A joint as defined in claim 2 wherein a high dielectric strength plug is fitted into said mutually perpendicular slots.

6. A rotary waveguide joint of the type wherein high frequency energy is coupled from at least one input waveguide to at least one other relatively rotatable output waveguide, said joint comprising a first annular wall member, a second annular wall member which is rotatable with respect to the first annular wall member and which is placed coaxially with and in close concentric proximity to said first annular wall member to form a substantially enclosed annular waveguide cavity, a miter corner associated with said input waveguide and extending into said annular waveguide adapted to direct energy from said input waveguide into said annular waveguide, openings in said wall members, and a hybrid T formed with said annular waveguide and externally thereof, said hybrid T being in communication with said openings and directing energy from said annular waveguide into said at least one output waveguide.

7. A joint as defined in claim 6 wherein said hybrid T is constituted by said annular waveguide functioning as two colinear arms, an E-plane side arm, and H-plane side arm, said side arms being fed through openings in said wall members.

8. A joint as defined in claim 7 wherein a matching element is located in each of said side arms to produce reflections to cancel reflections from the T-junction.

9. A joint as defined in claim 6 wherein said hybrid T is connected to a second hybrid T with corresponding arms being connected together and said second hybrid T is adapted to direct energy received from said first-mentioned hybrid T into said output waveguide.

10. A rotary waveguide switching structure wherein high frequency energy is coupled from at least one input waveguide to at least two other relatively rotatable output waveguides comprising a first annular wall member, a second annular wall member which is rotatable with respect to the first annular wall member and which is placed coaxially with and in close concentric proximity to said first wall member to form a substantially enclosed annular waveguide cavity, means adapted to direct energy from said input waveguide into said annular waveguide, openings in said annular waveguide, and means adapted to direct energy from said annular waveguide alternately into said output waveguides, said directing means being characterized by structural arrangements lying wholly outside said annular waveguide and communicating with said openings.

11. A rotary waveguide switching structure wherein high frequency energy is coupled from at least one input waveguide to at least two other relatively rotatable output waveguides comprising a first annular wall member, a second annular wall member which is rotatable with respect to the first annular wall member and which is placed coaxially with and in close concentric proximity to said first wall member to form a substantially enclosed annular waveguide cavity, means adapted to direct energy from said input waveguide into said annular waveguide, and a directional coupler associated with each said output waveguide and having a wall in common with said annular waveguide and two mutually perpendicular slots formed in said common wall with each slot resonant at the design operating frequency of the structure whereby substantially complete transfer of energy can be effected from said annular waveguide into each said output waveguide, said directional couplers being symmetrically arranged about said annular waveguide.

12. A rotary waveguide switching structure wherein high frequency energy is coupled from at least one input waveguide to at least two other relatively rotatable output waveguides comprising a first annular wall member, a second annular wall member which is rotatable with respect to the first annular wall member and which is placed coaxially with and in close concentric proximity to said first wall member to form a substantially enclosed annular waveguide cavity, means adapted to direct energy from said input waveguide into said annular waveguide, openings in said annular waveguide, and at least two hybrid T's formed with said annular waveguide and externally thereof in communication with said openings, said hybrid T's being symmetrically disposed about said annular waveguide and each adapted to transfer energy from said annular waveguide into its associated output waveguide.

13. A structure as defined in claim 11 wherein a high dielectric strength plug is fitted into each set of mutually perpendicular slots.

14. A rotary waveguide switching structure wherein high frequency energy is coupled from at least one input waveguide to at least two other relatively rotatable output waveguides comprising a first annular wall member, a second annular wall member which is rotatable with respect to the first annular wall member and which is placed coaxially with and in close concentric proximity to said first wall member to form a substantially enclosed annular waveguide cavity, means adapted to direct energy from said input waveguide into said annular waveguide, energy path controlling means including a plug blocking said annular waveguide through an arc length in degrees equal to

$$360-\frac{360}{n}$$

where n is the number of output waveguides, openings in said annular waveguide, and means symmetrically ar-

ranged around said annular waveguide with each in communication with at least one of said openings and associated with one of said output waveguides, each said means being adapted to direct energy into its associated waveguide from said annular waveguide.

15. A structure as defined in claim 14 wherein said plug terminates with a portion composed of a highly attenuative "lossy" material.

16. An antenna coupling system wherein high frequency energy is coupled from at least one waveguide to at least one other relatively rotatable waveguide which is to be connected to a rotatable antenna comprising the combination of a first annular wall member, a second annular wall member which is rotatable with respect to said first annular wall member and which is placed coaxially with and in close concentric proximity to said first wall member to form a substantially enclosed annular waveguide cavity, a directional coupler arranged to receive high frequency energy from said input waveguide and having a wall in common with said annular waveguide and two mutually perpendicular slots formed in said common wall with each slot resonant at the intended operating frequency of the joint whereby substantially complete transfer of energy can be effected from said coupler into said annular waveguide, means adapted to direct energy from said annular waveguide into said output waveguide, a rotatable antenna, means connecting said rotatable waveguide to said antenna, and means for continuously rotating said antenna, rotatable waveguide, and rotatable wall member together as a unit.

17. An antenna coupling system wherein high frequency energy is coupled from at least one waveguide to at least one other relatively rotatable waveguide which is to be connected to a rotatable antenna comprising the combination of a first annular wall member, a second annular wall member which is rotatable with respect to said first annular wall member and which is placed coaxially with and in close concentric proximity to said first wall member to form a substantially enclosed annular waveguide cavity, a miter corner associated with said input waveguide and extending into said annular waveguide adapted to direct energy from said input waveguide into said annular waveguide, a hybrid T adapted to direct energy from said annular waveguide into said output waveguide, a rotatable antenna, means connecting said rotatable waveguide to said antenna, and means for continuously rotating said antenna, rotatable waveguide, and rotatable wall member together as a unit.

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