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WAVE GUIDE ROTARY SWITCH

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FIG. 1

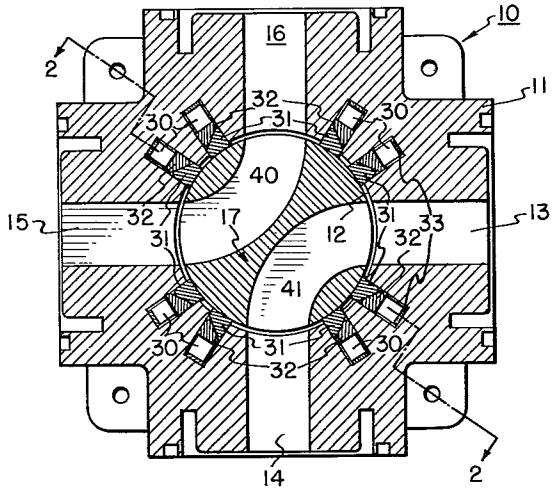


FIG. 2

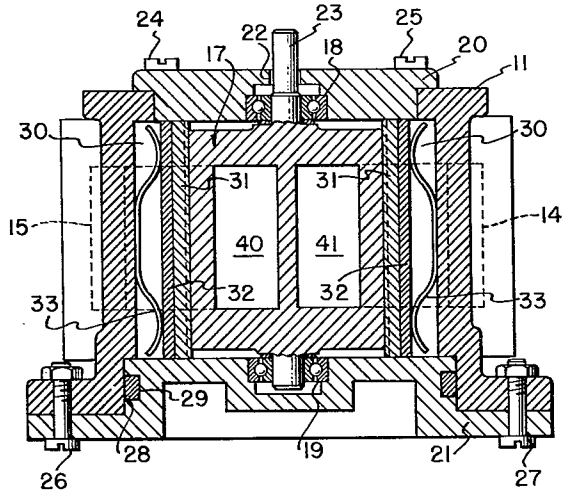
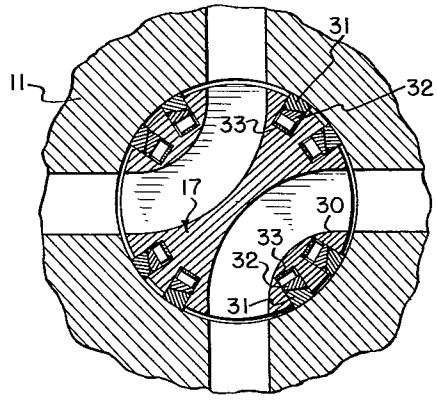


FIG. 3



INVENTORS
DANIEL OLIVIERI
LEE W. FORKER
BY
R. V. Braddock
ATTORNEY

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WAVE GUIDE ROTARY SWITCH

Daniel Olivieri, Yonkers, and Lee W. Forker, Bayville, N.Y., assignors to Sperry Rand Corporation, Great Neck, N.Y., a corporation of Delaware

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This invention relates to rotary switches for use in wave guide transmission lines.

In microwave communication systems it is often required that it be possible to selectively connect one wave guide transmission line to any one of a plurality of other wave guide transmission lines. This is most often accomplished in rectangular wave guide transmission lines by employing a rotary switch wherein the different wave guide transmission lines are disposed about, and are in communication with, a hollow cavity in a stator member of the switch. A cylindrical rotor member having a curved wave guide channel therein is disposed within the stator cavity and is rotatable with respect to said stator member so that the rotor wave guide channel may be selectively positioned to connect one of the stator wave guide transmission lines to any one of several other stator wave guide transmission lines.

The rotor wave guide channel may be curved in a plane parallel to the electric field vectors of the waves propagating in the wave guides, an E plane bend, or may be curved in a plane parallel to the magnetic field vectors of the waves, an H plane bend. Because of the propagating characteristics of a transverse electric wave in a rectangular wave guide it is possible to make a sharper bend in the E plane than in the H plane. Therefore, where the size and weight of the rotary switch are important factors, it is desirable to employ an E plane bend in the rotor wave guide channel. E plane rotary switches, however, quite often suffer from poor isolation between selected and non-selected wave guide channels and high VSWR in the selected channels. This results from the fact that the electric vector of the waves propagating in the wave guides are perpendicular to the axis of the stator cavity, and cylindrical rotor member, and may propagate in the gap which separates the stator and rotor members.

One means that has been used in the past to improve the isolation between selected and non-selected wave guide channels and to reduce the VSWR in the selected channels is to employ quarter wavelength chokes in the well known manner in the rotor or stator members. This method has been successful in some instances but the switch is inherently a narrow band device since the quarter wavelength chokes are frequency sensitive. Additionally, if the quarter wavelength chokes are placed in the rotor member the rotor must be large enough to accommodate the slots which comprise the chokes, and the rotor member approaches the size of an H plane rotor and the advantage of an E plane switch is lost. Dielectric materials have been inserted into the choke slots in order to reduce their lengths, but this has not proved entirely satisfactory since the chokes are still frequency sensitive.

Another difficulty which has been encountered in the prior rotary wave guide switches is that at high power levels arcing occurs between the rotor and stator members since they are separated by only a small air gap.

It is therefore an object of this invention to provide an E plane rotary wave guide switch which is operable over a wide range of frequencies.

It is another object of this invention to provide a rotary wave guide switch having a high degree of isolation between selected and non-selected wave guide channels.

Another object of this invention is to provide a rotary wave guide switch which produces a low VSWR in the selected wave guide channels.

A further object of this invention is to provide a rotary wave guide switch which is operable at high power levels.

A still further object of this invention is to provide a small, lightweight rotary wave guide switch.

These and other objects of the invention which will become more apparent as the description proceeds are achieved by providing a stator member having a cylindrical cavity portion and a plurality of wave guide channels radially extending from the cavity at spaced intervals on its periphery. A cylindrical rotor member having at least one wave guide channel extending therethrough is rotatably disposed within the cavity so that said rotor wave guide channel connects different stator wave guide channels when rotated to different predetermined angular positions. Said rotor wave guide channel is curved in the E plane. A plurality of circumferentially spaced longitudinal slots are disposed about the cavity wall of said stator and each is positioned immediately adjacent a broad wall of a stator wave guide channel. Slideably positioned within each slot is a solid conductive member which has a longitudinal height greater than the broad dimension of said wave guide channels. Means are positioned within each slot for urging the solid conductive members into a sliding surface contact with the rotor member, and for urging said conductive member into a surface contact with one wall of its respective slot.

The invention will be described in connection with the following drawings, wherein:

FIG. 1 is a plan view of the novel rotary switch of this invention;

FIG. 2 is a sectional view of the rotary switch of this invention taken at section 2—2 of FIG. 1; and

FIG. 3 is a partial sectional view of an alternative embodiment of the present invention.

Referring now more particularly to FIGS. 1 and 2 the rotary wave guide switch **10** is comprised of a stator member **11** having a cylindrical cavity portion **12** and a plurality of rectangular wave guide channels **13—16** radially extending from cavity **12**. A cylindrical rotor member **17** is disposed within stator member **11** and is rotatable with respect thereto by means of bearing members **18** and **19**, FIG. 2, shown as ball bearings.

Rotor member **17** has two curved wave guide channels **40** and **41** extending therethrough for providing conductive wave guide paths between different pairs of stator wave guide channels when rotated to different predetermined angular positions.

Cover members **20** and **21**, FIG. 2, enclose the ends of stator member **11** and also provide supporting means for the outer races of ball bearing members **18** and **19**, respectively. The top cover member **20** is provided with a center aperture **22** through which passes the shaft **23**. Shaft **23** may be coupled to actuating means, not shown, for rotating rotor member **17**. Screws such as **24**, **25** and **26**, **27** secure cover members **20** and **21**, respectively, to stator member **11**. An O-ring **28** of suitable material is positioned in a groove **29** in bottom cover member **21** for providing an air-tight seal between bottom cover member **21** and stator member **11** so that the wave guide switch may be employed in a pressurized wave guide system. Suitable means associated with the rotor actuating means, not shown, provides a pressure seal on top cover member **20**.

A plurality of longitudinal slots **30** are circumferentially spaced around the wall of cavity **12** and extend radially into stator member **11**. Each of the slots is positioned immediately adjacent a broad wall of one of the stator

wave guide channels, as will be more fully explained herebelow.

Slideably positioned within each of the slots **30** is a solid conductive member **31**. Each conductive member **31** has a wedge-shaped end which is housed within the corresponding slot. A wedge-shaped member **32** in each slot has a surface area in contact with a corresponding surface of each conductive member **31**. A resilient spring member **33** is positioned between the end wall of each slot and the wedge-shaped member **32** and urges the wedge-shaped members **32** outwardly, and consequently urges conductive member **31** into sliding contacts with rotor member **17**.

Conductive members **31** have longitudinal heights which are greater than the width of the broad walls of the wave guide channels, and as illustrated in FIG. 2, preferably have heights at least as great as the longitudinal dimension of rotor member **17**. Conductive members **31** should have heights greater than the width of the broad walls of the wave guide channels so that the ends of the wave guide channels in rotor member **17** may freely pass over the conductive members **31** when said rotor member is rotated. The conductive members **31** provide short-circuiting surface contacts with rotor **17** along the entire length of the rotor, and thus substantially completely block the air gap extending between the rotor and stator members. The ends of conductive members **31** which are in sliding contact with rotor **17** are accurately fashioned so as to conform to the cylindrical surface of the rotor **17** and thus assure a good surface contact therewith.

Conductive members **31** are preferably made of graphite, or a similar substance, or mixture, which possesses the property of having low electrical resistivity, and also possesses the property being a dry lubricant. Conductive members having these properties will provide a good electrical short circuit between the stator and rotor members, and will also provide a low friction, sliding contact with rotor **17**.

In practice, conductive members made of graphite, and also made of "Graphalloy," grade 411, a graphite and silver particle mixture which is a product of Graphite Metallizing Corporation, have been used with great success.

The operation of a wedge-shaped member **32** on a conductive member **31** may be explained as follows. The angle of the taper of the wedges on members **31** and **32** are different for reasons which will now become apparent. Spring **33** urges wedge-shaped member **32** outwardly, and in turn wedge-shaped member **32** exerts a force against conductive member **31**. Because the two surfaces are inclined at different angles to the direction of the exerted force, it may be considered that two component forces are acting on the conductive member **31**, one component being directed radially along the slot and urging conductive member **31** outwardly, and the other component, resulting from the wedging action, being directed transversely to the slot and urging the conductive member laterally against the side wall of the slot. In this manner each conductive member **31** is caused to make a good surface contact with rotor member **17** at its outer end, and is also caused to make a good surface contact over one of its sides with the wall of the slot **30** in stator member **11**.

Slots **30** are positioned as close to a broad wall of a wave guide as possible so that the electrical short presented by conductive members **31** are reflected back along the air gap to the cavity ends of the stator and rotor wave guides without any substantial impedance inversion, thus causing no appreciable discontinuity to appear in the wave guide path joining the stator and rotor wave guide channels. Because the distance between the cavity ends of the stator and rotor wave guide channels and the nearest conductive members **31** is a very small fraction of a wave guide wavelength of the waves propagating in the wave guide channels, the frequency of the waves may vary over a considerable frequency range without any appreciable change in the effective short circuit presented at the junction of the stator and rotor wave guide broad walls. In a wave guide switch constructed in accordance with the principles of this invention, the electrical distance between each conductive members **31** and the nearest wave guide channel was less than $\frac{1}{16}$ wave guide wavelength at the center of the operating frequency band.

FIG. 3 is a partial plan view illustrating an embodiment of the present invention wherein the slots **30** are positioned in the rotor member **17**. Solid conductive members **31**, wedge-shaped members **32**, and spring members **33** are disposed within slots **30** in the manner explained above.

One possible disadvantage of placing the slots on the rotor member is that the size of the rotor may have to be increased in order to accommodate the slots.

It will be noted in FIG. 1 that conductive members **31** and wedge-shaped members **32** are positioned so that conductive members **31** are urged into a surface contact with the side of the respective slots which is located nearest an adjacent stator wave guide broad wall. This assures that the short circuit produced by a conductive member **31** appears as close as possible to the adjacent stator and rotor wave guide broad walls. Because conductive members **31** possess the property of having low electrical resistivity and are in a surface contact with both the rotor **17** and stator **11**, the short circuit is of excellent quality, and by making the conductive members of graphite or a similar dry lubricant material, a relatively small actuating force is required to rotate rotor member **17**.

An embodiment of the present invention constructed substantially as illustrated in FIGS. 1 and 2 had the following approximate dimensions:

	Length	Width
Stator Cavity 12	1.81″	x 1.56″
Rotor Cylinder 17	1.68″	x 1.53″
Slots 30	1.78″	x .172″
Conductive Members 31	1.765″	x .167″
Wedge-Shaped Member 32		.156″
Wedge on end of Conductive Member 31	34°±0°30′	
Wedge on Wedge-Shaped Member 32	35°±0°30′	
Distance Between Slot and Nearest Wave Guide Broad Wall.	.125″ (less than $\frac{1}{16}$ wave guide wavelength at center of frequency band).	

In the operation of the novel switch of this invention over the frequency range of 7,000 mc. to 10,000 mc., the VSWR in selected wave guide channels varied from a minimum of 1.03 to a maximum of 1.09, and the minimum isolation of the non-selected wave guide channels was 70 db. The power handling capability of the switch was at least as great as the capabilities of the system in which it was operated.

While the invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than of limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of the invention in its broader aspects.

What is claimed is:

1. A wave guide rotary switch comprising, a stator member having a cylindrical cavity portion and a plurality of rectangular wave guide channels radially extending from said cavity at spaced intervals on the periphery thereof, a cylindrical rotor member having at least one rectangular wave guide channel extending therethrough and being rotatably disposed within said cavity, said stator and rotor wave guide channels having their broad walls disposed parallel to the longitudinal axis of said

cavity, first and second end plate members for enclosing the ends of said cavity and providing means for supporting said rotor member, a plurality of longitudinal slots radially disposed about the inner surface of said stator member, said slots having lengths greater than the wide dimension of said wave guide channels, each of said longitudinal slots being separated from a broad wall of a wave guide channel by a distance which is considerably less than one-quarter wave guide wavelength of waves propagating through said channels, elongated conductive members having lengths greater than the wide dimensions of said wave guide channels positioned in each of said slots and each having a longitudinal surface slideably contacting said rotor member, said conductive members having a wedge-shaped end disposed within said slots, a wedge-shaped member within each of said slots and making contact over a portion of its wedged surface with the similarly shaped end of said conductive member, and means for urging said wedge-shaped members against said conductive members, whereby said conductive members are urged against a wall of said slot nearest the adjacent wave guide channel.

2. A wave guide rotary switch comprising, a stator member having a cylindrical cavity portion and a plurality of rectangular wave guide channels radially extending from said cavity at spaced intervals on the periphery thereof, a cylindrical rotor member rotatably disposed within said cavity and having at least one rectangular wave guide channel extending therethrough for providing a conductive wave guide path between different pairs of stator wave guide channels when rotated to different predetermined angular positions, said stator and rotor wave guide channels having their broad walls disposed parallel to the longitudinal axis of said cavity, a plurality of circumferentially spaced longitudinal slots extending radially into the cylindrical wall at said stator, each of said slots being positioned immediately adjacent a broad wall of a wave guide channel, a solid conductive member having a longitudinal height at least as great as the height of said rotor member slideably disposed in each of said slots, the outwardly extending longitudinal surface of each conductive member being conformal to the cylindrical surface of said rotor member, and a spring biased wedge-shaped member disposed in each of said slots to urge the respective conductive member outwardly and into a slideable contact with said rotor member and to urge the conductive member transversely and into a surface contact with the side of said slot.

3. A wave guide rotary switch comprising a stator member having a cylindrical cavity portion and a plurality of wave guide channels extending outwardly from said cavity at spaced intervals on the periphery thereof, a cylindrical rotor member rotatably disposed within said cavity and having at least one wave guide channel extending therethrough, said rotor channel being located to bring the ends thereof into registration with the ends of different pairs of stator wave guide channels when the rotor is rotated to different predetermined angular positions, a plurality of elongated conductive members extending between said stator and rotor members at spaced intervals around the periphery of said cavity, said conductive members having longitudinal dimensions parallel to the center axis of said cavity greater than the maximum cross-sectional dimensions of said wave guide channels, each of said conductive members having longitudinally extending surface areas extending substantially throughout its entire length in contact with said rotor and stator members to provide a short circuit connection between the rotor and stator members, at least one of said contacting surface areas of each of said conductive members making a sliding contact during rotation of said rotor member, and each of said conductive members being positioned from the end of a stator wave guide channel by a distance considerably less than one quarter wave guide wavelength when said rotor wave guide channel is in registration with a pair of stator channels.

4. A wave guide rotary switch comprising a stator member having a longitudinal cavity portion and a plurality of wave guide channels extending outwardly from said cavity at spaced intervals on the periphery thereof, a cylindrical rotor member rotatably disposed within said cavity and having at least one wave guide channel extending therethrough for providing a conductive wave guide path between different pairs of stator wave guide channels when rotated to different predetermined angular positions, a plurality of circumferentially spaced longitudinal slots extending into the cavity wall of said stator, each of said slots being separated from the cavity end of a stator wave guide channel by a distance substantially less than one quarter wave guide wavelength, a solid conductive member having a longitudinal height greater than the longitudinal dimension of a wave guide channel slidably disposed in each of said slots, and means for urging each of said conductive members outwardly into contact with said rotor member and transversely into contact with a wall of its respective slot, the contacts between said conductive members and said rotor member being sliding contacts during rotation of said rotor member.

5. A wave guide rotary switch comprising a stator member having a cylindrical cavity portion and a plurality of wave guide channels extending outwardly from said cavity at spaced intervals on the periphery thereof, a cylindrical rotor member rotatably disposed within said cavity and having at least one wave guide channel extending therethrough, said rotor channel being rotatable to bring the ends thereof into registration with the ends of different pairs of stator wave guide channels, a plurality of elongated conductive elements extending between said stator and rotor members at spaced intervals around the periphery of said cavity, said conductive elements having axial dimensions parallel to the center axis of said cavity greater than the maximum cross-sectional dimensions of said wave guide channels, each of said conductive elements being slidably positioned in a longitudinal slot in one of said members, each of said conductive elements having longitudinally extending surface areas extending substantially throughout its entire length in contact with said rotor and stator members to provide a short circuit connection therebetween, and means disposed in each of said slots for urging said conductive elements outwardly into contact with the other of said members to maintain said contact during rotation of said rotor member, each of said slots being positioned immediately adjacent a rotor wave guide broad wall when said rotor is in one of its registering positions.

6. The combination of claim 5 wherein said conductive members are comprised of a material which possesses the property of being self-lubricating.

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