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FOLDED CYLINDER GAS FILLED MICROWAVE SWITCH TUBE HAVING LONGITUDINAL RIBS FOR GAP SPACING

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FIG. 1

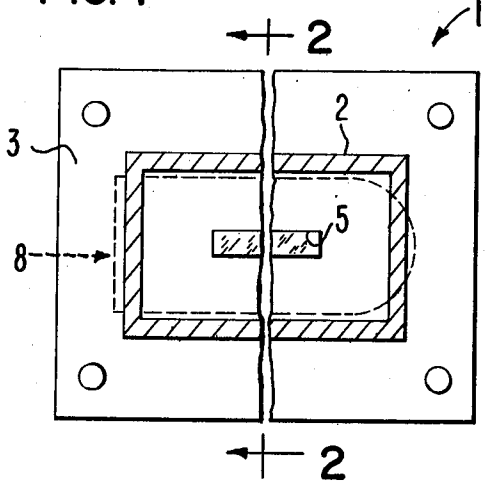


FIG. 2

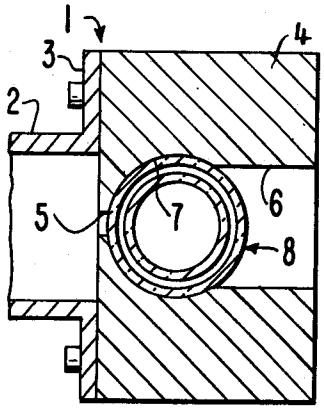


FIG. 3

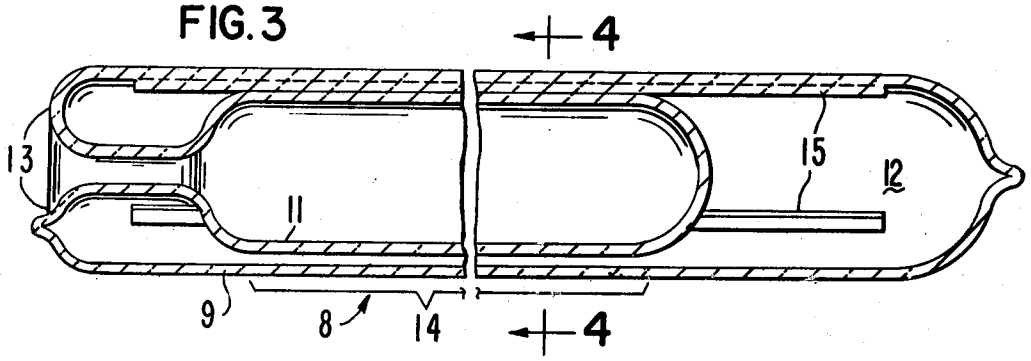
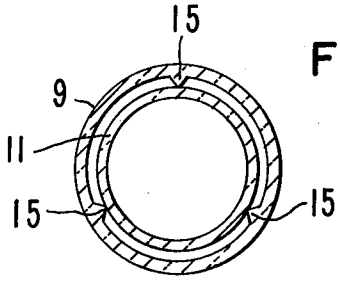


FIG. 4



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FOLDED CYLINDER GAS FILLED MICROWAVE SWITCH TUBE HAVING LONGITUDINAL RIBS FOR GAP SPACING

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ABSTRACT OF THE DISCLOSURE

A folded cylinder gas filled microwave switch tube is disclosed. The gas filled switch tube includes a dielectric envelope structure as of quartz filled with noble gas such as argon to subatmospheric pressure. The switch tube envelope structure includes an active switching region defined by the annular gas filled space between a pair of concentrically disposed tubular wall portions of the envelope structure. The thickness of the annular active switching portion is preferably as thin as possible in order to improve the recovery time of the microwave switch tube. The gap spacing between the concentrically disposed tubular wall portions of the envelope is preferably less than 0.020". The precise concentric spacing of the tubular wall portions is maintained by the provision of a plurality of longitudinally directed ribs formed on one of the opposed surfaces of the concentrically disposed tubular wall members. The ribs are preferably spaced at 120° intervals of rotation about the longitudinal axis of the folded cylinder in order to maintain precise concentricity of the tubular wall portions with a minimum number of ribs. Each of the tubular wall portions of the envelope is closed at the same end with the end walls axially spaced to define a gas reservoir at one end of the annular switching region. The concentrically disposed tubes are sealed together at their other ends to close off the envelope.

DESCRIPTION OF THE PRIOR ART

Heretofore, folded cylinder gas filled microwave switching tubes have been employed in TR and pre-TR microwave radar components. Such folded cylinder gas switch tubes have included a portion of their envelope defined by a pair of concentrically disposed quartz tubes. An example of such a prior art folded cylinder gas switch tube is found in U.S. Patent 2,922,124 issued Jan. 19, 1960 and assigned to the same assignee as the present invention. In these prior folded cylinder tubes, the radial gap spacing between the concentrically disposed tubular portions of the envelope was limited, in practice, to a spacing of approximately 0.020" due to the difficulty in maintaining precise concentricity of the two cylindrical portions of the envelope during fabrication of the gas switch tube. As a result the recovery times for such switch tubes, when employed with a pure noble gas fill such as argon, were in excess of 100 microseconds.

SUMMARY OF THE PRESENT INVENTION

The principal object of the present invention is the provision of an improved folded cylinder gas filled microwave switch tube.

One feature of the present invention is the provision, in a folded cylinder gas filled microwave switch tube, of rib means formed on one of the opposed surfaces of the concentric pair of dielectric tubes defining the annular gas filled switching region of the folded cylinder tube for precisely defining the annular thickness of the active switch portion of the folded cylinder.

Another feature of the present invention is the same as the preceding features wherein the rib means comprises a plurality of longitudinally directed ribs formed on the inside surface of the outer concentric tube, such ribs being provided at three positions about the circumference of the switch region.

Other features and advantages of the present invention will become apparent upon a perusal of the following specification taken in connection with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a transverse sectional view of a pre-TR microwave component incorporating a folded cylinder switch component incorporating a folded cylinder switch tube having features of the present invention,

FIG. 2 is a sectional view of the structure of FIG. 1 taken along line 2—2 in the direction of the arrows,

FIG. 3 is an enlarged longitudinal sectional view of a folded cylinder gas switch tube incorporating features of the present invention, and

FIG. 4 is a sectional view of the structure of FIG. 3 taken along lines 4—4 in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2 there is shown a transmit-receive (TR) type micrawave component **1** useful in microwave radar systems and incorporating features of the present invention. The TR-tube **1** includes an input section of rectangular waveguide **2** having a flange **3** bolted to a solid block of conductive material **4**, as of aluminum. The block body **4** closes off one end of the waveguide **2** and includes a centrally disposed rectangular iris **5** having a resonant frequency at the center of the passband of the microwave TR component **1**. The block body **4** includes a rectangular longitudinally directed bore **6** therein substantially of the same size as the rectangular passageway defined by the rectangular waveguide **2**. The rectangular bore **6** is axially aligned with the rectangular passageway formed by the rectangular waveguide **2**. A transversely directed cylindrical bore **7**, intersecting with the rectangular bore **6**, passes through the block **4** adjacent the iris **5**.

A folded cylinder microwave gas filled switch tube **8** is inserted within the bore **7**. The folded cylinder switch tube **8**, more fully described with regard to FIGS. 3 and 4, comprises a dielectric gas tight envelope structure as of quartz filled with a noble gas such as argon to a subatmospheric pressure such that the gas will be ionized by a substantial amount of microwave power applied to the gas tube **8** via the iris **5**. When the incident microwave power ionizes the gas fill of the switch tube **8** the gas becomes conductive and presents a substantial short circuit to the R.F. power in the waveguide at the iris **5**. Thus, the high power incident on the iris is reflected back down the waveguide **2** without passing through the switch tube **2** to more sensitive microwave components such as a microwave receiver which would be coupled to the TR component **1** on the side thereof remote from the input waveguide **2**.

Referring now to FIGS. 3 and 4, the microwave switch tube is shown in greater detail. The folded cylinder gas switch tube **8** includes a pair of concentrically disposed thin wall test-tube-shaped quartz tubes **9** and **11** axially spaced apart at their closed ends to define a reservoir portion **12** and sealed together at their open ends **13**. A relatively thin annular switching region **14** is defined in the annular space between the closely spaced side walls of the tubular members **9** and **11**.

A plurality of longitudinally directed ribs **15** are

formed on the inside wall of the outer cylindrical tubular member **9** at approximately 120° intervals about the longitudinal axis of the tube **9**. The ribs **15** are conveniently formed by extruding the tubular member **9** over a mandrel having inwardly dished grooves formed at 120° intervals to produce the inwardly directed ribs **15**. In a preferred embodiment, the tubes **9** and **11** are made of fused quartz and the mandrel is conveniently made of molybdenum. The ribs **15** serve to provide precise spacers for maintaining precise concentricity between the inner cylindrical tube **11** and the outer cylindrical tube **9** such that the annular switching gap **14** has a precisely defined and uniform thickness.

The annular gap **14** preferably has as small a radial thickness as possible in order to decrease the recovery time of the microwave switch tube **8**. Recovery time is the time it takes the discharge to quench within the gas filled folded cylinder **8** upon the termination of the incident R.F. energy. The ionized gas fill is rendered nonconductive by the ionized gas particles, within the discharge region, re-combining with electrons generally provided at the interior surfaces of the tubes **9** and **11**. Thus, the closer the spacing of the tubes **9** and **11**, the less distance that an ionized gaseous particle has to travel before it can be neutralized.

In a typical C-band folded cylinder example, the outer quartz tube **9** has a length of 4" and a wall thickness of 0.040" with an inside diameter of 0.522". The inner tube **11** had a length of 2.75" with a wall thickness of 0.040" and an outside diameter of 0.502" to define an interaction gap **14** having an annular thickness of 0.010"±0.005". The gas fill was argon at subatmospheric pressure. This switch tube was capable of operating up to 2 megawatts peak power with average powers of 50 watts to 1 kilowatt.

In another example at K*u* band, the ribs **15** cause the spacing of the annular discharge gap **14** to have a thickness of 0.005"±0.0005". The gas switch tube **8** had a recovery time less than 0.5 microsecond.

Although the ribs **15** have been shown as formed in the inner surface of the outer quartz tube **9** these ribs may equally well have been formed in the outer surface of the inner tube **11**. In addition, it is contemplated that the ribs **15** need not be formed in either of the tubes **9** or **11** but may be provided by a rib means formed by a strand of quartz fiber helically wound around the inner tube **11** such as to be disposed in between the tubes **9** and **11** to precisely define the thickness of the annular gap **14**.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a folded cylinder microwave gas filled switch tube, means forming a hollow gas filled dielectric envelope structure, said envelope structure including a portion defined by a pair of concentrically disposed radially spaced dielectric tubes to define an elongated annular gas filled switching region in the annular space between said pair of concentric tubes, the embodiment comprising, elongated rib means formed on one of the opposed surfaces of said pair of concentrically disposed tubes at a plurality of angular positions of rotation about the longitudinal axis of the tubes to precisely define the radial thickness of the annular switching region between said tubes, said ribs extending the length of said inner dielectric tube.

2. The apparatus of claim **1** wherein said rib means has the radial extent less than 0.015" to define an annular switching region with a radial thickness less than 0.015".

3. The apparatus of claim **1** wherein said rib means includes 3 ribs spaced at 120° intervals of rotation about the longitudinal axis of said tube.

4. The apparatus of claim **3** wherein said rib means are provided on the inner surface of said outer concentric tube.

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U.S. Cl. X.R.

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