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Sladek

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[54] **MICROWAVE COAXIAL SWITCH**

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[52] **U.S. Cl.** ..... **333/97 S,** 200/153 S

[51] **Int. Cl.** **H01p 1/10**

[58] **Field of Search** ..... 333/97 S, 97 R, 84 M, 333/7, 98 S; 200/153 S

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[57] **ABSTRACT**

A microwave coaxial switch which provides relatively high isolation for the unused channel over a relatively large frequency band. The switch terminals and interconnecting switch blades are positioned in a rectangular chamber proportioned to form a waveguide below cut-off for the principal waveguide mode in the operating frequency range of the switch. A recess is provided in the wall of the chamber above the terminals with a terminal-interconnecting blade being positioned in the recess in physical and electrical contact with the recess upper wall when the blade is in its inactive position.

4 Claims, 3 Drawing Figures

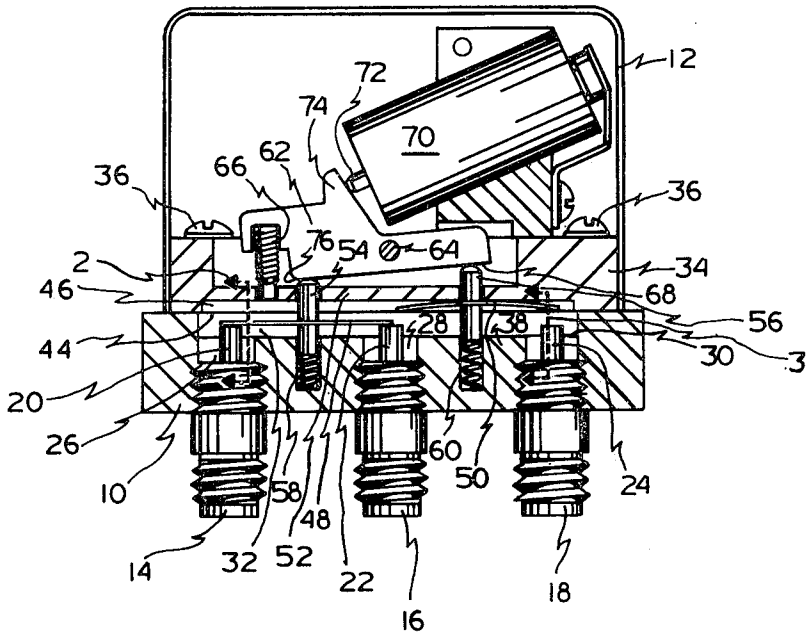
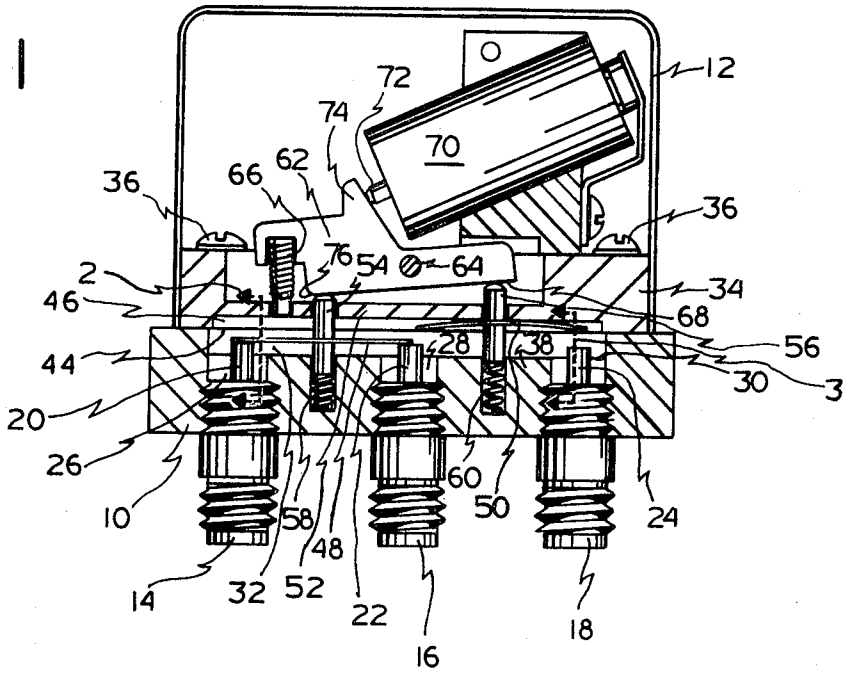


FIG. 1



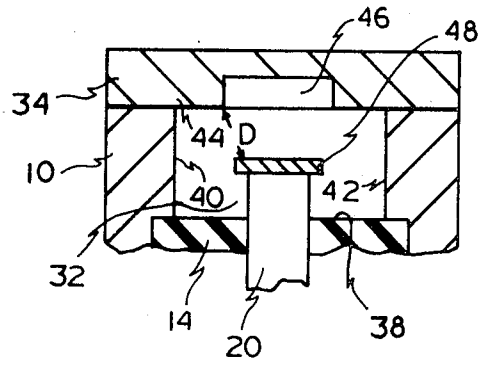


FIG. 2

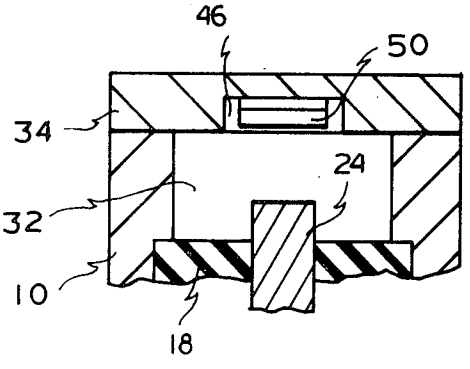


FIG. 3

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MICROWAVE COAXIAL SWITCH

This invention relates to microwave or RF coaxial switches and more particularly to a microwave coaxial switch which provides relatively high isolation for the unused channel over a relatively large frequency band.

RF coaxial switches are used for transmit-receive switches to switch a single antenna between transmitter and receiver and for many transfer purposes. As the frequencies of interest have climbed ever higher, it has been increasingly difficult to maintain optimize impedance match to the active channel, thus obtaining low VSWR (Voltage Standing Wave Ratio) and adequate RF voltage and RF power handling capabilities while still maintaining good isolation for the unused channel. While this problem may to some extent be overcome by the use of electronic devices such as semi-conductor diodes, ionizable electron tubes and various breakdown devices as the switching elements, mechanical switches are still preferrable in many instances.

Mechanical microwave switches presently being utilized for high frequency [12 gigahertz (GHz) and above] have positioned the switch blades and terminals in a chamber which is proportioned to function as a waveguide below cut-off for the principal waveguide mode in the operating frequency range of the switch. However, in order to achieve the desired level of isolation (i.e., at least 60dB of attenuation for the unused channel throughout the operating frequency range of the switch) it has heretofore been necessary to maintain the switch blade for the unused channel in uniform and intimate electrical contact with the upper wall of the waveguide chamber. In order to achieve such uniform contact, it has been necessary to provide both an absolutely flat switch blade and an absolutely flat chamber wall, the end-to-end flatness between the switch and the wall being within two mils tolerance. To achieve such a tolerance between the blade and the wall, the blade and the wall themselves must be flat to within a tolerance of less than one mil.

While with suitable care it is possible to construct elements within these fine tolerances, such tolerances are difficult and expensive to maintain. The scrap rate for elements requiring such fine tolerances is also relatively high. Further, since the cut-off frequency of the waveguide is inversely proportional to the long dimension of the waveguide cross-section, higher frequency operation for the switch can be most easily achieved by reducing the chamber size. Such reduction in size makes the parts smaller and thus more difficult to handle and further complicates the problem of maintaining extremely fine tolerances.

It is thus apparent that a need exists for a microwave coaxial switch which provides good isolation at higher frequencies while not requiring that extremely fine tolerances be maintained in the manufacturing operation.

It is therefore a primary object of this invention to provide an improved microwave coaxial switch.

A more specific object of this invention is to provide a microwave coaxial switch capable of providing adequate isolation for the unused channel at higher frequencies while not requiring that extremely fine flatness tolerances be maintained in manufacturing the switch.

Still another object of this invention is to provide a microwave coaxial switch of the type indicated above which is easier and less expensive to manufacture.

In accordance with these objects, this invention provides a microwave coaxial switch which includes a rectangular chamber proportioned to form a waveguide below cut-off for the principal waveguide mode in the operating frequency range of the switch. At least two spaced terminals project into the chamber through a first long wall of the chamber, each of the terminals being adapted to have a coaxial connector connected to it. A recess is formed along the length of the second long wall of the rectangular chamber with the recess being positioned over the terminals. A blade is positioned in the chamber to be moved between an active position interconnecting two of the terminals and an inactive position in the recess in physical and electrical contact with the recess upper wall. Means are also provided for moving the blade between its inactive and active positions.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention as illustrated in the accompanying drawings.

In the drawings:

FIG. **1** is an elevation in section of a single-pole double-throw microwave coaxial switch in accordance with the invention.

FIG. **2** is a sectional view taken along the line **2—2** in FIG. **1.**

FIG. **3** is a sectional view taken along the line **3—3** in FIG. **1.**

Referring now to FIG. **1,** a single pole, double-throw coaxial switch is depicted having a support base **10,** a dust cover **12,** and three coaxial connections **14, 16** and **18.** As will be seen, connector **16** is a common connector which is connected alternatively to one of connectors **14** and **18** by the switch. Connectors **14, 16** and **18** are mounted in a conventional manner to base **10** with their respective central terminals **20, 22** and **24** passing through apertures **26, 28** and **30** and projecting into common cavity **32.** Cavity **32** is formed by base **10** and cap **34** mounted securely on top of base **10** as by bolts **36.** Cavity **32** is bounded by walls or surfaces **38, 40** and **42** of base **10** (see FIG. **2**) and surface **44** of cap **34.** Surface **44** has a recess **46** formed in it along substantially its entire length. The dimensions of chamber **32** are such that it forms a waveguide below cut-off for the principal waveguide mode in the operating frequency range of the switch. For a switch designed to operate up to 18 GHz, these dimensions, as viewed in FIG. **2,** might be 0.18 inches by 0.1 inches. The length of the chamber would typically be from 1 to 2 inches. The dimensions of recess **46** depend on other factors which will be described later.

Positioned in cavity **32** is a first moveable conductive blade **48** positioned so that it is adapted to make an electrical connection between terminals **20** and **22.** A second moveable conductive blade **50** is positioned so that it is adapted to make electrical contact between terminals **22** and **24.** As depicted in FIG. **1,** blade **50** is positioned in recess **46.** The blade **50** is shown as being slightly bowed so that only its center portion is in intimate physical and electrical contact with the upper wall or surface **52** of recess **46.** However, the bowed in blade **50** has been exaggerated for purposes of illustration and for proper operation of the switch up to 12 to 18 GHz, this bow should not exceed 6 mils. The less the bow in blade **50** and the more intimate the contact be-

tween this blade and surface **52**, the better are the isolation and insertion loss characteristics of the switch. However, extremely fine tolerances in the selection of these elements is not essential in order to achieve satisfactory operation of the switch. While the tolerances on the flatness for the surface **52** are smaller than that for blade **50**, three or four mils tolerance from absolute flatness can be tolerated for switches having previously indicated performance characteristics. It should be noted that when blade **48** is in its inactive position in recess **46**, it too is slightly bowed.

Blades **48** and **50** are mounted respectively on pins **54** and **56**. These pins each have an axis perpendicular to the plane of the respective blade. One end of each of the pins **54** and **56** rides in a respective recess in base **10** with pin **54** resting against a compression spring **58** and pin **56** resting against a similar compression spring **60**. The opposite ends of each of the pins **54** and **56** each pass through appertures in cap **34** so that they can be moveably actuated by a rocker arm **62**. Rocker arm **62** pivots about a centrally located axis **64** and is normally positioned under control of compression spring **66** to cause a surface **68** to bear against pin **56** moving blade **50** into contact with terminals **22** and **24**. When solenoid **70** is energized, as shown in FIG. **1**, actuator **72** of the solenoid bears against projection **74** of rocker arm **62** rotating the rocker arm to cause surface **76** of the rocker arm to bear against pin **54** transferring the switch to the position shown in FIG. **1**. Springs **58** and **60** insure intimate physical and electrical contact between the blade for the unused channel and recess surface **52**.

Referring now to FIG. **3**, it is seen that the depth of recess **46** is such that when blade **50** is positioned therein, no portion of it projects into cavity **32**. The width of recess **46** is preferrable just greater than the width of the blades **48** and **50**. However, because there is some lateral movement of the blade as it is transferred between its two positions, some additional space is provided. However, the width of the recess should not exceed the width of the blade by more than 20 mils.

Since the waves propagating in chamber **32** tend to conform to the shape of the principal portion of the chamber, little of the electromagnetic energy tends to stray into recess **46** and the blade position in this recess is thus able to be more effectively isolated than would be the case if it was positioned in the chamber. Thus, more relaxed tolerances are permissable in the grounding of the blade than would otherwise be the case.

It should be noted that the switch design shown in the figures does not result in any decrease in the dimension D (see FIG. **2**), and therefore does not cause any reduction in the voltage or power handling capability of the switch. The design further results in no change in the shape, size, or orientation of the blades when in their active position and therefore permits the impedance matching characteristics of the switch to be maintained, thus maintaining a low VSWR.

While in the discussion heretofore, the switch has been referred to as a coaxial switch and the inputs as being coaxial connectors, the inputs could in fact be in the form of coaxial lines and cables, parallel plate lines, stripline, microstrip, waveguide, or any other acceptable transmission line for microwave energy. The term "coaxial" is thus being used as a generic term for the type of switch involved. It should also be understood that the actuator mechanism shown in FIG. **1** is merely by way of illustration and that any suitable actuator mechanism for transferring switch blades **48** and **50** may be utilized. The dimensions suggested for the various components have also been provided by way of illustration and would vary with specific applications.

Thus, while the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A microwave coaxial switch comprising:

a rectangular chamber proportioned to form a waveguide below cut-off for the principal waveguide mode in the operating frequency range of the switch, said chamber having first and second long walls parallel with each other;

at least two spaced terminals projecting into said chamber through said first long wall, each of said terminals being adapted to have a microwave transmission line connected thereto;

a recess formed along the length of said second long wall, said recess being positioned over said terminals and having a substantially flat upper surface;

a blade positioned to be moved between an active position interconnecting two of said terminals and an inactive position in said recess in physical and electrical contact with said upper surface, said recess being deep enough so that when said blade is positioned in said recess, in its inactive position, no portion of said blade projects into said rectangular chamber; and

means for moving said blade between its active and inactive positions said blade is substantially flat, but having a slight bow of no more than 6 mils, the bow being such that when the blade is in the inactive position, only its center portion is in intimate physical and electrical contact with said upper surface.

2. A switch of the type described in claim **1** wherein the width of said recess is slightly greater than the width of said blade.

3. A switch of the type described in claim **1** wherein the upper surface of said recess is flat to within 4 mils tolerance.

4. A switch of the type described in claim **1** wherein there are three of said spaced terminals projecting into said chamber;

wherein there is a first blade for interconnecting a first and second of said terminals and a second blade for interconnecting said second terminal and a third terminal; and

wherein said blade moving means is operative to move said blades in a manner such that when one of said blades is in its active position, the other blade is in its inactive position.

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