Dec. 15, 1959 J. E. JENNINGS ET AL 2,917,596

COAXIAL SWITCH

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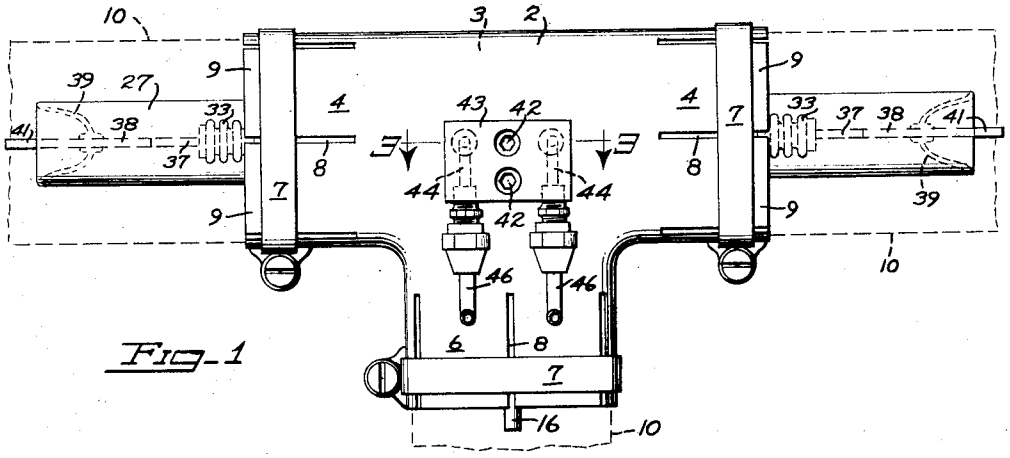


Fig-1

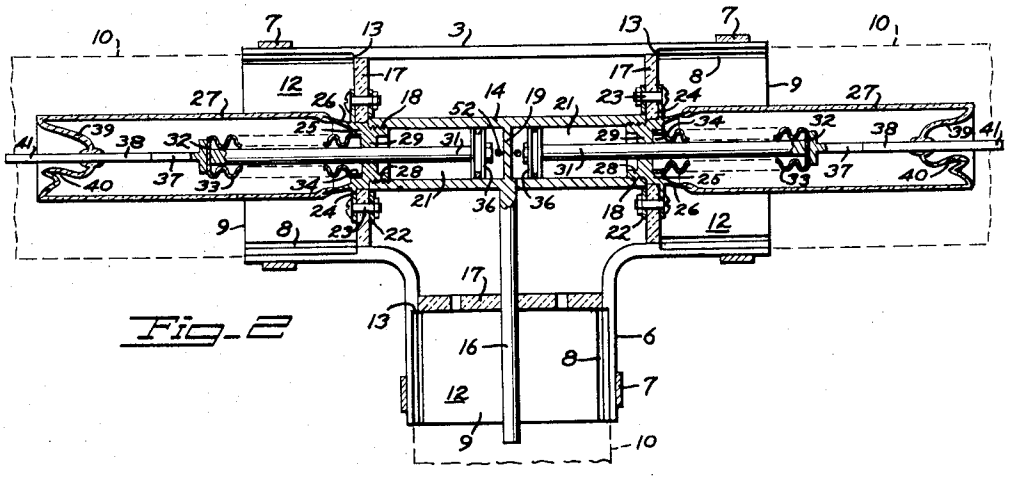


Fig-2

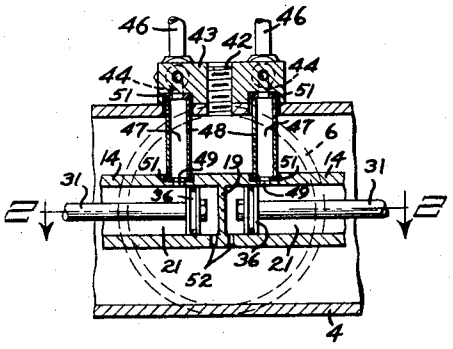


Fig-3

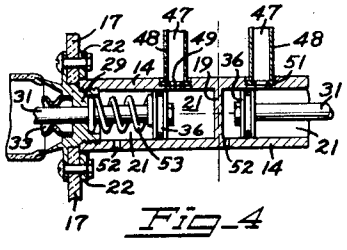


Fig-4

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COAXIAL SWITCH

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10 Claims. (Cl. 200—82)

Our invention relates to coaxial switches, and particularly to coaxial switches in which the contact elements are enclosed in a vacuum.

One of the objects of the invention is the provision of a pneumatically operated coaxial switch.

Another object is the provision of a vacuum-break coaxial switch having high impedance and a low standing-wave-ratio.

Another object is the provision of a vacuum coaxial switch which may be remotely controlled without creating shock waves in the circuit or unduly disturbing the standing-wave-ratio.

Still another object is the provision of a vacuum coaxial switch in which capacitance between adjacent circuits is negligible.

A still further object is the provision of a coaxial switch structure easily converted from a characteristic high impedance to one of relatively low impedance.

The invention possesses other objects some of which with the foregoing will be brought out in the following description of the invention. We do not limit ourselves to the showing made by the said description and the drawings, since we may adopt variant forms of the invention within the scope of the appended claims.

Referring to the drawings:

Fig. 1 is a plan view of the assembled switch. The interconnection of the outer housing of the switch with the outer conductor of the transmission line is indicated by dash lines.

Fig. 2 is a horizontal sectional view taken in the plane indicated by the line 2—2 of Fig. 3.

Fig. 3 is a fragmentary vertical sectional view taken in the plane indicated by the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary vertical sectional view taken in the same plane as Fig. 3, and showing a modified arrangement of actuating means.

All figures are drawn approximately half actual size.

Broadly considered, the coaxial switch of our invention comprises a hollow metallic outer housing having integral main and transverse portions adapted to connect with the outer conductor of standard coaxial transmission lines. Concentrically spaced within the outer housing and insulated therefrom is an inner conductor having main and transverse portions coaxial with corresponding portions of the outer housing. The transverse inner conductor serves as a radio frequency input lead integrally connected to the main portion of the inner conductor, which in turn is adapted to be selectively connected or disconnected to a standard coaxial transmission line. The inner conductor and outer housing are maintained in insulated coaxial relation by spaced dielectric walls interposed therebetween. Axially aligned fixed and movable conductive contact elements are detachably mounted on the main portion of the inner conductor and provide means for making and breaking a circuit through the switch. A vacuumized envelope, also detachably mounted on the inner conductor, encloses the fixed and movable

contact elements, and pressure responsive means outside the envelope are provided to move the enclosed movable contact element to make or break a circuit through the switch.

In television and radio, there is a continuing need for coaxial switches capable of remote control, to effect fast shifting of circuits between various coaxial transmission lines. Thus, by the use of one of our coaxial switches, one or more transmitters may be routed to various antennas or dummy loads, at the discretion of the control engineer, or automatically as the result of a mechanical failure in the circuit. The switch is capable of handling many kilowatts on the television band or in lower frequencies, without causing undue electrical disturbance in the transmission line due to its insertion.

In more specific terms, our coaxial switch comprises a hollow copper outer housing corresponding to the outer conductor of a coaxial transmission line. The housing is T-shaped and split to provide two complementary parts 2 and 3, each part having integral main and transverse portions 4 and 6 respectively. The complementary parts are held together by releasable clamps 7, and in their assembled condition, shown in Fig. 1, the housing possesses a cylindrical cross-section. Each of the free ends of the T-shaped housing is provided with slots 8, defining resilient free end portions 9, which cooperate with the clamps to connect the housing into a transmission line 10, shown in dash lines in Fig. 1. A snug slip fit between housing and transmission line is insured by providing a machined area 12 on the inner end surface of the housing. A shoulder 13 determines maximum interengagement of the housing with the associated transmission line.

Radio frequency energy is introduced into and distributed from the switch by an inner copper conductor coaxial with the outer housing and having main and transverse portions 14 and 16, respectively, corresponding to outer housing portions 4 and 6. The inner conductor portions are maintained in spaced coaxial relation to the outer housing by annular dielectric walls 17 extending therebetween, which also serve to electrically insulate the inner conductor from the outer housing.

The input lead 16 of the inner conductor is preferably cylindrical, and extends into the housing through the annular dielectric wall 17 associated with the transverse portion of the housing. At its inner end the input lead is integrally joined perpendicularly to the main portion 14 of the inner conductor. The outer end of the input lead is adapted for connection to a source of radio frequency energy. The main portion of the inner conductor is preferably tubular and provided with internal threads 18 at each end. A transverse partition 19 within the tubular conductor, positioned midway between the ends thereof, divides the interior of the tubular inner conductor into two separate axially aligned and oppositely opening chambers 21 constituting piston cylinders. Each outer end of the tubular conductor is supported in coaxial relation to the outer housing by a metallic annulus 22 which closely surrounds an end portion of the conductor. Bolts 23 demountably secure the annulus 22 to the inner side of the associated dielectric wall 17, and also clamp an annular metallic mounting flange 24 to the opposite side of the annular dielectric wall 17.

Each flange 24 is integrally brazed to the outer periphery of a metallic end cap structure 25 having at one end a flange 26 hermetically sealed to the open end of glass envelope 27, and at its other end provided with a threaded cylindrical flange 28 adapted to engage the interior threads 18 in the open end of tube 14. The end cap structure fits snugly within the central aperture of the

annular dielectric wall **17**, which at once positions and secures the end cap structure against lateral displacement and vibration, and electrically insulates it from the outer housing.

Each end cap structure also provides a radially inwardly extending annular flange **29** adapted to slidably support a stem or piston rod **31**, one end of which is integrally brazed to the closed inner end **32** of an expansible metallic bellows **33** extending into the glass envelope and having an open end **34** hermetically brazed to the end cap **25**. The other end of piston rod **31** extends into the associated air cylinder **21**, and is provided adjacent its end with a piston **36**, reciprocable within the cylinder. Reciprocation of the piston effects inward and outward movement of the closed end **32** of bellows **33**. A small diameter movable contact rod **37**, preferably of tungsten, is integrally brazed on the bellows end **32**, opposite to and axially aligned with the piston rod **31**. The movable contact is selectively engaged and disengaged within the envelope **27** with a fixed contact rod **38**, also of small diameter tungsten rod and axially aligned with the movable contact rod and hermetically sealed in the glass end wall **39** of envelope **27**. Evacuation of the envelope is accomplished through tubulation **40**. Outside the envelope, the fixed contact rod projects in a portion **41** adapted to be engaged by the inner conductor of a coaxial transmission line. The small diameter of opposed contact elements and their relatively wide spacing when open reduces to a negligible amount the open circuit capacitance between the contact elements. This is an important consideration as frequencies are increased because it tends to prevent undesirable transfer of energy to adjacent open circuits.

In order to reciprocate the piston **36**, means are provided for admitting pressure air into the cylinders **21** on one side of the pistons. Fixed on the exterior of the outer housing by set screws **42**, is a junction block **43**, bored to provide air passages **44**, each communicating at one end with an air line **46** connected to a source of air under pressure, and at the other end connecting with a passage **47** formed by glass tube **48** and port **49** opening into the conductor tube **14** behind the piston. As shown in Fig. 3, each glass tube is provided with a gasket **51** at each end to prevent leakage of air and also to form a resilient cushion for the glass. Vent hole **52** in each cylinder ahead of the piston communicates with the interior of the outer housing, which is at atmospheric pressure, and prevents the entrapment of air ahead of the piston. The use of compressed air to actuate the movable contact, and its admittance by means of a glass tube, insures a minimum disturbance in the standing wave ratio of the circuit, and also prevents formation of a conductive escape path for the considerable difference in potential between the inner conductor and the outer housing, which is at ground potential.

It will be apparent from Fig. 2 that envelope **27** with end cap **25** and movable and fixed contact rods may be detached as a unit from the inner conductor by releasing the flange **24** and disengaging flange **28** from threads **18**. The impedance of the switch may then be increased or decreased by substitution of differently proportioned contact elements, designed to produce the desired impedance. For example, the switch illustrated is designed for a rated impedance of from 100 to 300 ohms, and operation at the lower frequencies. Efficient operation at higher frequencies may be achieved by substitution of contact elements having less impedance.

While the switch illustrated in Fig. 2 is of the normally closed type, it will of course be understood that the switch may be normally open or a combination of normally open-normally closed, and still fall within the scope of the appended claims. Fig. 4 illustrates a combined normally open-normally closed switch, in which a coil compression spring **53**, possessing sufficient resilience to overcome atmospheric pressure, is interposed between a piston **36** and the associated end cap **25**. The piston and vent hole **52** are relocated so that pressure air may be admitted into the chamber behind the piston to compress the spring and close the contacts, which are normally held open by expansion of the spring.

We claim:

1. A coaxial switch for coaxial transmission line circuits comprising a hollow metallic outer housing having integral main and transverse portions, an inner conductor having main and transverse portions coaxial with corresponding portions of the outer housing, a dielectric wall interposed between corresponding main and transverse portions of inner conductor and outer housing to retain them in insulated coaxial relation, axially aligned fixed and movable conductive contact elements detachably mounted on the main portion of the inner conductor, a vacuumized envelope detachably supported on the inner conductor and defining a vacuumized chamber about the contact elements, and pressure responsive means operatively connected to the movable contact element to selectively make or break a circuit through the main and transverse portions of the inner conductor.

2. The combination according to claim 1, in which the hollow metallic outer housing comprises two separable complementary parts, and releasable clamp means are provided for normally retaining the parts in assembled relation.

3. The combination according to claim 1, in which said main portion of the inner conductor comprises a cylindrical tube transversely partitioned intermediate its ends to provide a pair of oppositely opening hollow chambers, and said fixed and movable conductive contact elements are detachably supported adjacent the open ends of the chambers and are responsive to pressure therein to make and break a circuit.

4. The combination according to claim 1, in which said fixed contact is electrically insulated by a portion of the envelope from both the movable contact and the inner conductor in the open position of the contacts, and said movable contact is conductively related in all its positions with said inner conductor.

5. The combination according to claim 1, in which said vacuumized envelope includes a dielectric shell hermetically sealed at one end by a metallic end cap including an expansible metallic bellows, and the end cap and bellows are detachably mounted on the main portion of the inner conductor in conductive relation thereto.

6. The combination according to claim 3, in which dielectric tube means are provided interposed between the inner conductor and the outer housing to communicate the interior of each said hollow chamber with a source of air under pressure.

7. In a coaxial switch, a hollow metallic outer housing having integral main and transverse portions, an inner conductor having main and transverse portions coaxial with corresponding portions of the outer housing, said main portion of the inner conductor comprising a cylindrical tube transversely partitioned intermediate its ends to provide a pair of oppositely opening hollow chambers constituting piston cylinders, and a vacuumized envelope comprising a dielectric shell hermetically sealed at one end by a metallic end cap including a mechanically expansible metallic bellows.

8. The combination according to claim 7, in which annular dielectric wall means are provided interposed between the inner conductor and outer housing to retain the inner conductor in spaced concentric relation within the outer housing.

9. The combination according to claim 7, in which a pressure responsive piston and stem are operatively interposed between said bellows and said piston cylinders to effect selective expansion and contraction of the bellows.

10. The combination according to claim 7, in which a

contact element is integrally brazed on one end of the bellows within the envelope and is movable therewith.

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