

Dec. 18, 1956

C. D. MCGILLEM ET AL

2,774,946

CONTROLLER FOR WAVE GUIDE TUNER, PHASE SHIFTER, OR ATTENUATOR

Filed March 12, 1954

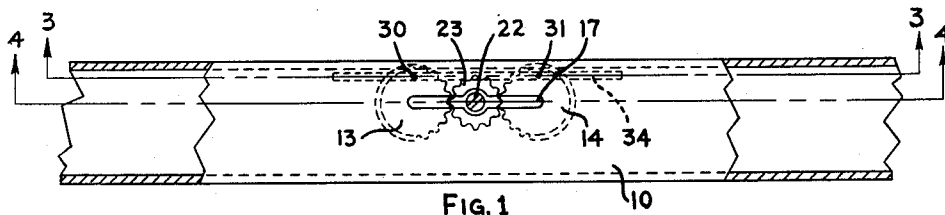


FIG. 1

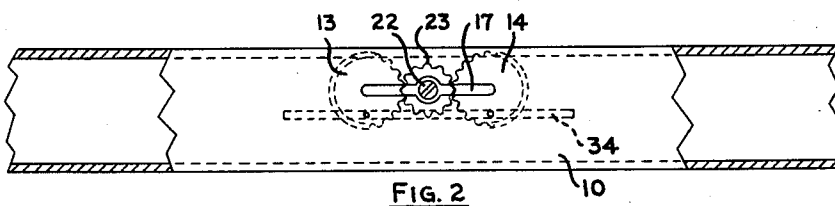


FIG. 2

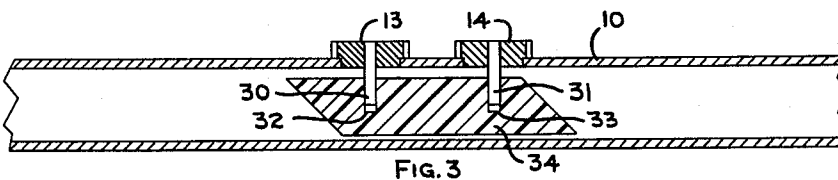


FIG. 3

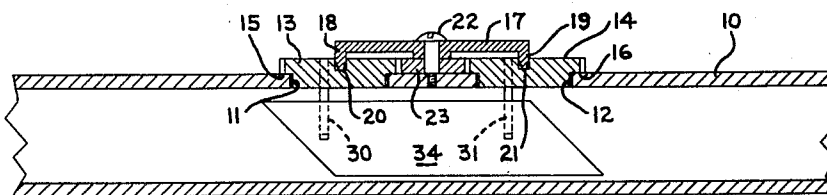


FIG. 4

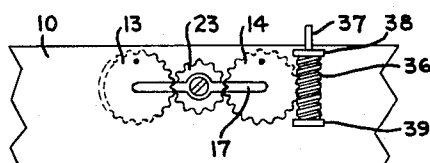


FIG. 5

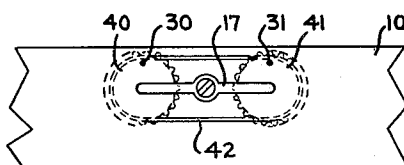


FIG. 6

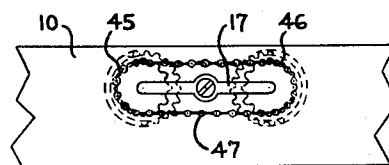


FIG. 7

INVENTOR.
CLARE D. MCGILLEM
BY FRANK E. HASSELD, JR.
G. D. McGillem
F. E. Hasseld, Jr.
ATTYS.

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CONTROLLER FOR WAVE GUIDE TUNER, PHASE SHIFTER, OR ATTENUATOR

Clare D. McGillem and Frank E. Hasseld, Jr., Indianapolis, Ind., assignors to the United States of America as represented by the Secretary of the Navy

Application March 12, 1954, Serial No. 415,987

10 Claims. (Cl. 333—98)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to waveguides and more particularly to a means for controlling a conductive impedance element or a dielectric impedance element within a rectangular waveguide from a point externally thereof in a compact manner to control the microwave energy therein without producing any openings, cavities, or extensions within the waveguide to otherwise deteriorate from or contaminate the microwave energy.

In the known tuner, attenuator, and phase shifter controlling devices for waveguides, the controlling mechanism is a rather cumbersome piece of equipment supported externally of the waveguide. In some of these devices one of the faces of the waveguide is slotted along the center and the internal element is mechanically raised or lowered into and out of the waveguide through the slot. Other means of single screw, single slug, or multiple screw or slug controlling devices are commonly used wherein variations in the depth of the screws or slugs, or of the spacing of multiple screws or slugs, provide the control at the sacrifice of cumbersome external manipulating means. Further, waveguide openings or cavities for these screw or slug means often produce undesirable modification in the microwave energy. The above known devices are usually made with coarse adjustment means and oftentimes do not provide a smooth operation for control over the microwave energy which is necessary in precision use of the controlling elements.

In the present invention spaced circular openings are cut through one face of a rectangular waveguide near a corner thereof. A pair of disks are rotatably mounted in these circular openings and are coupled together to rotate in unison. The inner surface of each disk is flush with the inner wall of the waveguide and each disk is eccentrically pivotally connected on its inner face to an elongated planar impedance or microwave control element, the pivotal points on the respective disks lying in the same relative eccentric position whereby the unitary rotation of the disks carries the microwave control element to and from the central area of the waveguide. The microwave control element is tapered on each end to a half wave length in the usual and ordinary manner of construction of these elements. If the device of the present invention is used as a tuner, the material of the microwave control element should be a good electrical conductor. If the device is used as an attenuator of the microwaves, the material of the microwave control element should be of a "lossy" material, as carbon. Polystyrene has been found to be the best material for constructing the microwave control element where the device is to be used to phase shift the microwave energy although most of the dielectric materials having a high dielectric constant may be used, where desired. It is therefore a general object of this invention to provide a compact manipulating means for controlling the microwave energy in a rectangular waveguide without making any obstructions or openings therein to contaminate or deteriorate from the microwave energy.

These and other objects, advantages, features, and uses will become more apparent as the description proceeds

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when considered with the accompanying drawing, in which:

Fig. 1 is a top elevational partial view of a waveguide showing the external adjustable means of the impedance element in accordance with this invention;

Fig. 2 is a view similar to Fig. 1 showing the impedance element in a different adjusted position;

Fig. 3 is a side longitudinal cross-sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is a side longitudinal cross-sectional view taken along the line 4—4 of Fig. 1;

Fig. 5 is a partial top view of the device shown in Fig. 1 showing an additional means to drive the adjustable means;

Fig. 6 is a top plan view of a modified form of the adjusting means shown in Figs. 1 and 2; and

Fig. 7 is a top plan view of still another modification of the impedance element adjusting means.

Referring more particularly to Figs. 1 to 4, there is shown a rectangular waveguide 10 on one face of which is supported an adjustable means for an internal microwave control element. Two circular openings 11 and 12 rotatably support two similar shouldered gears 13 and 14, the shoulders 15 and 16, respectively, of each resting against the outer surface of the waveguide 10 with the inner face of each being flush with the inner surface of the waveguide. The two gears 13 and 14 are held against movement outwardly from the openings 11 and 12 by a retaining bracket 17 having the outermost ends 18 and 19 turned at right angles and pivotally set respectively in central sockets 20 and 21 of gears 13 and 14. The retaining bracket 17 is held in position by a stud screw 22 threaded in a tapped opening of the waveguide equidistantly between the two gears 13 and 14. The stud 22 is shouldered at the end of the threaded portion to hold the retaining bar 17 in a predetermined position. On the shank of the screw 22 between the retaining bracket 17 and the wall of the waveguide 10 is an idler gear 23 that meshes with both gears 13 and 14. The idler gear 23 couples the gears 13 and 14 together to cause simultaneous rotation of these two gears in the same rotative direction and at the same angular speed.

Each of the gears 13 and 14 has a drilled opening eccentrically therethrough in each of which is fixed, as by cementing or press fitting, a dielectric rod or pin 30 and 31, respectively, more clearly seen in Fig. 3. Each rod is positioned at the same radial distance on the respective gear and in the same angular relation so that they will move in equal amounts over identical arcs from the side wall of the waveguide upon actuation of the gears 13 and 14. In order to arrange the rods 30 and 31 to operate between positions adjacent the side wall of the waveguide and the central area thereof, the openings 11 and 12 are made near one corner of the waveguide as shown. The rods 30 and 31 extend into blind bores 32 and 33, respectively, of a thin microwave control element 34, best seen in Fig. 3. The element 34 is a thin strip of material that is slightly narrower than the waveguide inner sidewall dimension to permit it to be slidably carried by the rods 30 and 31 laterally back and forth across the waveguide from the waveguide sidewall to the central area, as seen in Fig. 2. The side faces of the element 34 always remain parallel to the sidewalls of the waveguide such that in the position where the element 34 is fully withdrawn from the central area of the waveguide it is held flat against the sidewall and is substantially ineffective on the microwave energy. The element 34 is shown as a dielectric material such as polystyrene for the purpose of illustrating the invention although conductive material or carbonous material may be used where the device is to function as a tuner or an attenuator, respectively. The ends of the element 34 are cut at an angle forming a parallelogram with

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the sides, as viewed in Figs. 3 and 4, as is the usual practice in controlling the phase of the microwaves, these tapered portions being in the order of one half a wavelength of the microwaves for optimum matching.

The teeth on the gears 13 and 14 serve as knurled portions for manually manipulating the adjustment of the microwave control element 34, the actuation of either gear producing the adjustment. It may be desirable in some instances to actuate the adjustable means by a motor-driven means to produce cycling, or the like. In such instances a worm gear 36, as seen in Fig. 5, may be meshed with the gear teeth of one of the gears 13 or 14 and rotated through an integral or fixed shaft 37. The worm gear 36 and shaft 37 are supported in bearing supports 38 and 39 attached to the waveguide.

The two gears 13 and 14 may be replaced by pulleys 40 and 41, as shown in Fig. 6. The pulleys are coupled together by a belt 42 whereby the pulleys rotate in unison to carry the microwave control element 34 laterally back and forth in the waveguide. A driving or cycling means may be coupled to one of the pulleys in the same manner as shown in Fig. 5.

As shown in Fig. 7, the gears 13 and 14 may be replaced by sprocket wheels 45 and 46 and coupled together by a chain 47. The rim of one or both of the sprocket wheels could be toothed to provide knurled means for manual adjustment or to couple a driving or cycling means as shown in Fig. 5.

The operation of the waveguide controlling device is believed to be clear and apparent from the above description but a brief description of operation will be given herein for the convenience of reference. For an example in describing the operation, let it be assumed that the device is a phase shifter wherein the microwave control element 34 should be made of a dielectric material as polystyrene. In the position shown in Fig. 1 the control element 34 is adjacent the side wall of the waveguide where substantially no phase shift is produced. By rotating either gear 13 or 14 in either rotative direction the control element 34 will be carried in an increasing amount toward the center of the waveguide or the extreme position, as shown in dotted lines in Fig. 2. The shift in phase of the microwaves passing through the waveguide is a continuously increasing function as the distance of the control element 34 is increased from the sidewall to the center, the maximum occurring when the control element 34 is positioned in the central area of the waveguide. The inner faces of the gears 13 and 14 provide a smooth continuation of the inner wall surface of the waveguide so that the microwave energy is not altered in any way by the actuating mechanism.

Tuning can be accomplished in the same way where the microwave control element is of good electrical conductive material. Attenuation of the microwaves in the waveguide may likewise be adjustably controlled by using a "lossy" material as carbon, or the like.

While the preferred forms of the invention have been shown and described herein, it is to be understood that many modifications and changes may be made in the constructional details and features of this invention without departing from the spirit and scope thereof and we desire to be limited only in the scope of the appended claims.

We claim:

1. In a waveguide a means for controlling the microwave energy therein comprising, a pair of circular openings through a wall of the waveguide in longitudinal relation, a pair of circular elements rotatably journaled in said circular openings respectively with the inner face of each flush with the inner surface of said waveguide and being coupled to rotate in unison, and an elongated microwave control element in said waveguide and lying longitudinally thereof, said control element being pivotally associated with said pair of circular elements at separate points whereby rotation of either circular element of said

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pair will shift said control element laterally in said waveguide.

2. In a rectangular waveguide a means for controlling the microwaves therein comprising; a pair of circular openings through one wall of the waveguide in longitudinal relation thereof; a pair of circular elements, one each being rotatably journaled in one each of said circular openings with the inner face of each flush with the inner surface of said waveguide; means coupling said pair of circular elements for rotation thereof in unison; an elongated microwave control element within said waveguide lying longitudinally thereof; pivotal means connecting each circular element to said control element at spaced points; and means for rotating at least one of said circular elements of said pair whereby rotation of said one of said pair of said circular elements will shift said control element laterally of said waveguide.

3. A device as set forth in claim 2 wherein said circular openings are of a diameter equal to substantially one-half the internal width of said waveguide and a sidewall of said waveguide is tangential to said circular openings, and said pivotal means is a rod extension on each circular element eccentrically and parallel to the axis of each respective circular element each extending into a bore in said control element.

4. A device as set forth in claim 3 wherein said means for rotating at least one of said circular elements are gear teeth on the periphery of said one element extending above and externally of said waveguide.

5. A device as set forth in claim 4 wherein said means coupling said pair of circular elements for rotation in unison are gear teeth on the other of said circular elements extending above and externally of said waveguide and an idler gear meshing with the gear teeth of both said circular elements.

6. The device as set forth in claim 2 wherein said means coupling said pair of circular elements for rotation in unison is an idler gear between said circular elements cooperative with gear teeth on the periphery of said circular elements and said means for rotating at least one of said circular elements of said pair is a worm gear in mesh therewith, said worm gear having a shaft extension thereon for transmitting power from a rotational source.

7. A waveguide control device as set forth in claim 2 wherein said means coupling said pair of circular elements for rotation in unison is a belt passed over pulley portions of each circular element exterior of said waveguide.

8. A waveguide control device as set forth in claim 7 wherein said means for rotating at least one of said circular elements of said pair is a worm gear on a power input shaft in mesh with gear teeth on said one circular element.

9. A waveguide control device as set forth in claim 2 wherein said means coupling said pair of circular elements for rotation in unison is a chain passed over sprocket portions of each circular element exterior of said waveguide.

10. A waveguide control device as set forth in claim 9 wherein said means for rotating at least one of said circular elements of said pair is a worm gear on a power input shaft in mesh with gear teeth on said one circular element.

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