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DEFORMABLE WALL TUNING OF RESONANT CAVITIES
FOR ELECTRON DISCHARGE TUBES
Filed July 5, 1962

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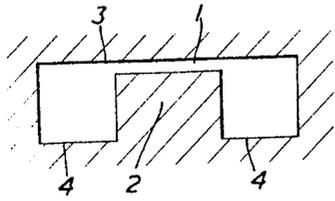


FIG. 1.

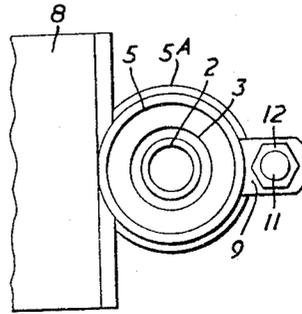


FIG. 2.

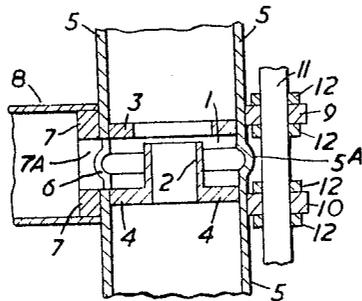


FIG. 3.

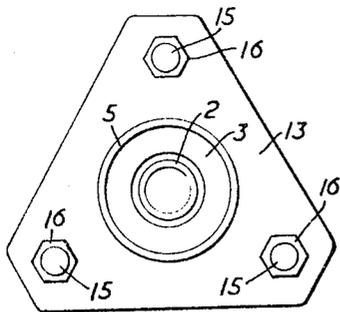


FIG. 4.

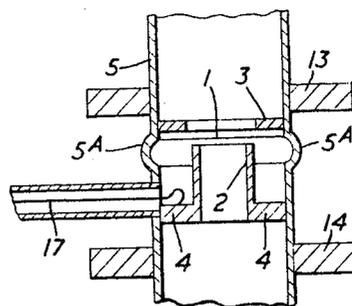


FIG. 5.

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DEFORMABLE WALL TUNING OF RESONANT CAVITIES FOR ELECTRON DISCHARGE TUBES**John Ralph Bagnall, Chelmsford, England, assignor to English Electric Valve Company Limited, London, England, a British company**

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1 Claim. (Cl. 315—5.22)

This invention relates to resonant cavities suitable for use in klystron and similar electron-velocity-modulated discharge tubes and to discharge tubes incorporating such cavities.

The invention is illustrated in and explained in connection with the accompanying drawings in which FIGURE 1 is a highly simplified cross section view illustrative of common current practice in tunable resonant cavities for use in klystrons; FIGURE 2 is a plan view and FIGURE 3 is a sectional elevation showing, so far as is necessary to an understanding thereof, one form of tunable resonant cavity in accordance with this invention and suitable for use in a klystron; and FIGURES 4 and 5 are views of the same nature as FIGURES 2 and 3 respectively, showing another embodiment of the invention.

FIGURE 1 illustrates the so-called cylindrical reentrant type of resonant cavity commonly employed in integral resonant cavity klystrons at the present time. Such klystrons may, of course, have one or more such cavities. The cavity proper is the unshaded space 1 within the metal walls represented in FIGURE 1 by the externally cross-hatched line bounding the space. As will be seen there is a central upstanding so-called "post" 2, the top of which faces the top wall 3 which is substantially parallel to and fairly close to the top of the post, the wall 3 being also substantially parallel to, but at a considerably greater distance from, the annular bottom wall 4 round the bottom of the post. The cavity thus formed is, in section, roughly dumb-bell shaped. It is common to provide for tuning a klystron resonant cavity by varying its axial dimensions and, at present, this is normally done by making one or the other of the opposite substantially parallel walls of the cavity in the form of a thin flexible metal diaphragm and providing a screw or other device to deform the flexible wall in question towards or away from the opposite wall. Thus, in the case of a cavity as illustrated by FIGURE 1, current practice would be to constitute the wall 3 or the wall 4 by a thin flexible metal diaphragm and to provide a screw or the like (not shown) to deform the diaphragm so as to vary, for tuning purposes, the separating gap between the wall 3 and the adjacent top of the post 2.

The amount of variation of separating gap required for tuning purposes is very small. Thus, to quote typical practical figures, a change of 0.001" in the separating gap of a cavity as represented by FIGURE 1 is sufficient to produce a change of somewhere about 200 to 250 mc./s. in the resonant frequency of a cavity designed for operation at about 10,000 mc./s. Accordingly, known tunable resonant cavities of the type described, wherein one of the cavity walls is constituted by a flexible diaphragm, have the serious defect that ambient temperature changes, ambient pressure changes, vibration and other more or less random extraneous causes are apt to produce undesired movements of the diaphragm big enough to result in material undesired changes in resonant frequency. The present invention seeks to avoid this defect.

According to this invention the walls of a tunable resonant cavity suitable for use in a klystron or like electron discharge tube include two mutually spaced walls connected together and spaced from one another by a

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third wall which is of tubular form. At least a portion of said third wall is deformable to vary its length and therefore to vary the separating distance between said two mutually spaced walls. By deforming the tubular wall to vary its length, the separating distance between the said two mutually spaced walls, and therefore the resonant frequency of the cavity, may be varied.

Preferably, though not necessarily, the tubular wall is circular in shape and the two mutually spaced walls are circular, one of the latter walls comprising an annular portion and a central post portion, the top of which is fairly close to the other wall.

Preferably the tubular wall is caused to be deformable by constructing it with at least one convolution or bellows-like bend in its length, means being provided for deforming said bend or convolution to vary the overall length of the whole tubular wall.

In one way of carrying out the invention, the means for deforming the tubular wall comprise means for varying its length symmetrically with respect to the axis so that, in any position of adjustment, the length of said tubular wall, measured along lines parallel to the axis, is the same for all such lines. In another way of carrying out the invention, however, the adjustment of length is asymmetrical, the length of the tubular wall at one place round the periphery being fixed and means being provided for deforming said wall to vary the length elsewhere.

Because variation of the resonant frequency is obtained by deforming a tubular wall to vary its length and thereby to vary the distance between two other walls joined by said tubular wall and co-operating therewith to form the cavity, and because neither of said two other walls is constituted by a diaphragm or is flexible in the ordinary sense of that word, there is good precise control of frequency adjustment and much greater immunity from undesired frequency variation due to ambient temperature and pressure variation, or to vibration, than is the case with the usual known structures of the diaphragm wall type. The deforming means may comprise screws or bolts symmetrically arranged round the tubular wall in the case of axially symmetrical adjustment of length or one screw or bolt in the case of axially asymmetrical adjustment of length.

FIGURES 2 and 3 show an embodiment, illustrated as applied to a klystron cavity with a waveguide feed to (or from) the cavity wherein the adjustment is axially asymmetrical. Here the space 1 within the cavity is between two transverse metal walls, namely the centrally apertured wall 3 and a wall formed with a central post 2 surrounded by an annular wall member 4. These transverse metal walls are spaced apart along the length of and are brazed to a circular deformable metal tube 5, part of the length of which, between the transverse walls, is formed with a convolution or bellows-like bend 5A which can be deformed to vary the spacing of the transverse walls. There is a hole 6 in the tube 5 for coupling high frequency energy into or out of the cavity and a window plate 7 with a corresponding hole 7A is brazed to the tube 5 so that, at the side where this plate is situated, the length of the tube 5 is rigidly fixed. A waveguide 8 is brazed to the plate 7 and is fitted with a vacuum-retaining mica or glass window (not shown) extending across it to pass high frequency wave energy in accordance with practice known per se. Two lugs 9 and 10 are brazed to the tube 5 near the transverse walls and on the outside of said tube opposite to the location of the plate 7 and waveguide 8. A single screw 11 (shown broken away) fitted with nuts 12 passes through the lugs. As will be apparent, it is possible by means of the screw 11 and nuts 12 to force the lugs 9 and 10 to-

wards or away from one another, deforming the part of the bend 5A opposite the waveguide 8 and thus changing the length of the tube 5 asymmetrically with respect to the axis. In this way the separation of the two transverse walls can be varied to vary the resonant frequency. The transverse walls are a fixed distance apart on the side adjacent the plate 7 but the separating distance on the opposite side is variable. In one successfully tested structure as illustrated in FIGURES 2 and 3, the tube 5 was made of nickel-iron alloy with a wall thickness of 0.03". This structure was found relatively simple and easy to tune and to be relatively insensitive to normal variations of ambient temperature and pressure and to vibration and shock.

The modification shown in FIGURES 4 and 5 will be found largely self-explanatory since like references are used for like parts in FIGURES 2 to 5. In FIGURES 4 and 5 two triangular plates 13 and 14 replace the lugs 9 and 10 of FIGURES 2 and 3 and the window plate 7 is dispensed with so that the length of the tube is variable in an axially symmetrical manner. Such variation is effected by three symmetrically arranged screws 15 fitted with nuts 16 (the screws and nuts are not shown in FIGURE 5) and connecting the plates 13 and 14 together. In FIGURES 4 and 5 a co-axial line feed 17 is shown in place of a waveguide.

I claim:

An electron discharge tube having a tunable resonant cavity comprising, a pair of separated rigid walls, a uni-

tary tubular wall joining and extending beyond said pair of rigid walls, said unitary tubular wall including a deformable portion disposed between said rigid walls, said unitary tubular wall having substantially uniform substantial thickness throughout its length including said deformable portion; a pair of spaced body portions extending transversely of and connected to said unitary tubular wall on opposite sides of said deformable portion, and means adjustably connected between said pair of spaced body portions and adjustable to apply pressure to said deformable portion through said tubular wall to distort said deformable portion to a greater or lesser extent to vary the distance separating said rigid walls, thereby varying the resonant frequency of the cavity.

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