Sept. 8, 1959 A. J. LOMBARDI 2,903,659

RESONANT CAVITY WITH FIXED CONTACT ADJUSTABLE PLUNGER

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Fig. 1

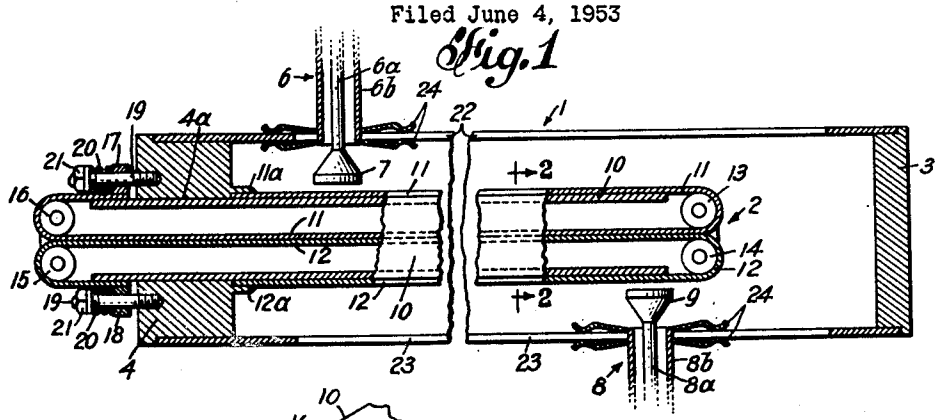


Fig. 2

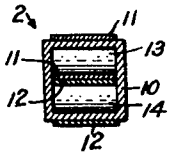


Fig. 2a

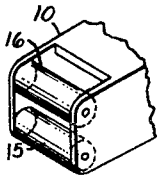


Fig. 3

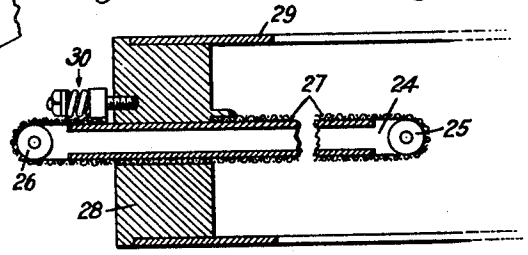


Fig. 4

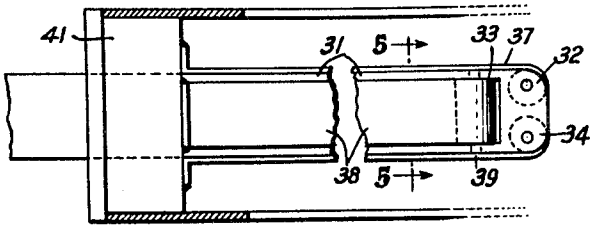


Fig. 5

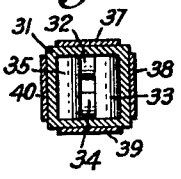
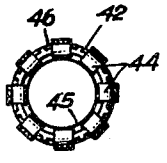


Fig. 7



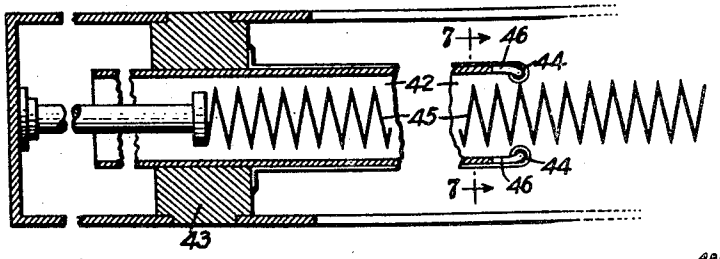


Fig. 6

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RESONANT CAVITY WITH FIXED CONTACT ADJUSTABLE PLUNGER

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11 Claims. (Cl. 333—82)

This invention relates generally to fixed contact adjustable plungers for use with a tunable resonant cavity.

The simplest form of a tunable cavity utilizing transmission line elements comprises a quarter wavelength of line, short circuited at one end and open circuited at the other end. The adjustments of the frequency at which the cavity resonates is accomplished by simply changing the length of the transmission line. In the past when a coaxial transmission line was utilized, the change in length has been accomplished by either moving the location of the short circuit relative to the open circuit end or by varying the length of the inner conductor and, in effect, varying the open circuit end. When the length of the inner conductor was changed it has been common to utilize an inner conductor which had a plurality of telescoping sections or an inner conductor having a screw thread which, by turning, caused the inner conductor to penetrate into the cavity. Both of these methods of varying the length of inner conductor are undesirable when the cavity is to have broad frequency band characteristics for use with high power transmission because of the contact losses that appear between the sliding surfaces when the inner conductor was varied in length. In addition to the mere contact losses, the continuous friction between the sliding elements eventually wore down the physical dimensions creating mechanical instability and other electrical losses.

One of the objects of this invention, therefore, is to provide an adjustable short circuit fixed contact capable of carrying high currents without excessive losses.

Another object of this invention is the design of an inner conductor which is fully adjustable in length within a resonant cavity without presenting any transverse discontinuity to radio frequency current flow.

A further object of this invention is to provide an ultra high frequency resonant coaxial line cavity wherein the conductive portions of the tunable cavity plunger are integral with the end wall of the cavity.

One of the features of this invention comprises the use of a quarter wavelength resonant coaxial transmission line cavity having an outer conductor formed of a hollow member and an inner conductor or tuning plunger. Input and output probes extend through the outer conductor and are in coupling relation with the inner conductor. In one form of the invention, for example, two conductors formed of thin conductive bands or ribbons are secured to the end wall adjacent to an elongated member which is movably supported in an opening in the end wall and extends coaxially into said hollow member. Rollers are provided at each end of the elongated member and the conductors extend from said end wall lengthwise adjacent said member and are mounted to permit a variable insertion of the elongated member within the cavity to provide for tuning. There are no moving contacts on the conductor, thus obviating any transverse discontinuity to radio frequency current flow. The high current point of the inner conductor ribbon or band is permanently fastened to the back of the cavity.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal cross-sectional view of one embodiment of a resonant cavity employing the fixed contact adjustable plunger of this invention;

Fig. 2 is a cross-sectional view of the adjustable plunger taken along lines 2—2 of Fig. 1;

Fig. 2*a* is a perspective view of part of the elongated member;

Fig. 3 is a longitudinal cross-sectional view of an alternate embodiment of the adjustable plunger of this invention;

Fig. 4 is a longitudinal cross-sectional view of another embodiment of the adjustable plunger of this invention;

Fig. 5 is a cross-sectional view taken along the lines 5—5 of Fig. 4;

Fig. 6 is a longitudinal cross-sectional view of an adjustable plunger for use with a helical inner conductor; and

Fig. 7 is a cross-sectional view taken along the lines 7—7 of Fig. 6.

Referring to Figs. 1 and 2 of the drawing a fixed contact adjustable plunger for use in the resonant cavity therein shown comprises a resonant coaxial transmission line structure having an outer conductor 1 formed of a hollow member and an inner conductor structure 2. The outer conductor 1 is terminated at one end by a cap 3 and at the other end by end wall 4. Radio frequency energy is coupled to the cavity by input coaxial cable 6 which has its inner conductor 6*a* terminated in probe 7 and its outer conductor 6*b* coupled to the hollow member 1 of the transmission line. Energy is coupled from the cavity by use of an output coaxial cable 8 having its inner conductor 8*a* terminated in an output probe 9 and its outer conductor 8*b* coupled to the outer conductor 1 of the transmission line. The inner conductor structure 2 comprises a movable elongated member 10 and a pair of conductors 11 and 12. The structure of the end of the elongated member 10 is depicted in the perspective view shown in Fig. 2*a*. The conductors 11 and 12 may be in the form of metallic bands or ribbons and may be mesh or solid and composed of a material such as silver alloy. Each conductor 11 and 12 is permanently secured as indicated at 11*a* and 12*a* to the inner side of end wall 4 adjacent to opening 4*a* of the resonant cavity. The elongated member 10 is movably supported in the opening 4*a* of end wall 4. The conductors 11 and 12 extend from end wall 4 lengthwise adjacent to the elongated member 10 to the forward end thereof and pass over rollers 13 and 14 mounted at the end of the elongated member 10. After passing over the rollers 13 and 14 the conductors 11 and 12 pass through the opening 4*a* in end wall 4 internal of the elongated member 10 and are passed over rollers 15 and 16 mounted on the outer end of member 10 and permanently coupled to tension blocks 17 and 18 which are on the outer side of plate 4. Each tension block 17 and 18 is securely fastened to end wall 4 by means of a screw 19. In order to maintain constant tension upon each conductor 11 and 12 a spring 20 and band tension nut 21 are provided.

In order to tune the cavity to resonance at a predetermined frequency the inner conductor 2 is moved into the outer conductor 1 for a distance substantially equal to a quarter wavelength at the predetermined frequency. It is obvious that as the inner conductor structure 2 is moved into or out of the structure 1 the conductors 11 and 12 remain fixed to tension blocks 17 and 18 and end wall 4, or in other words the high current point of the inner conductor ribbons are permanently

soldered to the back of the cavity, thus no moving contacts on the inner conductor are present, obviating any transverse discontinuities to the radio frequency current flow.

The probes 7 and 9 are movably mounted in tracks 22 and 23 and the outer conductors 6*b* and 8*b* of cables 6 and 8 are electrically connected to the cavity wall 1 by means of spring finger contacts 24 which insure good electrical contact with low leakage as the probes 7 and 9 are moved for optimum coupling relation. By moving the probes 7 and 9 along tracks 22 and 23, the loaded Q of each cavity is adjusted for proper bandwidth due to the change in location or orientation of the probes relative to the maximum E or H field coupling. Although loop type coupling can be utilized it is preferable to use capacitive probes since the location, and if necessary the depth, of the probe type coupling is most easily changed.

Referring to Fig. 3, an alternate embodiment of the fixed contact adjustable plunger of this invention is shown comprising a movable elongated member 24 terminated at each end by a roller 25 and 26. A conductor shown as a meshed belt 27 is permanently fastened to the end plate 28 terminating one end of the outer hollow member 29 of the cavity resonator and extends lengthwise of the elongated member 24 around roller 25 and back through the end plate 28 and around roller 26 and is fastened to the tension block assembly 30. The total length of the conductor 27 is substantially equal to twice the axial length of the elongated member 24. The elongated member 24 may be solid or hollow since the ribbon 27 is disposed only along its perimeter.

Referring to Figs. 4 and 5, another embodiment of the tuning plunger having a fixed contact in accordance with the principles of this invention is shown comprising movable elongated member 31 having a square cross section. Member 31 is termiated at its outer edge by a plurality of rollers 32–35, each roller associated with one surface of the support means 31. A plurality of conductors 37–40, one for each surface have one end fastened to an end plate 41 of the resonant cavity and extend lengthwise of the member 31 to rollers 32–35. Each of the conductors 37–40 is formed from a prestressed metallic belt so that in the absence of tension applied between its fastened end and its outer extremity the conductor will coil up upon itself. Due to the prestressing of the conductors as the member 31 is withdrawn from the resonant cavity the conductors 37–40 will coil upon rollers 32–35 decreasing the effective length of conductive ribbon in the cavity and therefore varying the resonant frequency.

Referring to Figs. 6 and 7 a fixed contact adjustable plunger for use in tuning the helical inner conductor of a resonant coaxial line comprises a tubular support member 42 movably mounted through the end plate 43. On the periphery of the member 42 are a plurality of prestressed conductors 44 each having one end fastened to the end plate 43. As the member 42 is withdrawn from the resonant coaxial line fewer turns of the helical inner conductor 45 are shorted out, thus lowering the resonant frequency of the cavity. In order to allow for the increased diameter of the conductors as they are coiled, slots 46 are provided which permit slight expansion of the outer edge of member 42. Alternately a roller may be provided upon which the prestressed conductors 44 may coil.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. A resonant cavity structure comprising a hollow member, a plunger extending coaxially into said member through an opening in an end wall defining a quarter wave resonant coaxial line, said plunger including an elongated member movably supported in said opening for adjustable extension beyond said wall, a flexible conductor having a relatively smooth continuous surface disposed in said hollow member lengthwise with said elongated member and folded over the end thereof, and means positionally fixing the ends of said flexible conductor to said hollow member whereby an adjustment of said elongated member into said hollow member causes said flexible conductor to protrude therein and a removal of said elongated member causes said flexible conductor to be drawn therefrom.

2. A resonant cavity structure according to claim 1 wherein said end wall of said hollow member comprises a short circuit plate and said conductor is secured to the inner side of said plate and extends into said hollow member from said short circuit plate along the axial length of said elongated member and back along the axial length of said member through said opening and is coupled to the outer side of said plate.

3. A resonant cavity structure according to claim 1 wherein said conductor comprises a metallic ribbon formed of a prestressed metal and extends from said hollow member end wall to the end of said elongated member whereby said prestressing of the metal belt causes said belt to coil about the end of said member as said elongated member is moved in said opening.

4. A resonant cavity structure according to claim 1 wherein said conductor comprises a ribbon formed of a wire screen.

5. A resonant cavity structure comprising a hollow member, a plunger extending coaxially into said member through an opening in an end wall thereof defining a quarter wave resonant coaxial line, said plunger including an elongated member movably supported in said opening for adjustable extension beyond said wall, a plurality of flexible conductors each having a relatively smooth continuous surface disposed in said hollow member lengthwise with said elongated member, said plurality of flexible conductors further disposed to each fold over a different adjacent portion of the end of said elongated member to have said folded conductor sections form the end of said plunger which extends into said hollow member, and means positionally fixing the respective ends of said plurality of conductors to said hollow member whereby an adjustment of said elongated member into said hollow member causes simultaneously each of said conductors to protrude therein and a removal of said elongated member causes simultaneously each of said flexible conductors to be drawn therefrom.

6. A resonant cavity structure comprising a hollow member, a plunger extending coaxially into said member through an opening in an end wall defining a quarter wave resonant line, said plunger including an elongated member movably supported in said opening for adjustable extension beyond said wall, a plurality of flexible conductors each having a relatively smooth continuous surface disposed in said hollow member lengthwise with said elongated member, said plurality of flexible conductors further disposed to each fold over a different adjacent portion of the end of said elongated member to have said folded conductor sections form the end of said plunger which extends into said hollow member, a plurality of rollers one associated with each of said conductors mounted in the forward end of said elongated member and means positionally fixing the respective ends of said conductors to said hollow-member whereby adjustment of said elongated member into said hollow member causes simultaneously each of said flexible conductors to protrude therein and a removal of said elongated member causes simultaneously each of said flexible conductors to be drawn therefrom.

7. A resonant cavity structure comprising a hollow

member, a plunger extending coaxially into said member through an opening in an end wall defining a quarter wave resonant line, said plunger including an elongated member movably supported in said opening for adjustable extension beyond said wall and terminated at each end by a pair of rollers, a pair of conductors each having one end fastened to the inner side of said end wall and being substantially twice the length of said elongated member and extending from said wall lengthwise adjacent said elongated member to the forward member thereof and passing around one pair of rollers and extending from said forward rollers lengthwise adjacent said elongated member through said opening and passing around said other pair of rollers and fastened to the outer side of said end wall substantially opposed to said inner fastening whereby the length of said extended part is varied in accordance with adjustment of said elongated member relative to said wall.

8. A resonant cavity structure according to claim 6 wherein said elongated member has a square cross section and said plurality of conductors comprises a metallic ribbon for each side of said square.

9. A device according to claim 6 wherein one end of each of said conductors is coupled to the outer side of said end wall by means of a tension mount.

10. A resonant cavity structure according to claim 6 which further includes means for coupling energy into said resonant cavity and means for coupling energy out of said resonant cavity.

11. A device according to claim 10 wherein each of said means for coupling energy comprises a capacitive probe slidably mounted on said hollow member and extending into said resonant cavity.

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