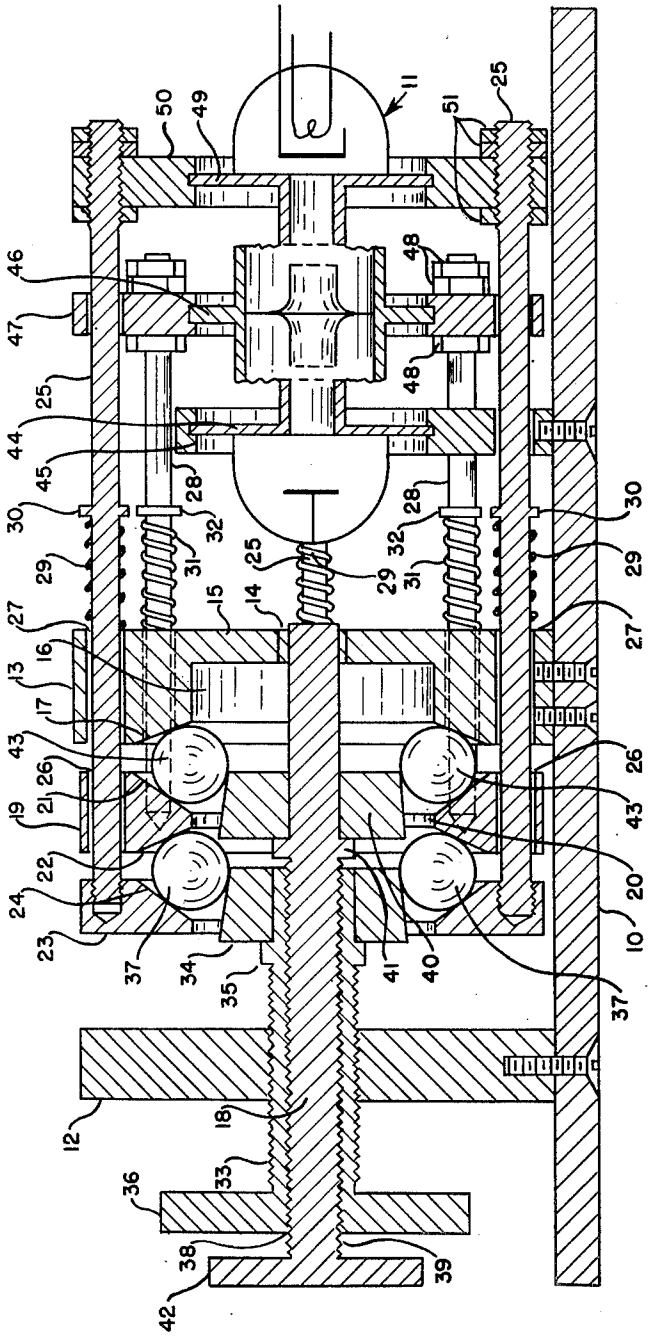
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MECHANICAL TUNING DEVICE

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MECHANICAL TUNING DEVICE

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This invention relates in general to mechanical vernier adjusting means. More particularly it relates to vernier adjusting means adapted to alter simultaneously the dimensions of the two resonant cavities employed on certain types of velocity modulated radio tubes so that said cavities have their dimensions altered uniformly and simultaneously at a very gradual and therefore useful rate.

In the use of double cavity velocity-modulated tubes it is very desirable to be able to tune both cavities at the same time by altering their dimensions in the same way and at the same rate by a single adjusting means.

Most devices which have been used for this purpose have considerable lost motion and do not alter the two cavities equally over a wide range of adjustment. As a result the oscillators employing these tubes do not operate at their highest efficiency or do not operate at all unless their frequencies are changed by elaborate means, and the two cavities employed do not resonate at the same frequency throughout the tunable frequency range of such oscillator, or as it is sometimes expressed, the cavities do not track properly as they are tuned.

It is therefore an object of this invention to provide a reliable vernier means for tuning simultaneously two resonant cavities so that they track in a satisfactory manner throughout the full range of adjustability. It is a further object of this invention that the device will have a negligibly small amount of lost motion.

Other objects, features and advantages of this invention will suggest themselves to those skilled in the art and will become apparent from the following description of the invention taken in connection with the single figure of the drawing which is a longitudinal sectional view of a preferred embodiment of this invention.

Referring now to the figure, base 10 has several elements attached to it which are intended to be immovable with respect to one another and with respect to one fixed portion of velocity-modulated tube 11 which this device is intended to tune. Fixed plate 12 is mechanically attached to base 10 by any suitable means such as screws. It is substantially at right angles to base 10. Fixed cup 13 is also fastened to base 10 by suitable mechanical means such as screws. The open end of fixed cup 13 faces in the direction of fixed plate 12 so that the bottom portion 15 of fixed cup 13 is parallel to fixed plate 12.

Sufficient space is left between fixed plate 12 and fixed cup 13 to allow room for driving mechanism and moving parts which will be described below.

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Fixed cup 13 has a bearing 14 in the center of the bottom 15. This bearing is coaxial with an internal cylindrical portion 16 of fixed cup 13. Near the open side of fixed cup 13 cylindrical portion 16 terminates at a conically flared portion 17 which is so formed that the hollow inner portion of fixed cup 13 where it flares sharply outward from cylindrical portion 16 defines a space having the shape of a flat truncated cone.

There is an internally threaded hole formed through fixed plate 12 with its center at the same distance above base 10 as the center of bearing 14. Because of the location of the internally threaded hole it will be possible to place a single shaft 18 having a smooth end fitted into bearing 14 at the same time that it has a threaded end passing through the hole in plate 12. The exact arrangement of a screw driving means arranged substantially in this fashion will be described hereinafter.

Floating movable ring 19 is one of the movable elements located in the space referred to above between fixed cup 13 and fixed plate 12. The ring 19 is substantially ring shaped, having an outer diameter somewhat smaller than the outer diameter or fixed cup 13, and an inner diameter of the same diameter as internal cylindrical portion 16 of the cup 13. Ring 19 has an internal cylindrical surface 20 having the diameter described above and being in length a small fraction of the width of floating ring 19. On both sides of floating ring 19 internal cylindrical surface 20 terminates in outwardly flared conical surfaces 21 and 22 which are shaped in the same manner as conically flared portion 17. Floating movable ring 23 is another of the movable parts of this mechanism located in the space between cup 13 and plate 12. It has the same external diameter as floating ring 19 and has an internal cylindrical surface having the same diameter as the internal cylindrical surface 20 of floating ring 19. Its conical surface 24 has the same shape as flared portion 17 of cup 13 and has the same general shape as the various conical surfaces already described.

Four relatively long tierods 25 are mechanically fastened around the edges of floating ring 23 by any suitable means such as by being screwed into floating ring 23. Tierods 25 are attached to ring 23 at four equally spaced points around and near to its outer edge and the axes of these rods are parallel to one another and also to the imaginary

axis of the cylindrical surface of floating ring 23. Floating ring 19 has four holes 26 cut longitudinally through it near its outer edges in positions corresponding to the locations of tierods 25. Since tierods 25 are equally spaced around the edge of floating ring 23 holes 26 should correspondingly be equally spaced around the edge of floating ring 19. These holes are large enough so that tierods 25 can slide freely in them without undue binding or restriction.

Cup 13 is also provided with four holes 27 which correspond in their location around the edge of cup 13 to the locations of holes 26 in the edge of floating ring 19. When this device is assembled, tierods 25 are fitted through the holes in floating ring 19 and floating ring 19 is pushed along those rods until it abuts against floating ring 23. In a similar manner this assembly composed of rings 19 and 23 and of tierods 25 are loosely joined to fixed cup 13 by sliding tierods 25 through holes 27. There are four other somewhat shorter tierods 28 which are mechanically fastened to ring 19 with their axes located with respect to ring 19 in the same manner as described above with respect to the mechanical connection between tierods 25 and ring 23. Tierods 28 are attached to the edge of ring 19 at four points midway between holes 26.

To accommodate tierods 28 there are four additional holes in fixed cup 13 which are located midway between each pair of holes 27. In this way when rings 19 and 23 are assembled loosely with cup 13 and with tierods 25 and 28, eight tierods protrude from the surface of cup 13 which is farthest away from plate 12. Fitted over tierods 25 where they emerge from holes 27 are compressible springs 29. These springs are held under compression by collars 30 so that rings 23 and 19 and cup 13 are all held tightly together. In a similar manner compressible springs 31 and collars 32 are fitted over tierods 28. Because of the presence of springs 31 and collars 32, in this arrangement, ring 19 is drawn tightly up against cup 13 independently of the action of springs 29.

Adjusting screw 33 is designed to screw directly into the threaded hole in plate 12. At one end adjusting screw 33 carries truncated cone 34 whose conical outer surface has a gradual taper and has its smaller end on its side nearest to cup 13. Truncated cone 34 cannot be forced beyond a certain point on adjusting screw 33 because of collar 35. At the opposite end of adjusting screw 33 there is a knob 36 by which adjusting screw 33 can be readily turned thereby driving cone 34 in the direction of cup 13. A row of ball bearings 37 are fitted into the wedge-shaped opening formed by abutting conical surfaces 22 and 24. These balls are selected to have such a diameter and truncated cone 34 is formed to be of such size that the spherical surfaces of balls 37 rest simultaneously against internal conical surfaces 22 and 24 and the external conical surface of truncated cone 34.

Adjusting screw 33 has an internally threaded hole 38. Tracking adjusting screw thread 39 is formed on a portion of shaft 18 and is screwed into hole 38. Fitted to shaft 18 are truncated cone 40, collar 41 and tracking knob 42. They are arranged, with respect to shaft 18, in the same manner as the arrangement described above of truncated cone 34, collar 35 and knob 36 with respect to adjusting screw 33.

A row of ball bearings 43 occupies the wedge-shaped space between abutting internal conical surfaces 17 and 21 and are held in contact with those surfaces by truncated cone 40 in a manner corresponding to that described above with respect to the row of balls 37.

There has been described thus far the arrangement of the essential working parts of this vernier mechanism so that movement of knob 36 is translated into rectilinear mechanical movement of tierods 25 and tierods 28. Immediately hereafter there will be described additional parts of this mechanism adapted to communicate this rectilinear movement to the tuning flanges associated with the cavities of a two cavity, velocity-modulated type of tube.

Velocity-modulated tube 11 has a fixed tuning flange 44 which is surrounded and clamped by split circular clamp 45. Clamp 45 is fastened to base 10 by screws or any other suitable means so that fixed tuning flange 44 is held immovable with respect to all the fixed portions of this mechanism.

Movable tuning flange 46 is clamped in a similar manner by a split circular clamp 47. Clamp 47 is connected to the ends of tierods 28 which are fastened into ring 19. The mechanical connection between tierods 28 and clamp 47 can be of some conventional adjustable variety so that coarse adjustment of the distance between circular clamp 47 and circular clamp 45 can be made without resort to the drive mechanism described above. Such means, as indicated in the figure, may be nuts and lock nuts 48.

Movable tuning flange 49 is surrounded and held by split circular clamp 50 in the same manner as has been described above for the other split circular clamps, and split circular clamp 50 is joined to tierods 25 in a manner similar to that described above, which may be by the use of nuts 51 which accordingly perform a function similar to that performed by nuts 48. It may be seen that, due to the interconnection of the circular clamps and tierods and circular clamps and tuning flanges as well as the connection of the fixed tuning flange to base 10, rectilinear movement accomplished by the afore-described mechanism when knob 36 is turned will be communicated directly to the tuning flanges of velocity-modulated tube 11. A more complete description of the principles of operation of this mechanism will be given in the following portion of this description:

When it is desired to tune the two cavities of velocity modulation tube 11 simultaneously, knobs 36 and 42 will be turned at the same time. It may be feasible to have tracking adjusting screw thread 39 so tightly fitted into internally threaded hole 38 that shaft 18 will follow any rotational movement of knob 36 unless knob 42 is deliberately held while knob 36 is being turned. In this way when knob 36 is turned adjusting screw 33 will be propelled through fixed plate 12 in the direction of cup 13 carrying with it truncated cone 34 as well as shaft 18 and truncated cone 40. Cones 34 and 40 will force ball bearings 37 and 43 outward in radial directions. Since balls 37 and 43 are already wedged tightly between rings 19 and 23 and between cup 13 and ring 19, respectively, they will not have room to move radially unless they force these movable elements apart by widening the wedge-shaped spaces between the respective abutting conical surfaces. Ring 19 will move with respect to cup 13 by an amount equal to the movement of ring 23 with respect to ring 19 because of the fact that the slopes of the various conical surfaces involved are made to be the same and because the other parts involved in this operation, they being

ball bearings 37 and truncated cone 34, are likewise of similar dimensions. Obviously, since ring 23 is moved away from ring 19 due to the turning of knob 36, since the turning of knob 42 moves ring 19 from cup 13 and thus further moves ring 23 away from ring 19, and since these movements occur simultaneously and are equal, it follows that ring 23 moves twice as far away from cup 13 as does ring 19. Any rectilinear movement of ring 19 is communicated by tierods 28 to circular clamp 47 thus moving tuning flange 46 with respect to tuning flange 44 by the same precise amount. At the same time the movement of ring 23 will be communicated by tierods 25 to circular clamp 50 which accordingly moves tuning flange 49 with respect to tuning flange 44 for precisely twice the amount of the movement of tuning flange 46 with respect to tuning flange 44. In this way the two cavities of velocity-modulated tube 11 are reduced in length and therefore in volume by equal amounts.

Where an adjustment is sought in the opposite direction, that is where it is desirable to enlarge the cavities of velocity-modulated tube 11, knob 36 is turned in the opposite direction so that adjusting screw 33 is withdrawn away from cup 13. Due to the action of compressible springs 29 and 31, which exert a constant pressure tending to draw rings 23 and 19 toward cup 13, ball bearings 37 and 43 will be forced in inward radial directions toward truncated cones 34 and 40 as soon as these cones are withdrawn from them. Thus rings 19 and 23 and tierods 25 and 28 are free to be drawn in a rectilinear direction opposite to that described above and in such a direction that clamping rings 46 and 50 move away from fixed clamping ring 44.

Where it is necessary to compensate for any slight inaccuracy in tracking at some points in the adjustable range of the velocity-modulated tube it is possible to enlarge one cavity and reduce the other, instead of enlarging both or reducing both at the same time, by holding knob 36 immovable while moving knob 42 or vice versa. When this is done either truncated cone 34 or truncated cone 40 moves forward or backward in a rectilinear direction by itself and either rings 19 and 23 are drawn closer together or wedged further apart without any change occurring in the space between ring 19 and cup 13 or vice versa. Such a tracking adjustment is also useful when a new tube has first been installed and it is necessary to adjust the two cavities so that they have the same volume and hence the same resonant frequency.

It will be seen from the foregoing that this invention provides a vernier means of tuning two cavities simultaneously over a wide range; of maintaining tracking throughout that range; and of involving very little lost motion.

It will be obvious to those skilled in the art that this same principle of operation could be applied to mechanism for varying more than two cavities simultaneously. It is also obvious that other constructional details could be employed without departing from the principle of this invention. For example springs 29 and 31 could be located between fixed plate 12 and movable ring 23 so as to force movable ring in the direction of cup 13 rather than to have springs 29 and 31 in their present location.

It will be apparent that there may be deviations from the invention as described which still fall fairly within the spirit and scope of the invention.

Accordingly I claim all such deviations which

fall fairly within the spirit and scope of the invention as identified in the hereinafter appended claims.

What is claimed is:

1. A mechanical movement comprising a first member having an inwardly tapering first surface, a pair of aligned members of wedge-shaped cross-sectional areas disposed with the smaller ends thereof facing said inwardly tapering surface, a second member having a first aperture therein spaced from said first member and having opposed second and third surfaces inwardly tapering toward said aperture, said second surface facing said first surface, one of said wedge-shaped members being disposed within said aperture, a third member having a second aperture therein and a fourth surface inwardly tapering toward said aperture and facing said third surface, the other of said wedge-shaped members being disposed within said second aperture, a plurality of ball bearings of uniform size disposed between and in contact with said one wedge-shaped member and said first and second members, a second plurality of ball bearings of uniform size disposed between and in contact with said other wedge-shaped member and said second and third members, and means for simultaneously moving said pair of wedge-shaped members toward and away from said first member.

2. A mechanical movement as set forth in claim 1, wherein said pair of wedge-shaped members are of the same size, said first and third surfaces are parallel, said second and fourth surfaces are parallel, said ball bearings are all of the same size, and said means for simultaneously moving said wedge-shaped members includes means for moving said wedge-shaped members at the same rate.

3. A mechanical movement as set forth in claim 2, in which said first, second and third members are circular, said wedge-shaped members are truncated cone-shaped, and have apertures therethrough, and said means for simultaneously moving said wedge-shaped members comprise a first fixed member with a threaded aperture therein, a hollow shaft threaded internally and externally passing through and engaging said threaded aperture and passing through the aperture in said other wedge-shaped member, a collar on said shaft between said fixed member and said other wedge-shaped member for engaging said other wedge-shaped member, a second threaded shaft passing through and engaging the threaded aperture in said hollow shaft and passing through said one wedge-shaped member, a collar on said second shaft between said wedge-shaped members and engaging said one wedge-shaped member, and means for turning said hollow shaft and said second shaft in unison.

4. A mechanical movement as set forth in claim 3, further including means for rotating said hollow shaft and said second shaft independently.

5. A mechanical movement comprising a first member with a first surface at a first acute angle with respect to a reference plane, a second fixed member with a second surface at a second acute angle greater than said first angle with respect to said reference plane, a third member having a third surface at a first obtuse angle with respect to said reference plane and a fourth surface at a third acute angle greater than that of said first acute angle with respect to said reference plane, said third surface facing said second surface, means for preventing perpendicular movement of said third member with respect to said refer-

ence plane, a member having a fifth surface at a second obtuse angle with respect to said reference plane, said second obtuse angle being of similar magnitude to said first abtuse angle, means for preventing perpendicular movement of said fourth member with respect to said reference plane, a fifth member with a sixth surface at a fourth acute angle smaller than said second or third acute angles with respect to said reference plane, all the foregoing angles being measured in the same direction with respect to said reference plane, a first circular bearing disposed between and adjacent said first, second and third surfaces, a second circular bearing disposed between and adjacent said fourth, fifth and sixth surfaces, and means for moving said first and fifth members in unison toward said second member in a direction parallel to said reference plane.

6. A mechanical movement as claimed in claim 5, wherein said first and sixth, second and fourth and third and fifth surfaces are respectively parallel, and said circular bearings are of the same diameter.

7. A mechanical movement as claimed in claim 5, and further including means for moving said first and fifth members independently in said direction parallel to said reference plane.

8. Apparatus for maintaining constant the difference in distances between three spaced objects, comprising a first circular member having an inwardly tapering first surface, first and second like, aligned, truncated cone-shaped members disposed with the smaller ends thereof facing said first surface, a second circular member having a first central aperture therein spaced from said first member and having opposed second and third surfaces inwardly tapering toward said aperture, said second surface facing said first surface and said third surface being parallel to said first surface, said first truncated cone-shaped member being disposed within said aperture, a third circular member aligned with said second circular member having a second central aperture therein and at least a fourth surface inwardly tapering toward said second aperture, said fourth surface facing said second circular member and being parallel to said second surface, said second truncated cone-shaped member being disposed within said second aperture, a plurality of ball bearings of the same diameter disposed between and in contact with said first truncated cone-shaped member and said first and second circular members, a second plurality of ball bearings of the same diameter as said first plurality of ball bearings disposed between and in contact with said second truncated cone-shaped member and said second and third circular members, means for simultaneously moving at the same rate both of said truncated cone-shaped members toward and away from said first circular member, and means for maintaining a fixed distance relationship between said first, second and third circular members and the first, second and third of said given objects, respectively.

9. Apparatus for maintaining equal the spacings between three equally spaced parallel walls, comprising a fixed first circular member with a first central aperture, a plurality of apertures close to the periphery thereof and a first surface inwardly tapering toward said central aperture; first and second like, aligned, truncated cone-shaped members with central apertures therethrough and disposed with the smaller ends

thereof facing said first surface; a movable second circular member, having a second central aperture therein spaced from said first member and having opposed second and third surfaces inwardly tapering toward said second aperture, said second surface facing said first surface and said third surface being parallel to said first surface, said first truncated cone-shaped member being disposed within said second aperture; a movable third circular member aligned with said second circular member, having a third central aperture therein, and at least a fourth surface inwardly tapering toward said third aperture, said fourth surface facing said second circular member and being parallel to said second surface, said second truncated cone-shaped member being disposed within said third aperture; a first plurality of ball bearings of the same diameter disposed between and in contact with said first truncated cone-shaped member and said first and second circular members; a second plurality of ball bearings of the same diameter as said first plurality of ball bearings and disposed between and in contact with said second truncated cone-shaped member and said second and third circular members; a fixed fourth member with a threaded aperture therein parallel to said fixed first circular member; a hollow shaft threaded internally and externally passing through and engaging said threaded aperture and passing through the aperture in said second truncated cone-shaped member; a collar on said shaft between said fixed fourth member and said second truncated cone-shaped member for engaging said second truncated cone-shaped member; a second threaded shaft passing through and engaging the threaded aperture in said hollow shaft and passing through the aperture in said first truncated cone-shaped member; a collar on said second shaft between said first and second truncated cone-shaped members for engaging said first truncated cone-shaped member; said three equally spaced parallel walls being aligned and parallel to said fixed first member; the first of said parallel walls being fixed and positioned closest to said first fixed member, a first plurality of rods joining the second of said three walls to said movable second circular member; and a second plurality of rods joining the last of said three walls to said movable third circular member, each rod of said first and second plurality of rods passing through a different one of said plurality of apertures close to the periphery of said fixed first member.

10. Apparatus as claimed in claim 9, and further including a plurality of collars on said first and second plurality of rods between said fixed first member and said first wall, and a plurality of coil springs each on a different rod, compressed between said collars and said fixed first member.

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