June 28, 1960 J. A. LIGGETT ET AL 2,942,482

VARIABLE LIMIT STOP MECHANISM

Filed Jan. 30, 1959

FIG. 1

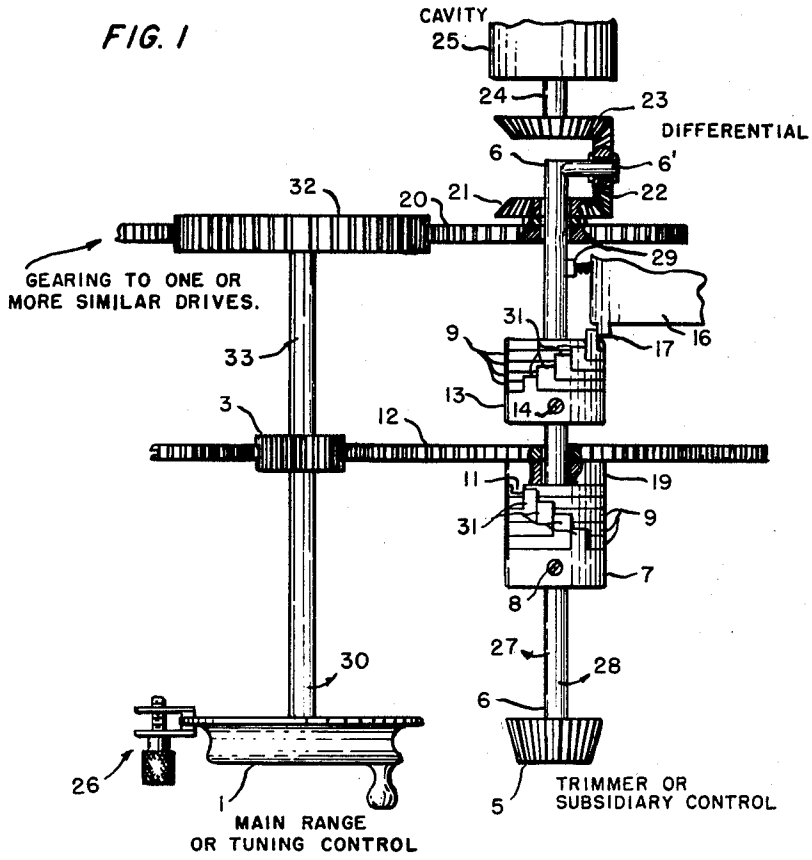
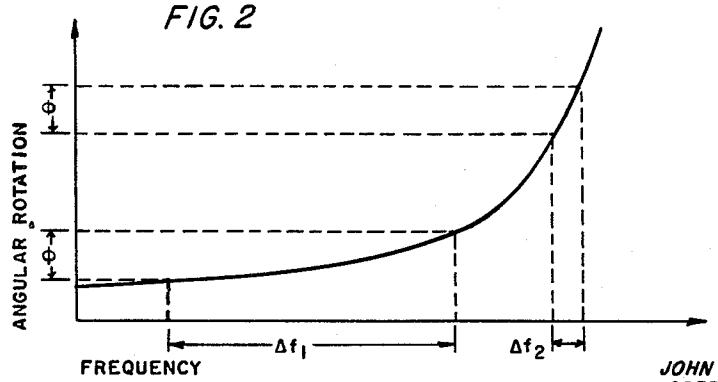


FIG. 2



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United States Patent Office 2,942,482 Patented June 28, 1960

2,942,482

VARIABLE LIMIT STOP MECHANISM

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Filed Jan. 30, 1959, Ser. No. 790,309

6 Claims. (Cl. 74—10.2)

This invention relates to shaft positioning means, and more particularly to apparatus for facilitating coarse and fine adjustment of the tuning mechanism of electronic components.

The objects of the present invention are to provide improved and simplified shaft positioning apparatus for automatically limiting the operating range of a subsidiary device whose limits of operation are varied either manually or by some external driving means as a function of a physical quantity, such as time. Other features and advantages of this invention will be apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a plan view of a shaft positioning apparatus embodying this invention; and

Figure 2 is a graph showing the effect of the shaft rotation on the frequency change of the driven electronic component.

Rotary limit stops are used in many devices to protect parts such as lead screws, contacts, gears, and several others from damage. In electronic devices, the limit stops are often utilized to restrict the tuning range of different resonant circuits. The present invention is particularly concerned with the utilization of these known rotary limit stops in a novel combination of shaft positioning apparatus for tuning ultra-high frequency cavity resonators. The preferred mechanism embodying the principles of this invention comprise a main range or tuning control geared to several interrelated driven devices and to subsidiary controls or trimmers having on their shafts two sets of limit stops for controlling the rotation thereof in opposite angular directions; the main control and the trimmers are mechanically coupled to the driven device through a differential or epicyclic gear.

In Figure 1, a cavity resonator **25** is tuned by a slug **24** fixedly secured at one end thereof to bevel gear **23**; any suitable type of securing means could be employed to fix the gear to the end of slug **24**. The teeth of the bevel gear **23** are adapted to be driven by the idler bevel gear **22** rotatably mounted on the offset portion **6'** of the trimmer shaft **6**. The idler gear **22** is in turn adapted to be rotated by the bevel gear **21** fixedly secured to gear **20** and rotatably mounted therewith upon shaft **6**. Gear **20** is driven by gear **32**, fixed on the driving shaft **33**, with knob **1**. Two collars **7** and **13** fastened to shaft **6** by set-screws **8** and **14**, respectively carry conventional tumbler stop washers **9** having radially and axially projecting fingers **31**, the function of which will be described later. Collars **7** and **13** are mounted on shaft **6** above and below gear **12**, as shown. Gear **12** is rotatably mounted on shaft **6**.

Trimmer control knob **5**, securely fastened to shaft **6**, cannot be turned in either direction when the parts are in the positions shown in Figure 1. Rotation of the knob **5** in the counterclockwise direction, arrow **27**, is prevented by the restraint on collar **7** caused by the pileup of stop washers **9** against an outwardly projecting stop shoulder

or lug **11** of radially mounted rotary stop member **19** securely fastened to gear **12**. The rotation of gear **12** is in turn controlled by the main range or tuning control knob **1**.

Trimmer control knob **5** cannot be turned in the clockwise direction, arrow **28**, due to the restraint on collar **13** caused by the pileup of stop washers **9** against stud **17** protruding from a stationary limit stop **16**. A friction load **29** is fastened to the stationary support **16** in order to provide friction on trimmer shaft **6**.

By releasing dial lock **26** and turning the main control knob **1** in a clockwise direction, arrow **30**, gear **3** drives gear **12** and stop lug **11** in a counterclockwise direction around shaft **6**. The displacement of lug **11** allows trimmer control **5** to be turned counterclockwise until the stop washers **9** again pile up against lug **11**. Clearly, the angle through which trimmer **5** can be rotated is directly proportional to the amount of rotation of the main tuning control knob **1**. The ratio of proportionality depends on the gearing ratio of gears **3** and **12**. This ratio can be suitably varied for any desired ratio of setting of the trimmer limit to main control. Also, the number of stop washers **9** on each collar and the spacing therebetween can be suitably selected for any number of desired stop limits. By allowing an initial space between fingers **31** of the stop washers **9** and the limit lugs **11** and **17**, any desired minimum range of control of the trimmer **5** may be established.

In operation, the cavity resonator is tuned by slug **24** which is coupled thru the differential gear train to the main control knob **1**. This selects the desired carrier frequency. Knob **1** drives shaft **33** with attached gears **3** and **32**. As previously mentioned, gear **3** drives gear **12** to control the limit of movement of trimmer shaft **6** by setting lug **11**. The opposite limit of rotation of shaft **6** is determined by lug **17**.

Gear **32** drives gear **20** and attached gear **21**, which in turn drives gears **22** and **23**, for shaft **6** is held against rotation by brake **29**. As shaft **6** is freed by the backing off of lug **11** from the position shown in Figure 1, shaft **6** can now be moved within the limits permitted by stops **11** and **17**, provided sufficient force is applied to knob **5** to overcome brake **29**. This movement of shaft **6** will drive gear **22** around gear **21** to rotate gear **23** and shaft **24**. Dial lock **26** may be engaged to prevent turning of shaft **33** and gears **32**, **20** and **21** during this operation. In the actual equipment the main control tunes several cavities which do not track exactly, the precise tuning of each cavity being performed by the separate trimmers **5** through the differential gear trains.

In Figure 2 the effect of the rotation of the main or trimmer controls on the frequency change of the resonant cavity is plotted in cartesian coordinates, as shown. It can be readily seen that at the lower end of the frequency band a small angular rotation of the main or of the trimmer control knob produces a great frequency variation Δf_1, in the resonator. Conversely, at the upper end of the curve the same angular rotation θ of the control knobs changes the frequency only by a small amount Δf_2. This is due to the non-linearity of the tuning curve. The mechanism of this invention is accordingly arranged to allow an increasing number of turns of the trimmer shaft **6** as the main tuning control approaches the less sensitive end of the tuning range.

The limit stops on the trimming control prevent tuning in a wrong carrier frequency or the unwanted sideband. Due to the non-linearity of the tuning curve, it is necessary to have limit stops which have broad limits at one end of the frequency band and narrow limits at the opposite end. These requirements are easily accomplished by the

shaft positioning mechanism in accordance with this invention.

While this invention has been described in conjunction with present preferred embodiments thereof, it should be apparent that the invention is not limited thereto. In particular, gear 12 can be driven by other means than those shown in Figure 1, such as geared down synchronous motors, etc. The limits on the trimmer control would then be set with respect to other functions, such as time. Moreover, the driven device could be any electrical or mechanical component such as variable inductors, potentiometers, capacitors, etc.

What is claimed is:

1. A control mechanism for varying an adjustable tuning element including, in combination, a first shaft having a first gear mounted thereon; a second shaft disposed parallel to said first shaft and having a second gear mounted thereon; a first and a second set of stop members rotatably mounted on said second shaft, the second gear being in mesh with said first gear; a stationary limit stop; a rotary limit stop fixedly secured to said second gear and concentrically mounted therewith upon said second shaft; the rotation of the second shaft in one angular direction being prevented by the pile up of said first set of stop members against said stationary limit stop, and in the opposite angular direction by the pile up of said second set of stop members against said rotary limit stop.

2. The control mechanism of claim 1, wherein means are secured on said first shaft for controlling the position of said rotary limit stop.

3. The control mechanism of claim 1, wherein a third gear is fixedly secured to said first shaft and a fourth gear is rotatably mounted upon said second shaft, the third and the fourth gear being in mesh, and means mechanically coupling said second shaft and said fourth gear to said tuning element.

4. The mechanism of claim 3, wherein said means is a differential gear.

5. The mechanism of claim 4, wherein said tuning element is a cavity resonator.

6. In a control mechanism for monitoring an adjustable element of a tuning device, a first shaft for broad tuning of said element having a first gear mounted thereon; a second shaft for limited tuning of said element disposed parallel to said first shaft; a second gear in mesh with said first gear rotatably mounted on said second shaft; a first and a second set of stop washers rotatably mounted on said second shaft; a stationary limit stop, a rotary limit stop fixedly secured to said second gear and concentrically mounted therewith upon said second shaft; the rotation of the second shaft in one angular direction being prevented by the pile up of said first set of stop washers against said stationary limit stop, and the rotation in the opposite angular direction being prevented by the pile up of said second set of stop washers against said rotary limit stop; and a differential gear mechanically coupling said second shaft to said adjustable element.

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