May 30, 1933. W. D. BUCKINGHAM 1,912,343

TUNING FORK TEMPERATURE COMPENSATION AND FREQUENCY ADJUSTMENT

Filed Jan. 23, 1932

FIG. 1

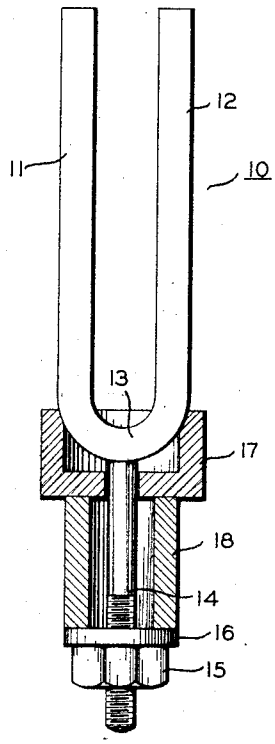
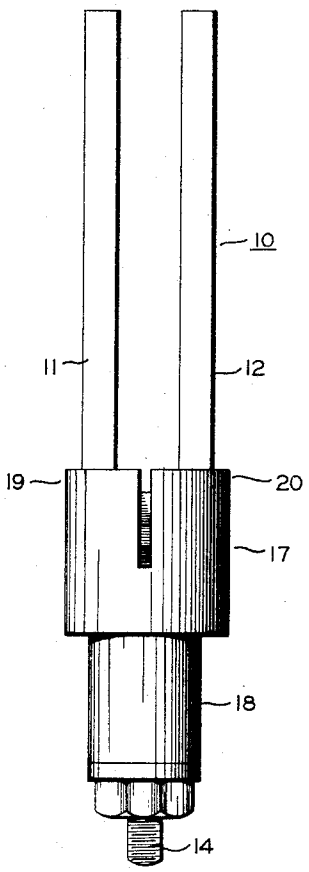


FIG. 2



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UNITED STATES PATENT OFFICE

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TUNING FORK TEMPERATURE COMPENSATION AND FREQUENCY ADJUSTMENT

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This invention relates to tuning forks and it has for an object to provide means to compensate for the changes in pitch of the fork resulting from changes in temperature.

It is well known that the pitch of a tuning fork will change when the temperature of the fork itself undergoes a change. A rise in temperature of a tuning fork will cause a decrease in the stiffness or a change of the modulus of elasticity of the material comprising the fork, resulting in a decrease in the pitch frequency or rate of vibration of the fork. Various methods well known in the art have been devised for overcoming these characteristics of tuning forks. Among these have been the introduction of damping means which may be varied to change the pitch, or the provision of weights which may be shifted along the tines of the forks for changing the pitch by varying the mass of the vibrating body.

As already stated the dropping off of the rate of vibration of the tuning fork with a rise in temperature is due to a decrease in the rigidity or stiffness of the material as the temperature of the material rises. This is a well known physical property of substantially all solids. From this it will be seen that if means can be devised for increasing the stiffness of the fork or portions thereof as the temperature rises, a compensating effect can be obtained which will cause the fork to vibrate at substantially the same frequency or pitch at different temperatures.

Another object of this invention, therefore, is to provide means for stiffening a section of the fork to produce a compensating effect in accordance with the modification of the rate of vibration of the fork due to temperature changes.

A further object is to combine with the foregoing, means to adjust the pitch of the tuning fork to any desired frequency within a certain range.

These and other objects of this invention will be apparent from the following description and claims taken in connection with the accompanying drawing forming a part of this application, in which:

Fig. 1 shows a view partly in section of the compensating arrangement; and

Fig. 2 is a view showing the modified form of the arrangement shown in Fig. 1.

According to this invention stiffening means, which will produce a compensating effect on the fork in proportion to the change of temperature, is provided by securing an abutment or the like to the stem of the fork and providing a thrust member arranged to extend from said abutment and engage the tines of the fork at points spaced from the base of the stem, the points being chosen preferably substantially at the nodal points of vibration of the fork. This thrust member may be adjusted to press upon the nodal points which will result in stiffening of the curve or yoke portion of the fork. With this arrangement a compensating effect is provided by utilizing a material for all or a part of the thrust member which has a higher coefficient of expansion than the stem of the fork.

Referring to the drawing, the arrangement illustrated in Fig. 1 comprises a tuning fork 10 having tines or prongs 11 and 12 arranged to extend substantially parallel and joined by a curved or yoke section 13. The fork is provided with a stem 14 extending from the center of the yoke section. The stem is preferably threaded at its lower end and fitted with nut 15 and cooperating washer 16 to provide an adjustable abutment on the stem. At the base of the fork a collar or ring member 17 is arranged to surround the yoke section and press upon the outer surfaces of the tines at a point slightly below where the surfaces of the tines become parallel to each other. When a vibrating fork has been fitted with a ring in this manner, it will be found that the points of engagement with the ring correspond very closely to the nodal points of vibration. As a result the minimum amount of damping or hysteresis loss is occasioned by the addition of a member, such as ring 17. Furthermore, there is less likelihood that the fork will become unbalanced than where shiftable weights are employed. The ring 17 is shown as a collar member of substantial width. However, any type of ring of suit-

able stiffness and providing the required engaging surface may be employed.

Between the ring and the adjustable abutment member at the lower end of the stem extends a sleeve member 18. The sleeve 18 and ring 17 together provide a thrust member extending from the adjustable abutment and engaging the tines of the fork. Although this thrust member is illustrated as comprising two separate elements, a single member of suitable size and contour may be employed. In its preferred form, however, the thrust member will be composed of two elements as illustrated, and the sleeve 18 will be of a material having a higher coefficient of expansion than the stem of the fork. A material such as zinc or brass has proven satisfactory in cooperation with a tuning fork and stem of steel.

When the tuning fork is set into vibration the pitch or rate of vibration of the fork may be adjusted over a reasonably wide range by tightening or loosening up the adjustable abutment of the stem. When the abutment is tightened against the thrust member, the collar 17 presses against the tines of the fork as illustrated, which causes an increase in the stiffness of the yoke section of the fork, that is, the section embraced within the collar member. The stiffening effect of the collar member is varied in proportion to the pressure applied to the tines of the fork. As will be appreciated, this is due in part to the fact that the circular collar member has a certain degree of elasticity which drops off in proportion to the strain which is applied to the material comprising the collar. The same principles apply to the yoke portion of the fork which is put under a strain by force applied to the collar member.

When the sleeve 18 is composed of zinc or other material having a coefficient of expansion greater than that of the stem, an increase in temperature of the assembly will cause the sleeve to elongate at a more rapid rate than the stem of the fork, increasing the pressure applied to the ring 17 and tending to raise the frequency, thereby compensating for the natural drop in frequency as the temperature of the fork rises. The proportion of difference of elongation between the stem 14 of the fork and the sleeve 18 may be adjusted to provide just the proper amount of increase in pressure applied to the collar by varying the proportional lengths of the stem and sleeve member. As it will be seen the collar 17 may be made of such size as to occupy any proportional part of the distance between the adjustable abutment on the stem and the point of engagement of the collar with the tines of the fork.

The arrangement illustrated in Fig. 2 is substantially the same as that just described in connection with Fig. 1. The primary difference is that the collar member 17 is shown as being somewhat elongated to illustrate a different proportional arrangement between the sleeve 18 and the stem 14 of the fork.

In addition the upper end of the sleeve 17 is slit down from the top to divide the upper section into two semi-circular elements 19 and 20. The collar is positioned so that the elements 19 and 20 engage the tines 11 and 12 of the fork with the slots disposed substantially midway between the tines. The effect of the slitting of the ring 17 is to provide increased resiliency or elasticity to the ring. It has been found that this arrangement provides wider limits of frequency adjustment. In other respects the operation of the embodiment of Fig. 2 is substantially the same as that shown in Fig. 1.

It will be observed from the foregoing description that means have been provided for adjusting the speed of vibration of the fork or the fork frequency within certain limits without the use of weights shiftable along the vibrating portion of the fork, which so easily introduce unbalanced effects if they are not accurately positioned with relation to each other. Moreover, an arrangement has been provided for accomplishing these results without resorting to damping of the fork in order to accomplish the frequency adjustment. According to this invention the fork is left free to vibrate in substantially the same way as when no compensating or adjusting means is applied thereto.

In addition to the foregoing it will be observed that an extremely simple and effective means has been provided for compensating for the variation in the pitch or frequency of a tuning fork due to temperature changes in direct proportion to said changes. Many other advantages of this arrangement will be apparent to those skilled in the art.

While this invention has been shown in but two forms it will be obvious to those skilled in the art that it is not so limited, but is susceptible to various other changes and modifications without departing from the spirit thereof, and it is desired, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The combination of a tuning fork and means to vary the pitch of the fork by stiffening a portion thereof, comprising means to press upon the fork at two points near the nodal points of vibration, and means for adjusting said pressure.

2. The combination of a tuning fork comprising a stem and tines and means to vary the stiffness of the fork comprising means disposed concentrically about the stem and arranged to press upon the tines at points spaced from the base of the stem, and means for varying said pressure.

3. The combination of a tuning fork and

means to compensate for drop in pitch of the fork due to temperature rise, said means comprising a thrust element arranged to press upon the fork at two points near the nodal points of vibration, and means to increase the pressure in accordance with an increase of temperature, whereby the increase in stiffness of a portion of said fork resulting therefrom will offset the decrease in the stiffness of other portions.

4. The combination of a tuning fork having a stem and tines, an abutment on said stem, a thrust member extending along said stem from said abutment and arranged to press upon the tines at points spaced from the base of the stem, said thrust member including a section composed of material having a greater coefficient of expansion than the stem of the fork.

5. The combination of a tuning fork having a stem and tines, an adjustable abutment on said stem, a thrust member extending along said stem from the abutment and arranged to press upon the tines of the fork at points spaced from the base of said stem whereby the frequency of the fork may be varied by adjusting said abutment.

6. The combination of a tuning fork having a stem and tines connected by a yoke portion, an abutment on said stem, a collar surrounding the yoke portion of said tines and arranged to press upon the outer surface of said tines substantially at the nodal point of vibration, and a thrust sleeve arranged to extend between said abutment and collar, said sleeve being composed of a material having a greater coefficient of expansion than the stem of the fork.

7. The combination of a tuning fork having tines connected together by a yoke, means to vary the stiffness of the yoke comprising a resilient member clamped to the yoke by a force applied between the member and a third point along the yoke, said member engaging the yoke at spaced points and means to vary the clamping force.

8. In combination a vibrating body having two or more nodal points of vibration, means to vary the frequency of vibration by applying forces having a stiffening effect on the portion of the body included between the nodal points of vibration, and means to vary said applied force.

9. In combination a vibrating body having two or more nodal points of vibration, and means to vary the frequency of the vibrating body comprising an auxiliary stiffening member adapted to be secured to the portion of the body included between two nodal points of vibration.

10. In combination a vibrating body having two or more nodal points of vibration, and means to vary the frequency of the vibrating body comprising an auxiliary stiffening member adapted to be secured to the portion of the body included between two nodal points of vibration, and means to vary the stiffening effect of the auxiliary member.

11. The combination of a tuning fork having tines connected together by a yoke and means to vary the pitch of the fork comprising means to apply a force to the yoke adjacent the nodal points of vibration, said force acting in the direction of vibration of the tines.

12. The combination of a tuning fork having tines connected together by a yoke and means to vary the pitch of the fork comprising a member disposed to engage the inclined faces of the yoke and means for supplying a variable pressure arranged to engage said member for applying said variable pressure therethrough to said inclined faces.

13. The combination of a tuning fork having tines connected together by a yoke and means to vary the pitch of the fork comprising a collar member disposed to engage the inclined faces of the yoke adjacent the nodal points of vibration for applying a variable pressure thereto.

14. The combination of a tuning fork having tines connected together by a yoke and means to vary the pitch of the fork comprising a collar member disposed to engage the inclined faces of the yoke adjacent the nodal points of vibration and a sleeve arranged to fit against the collar member for applying a variable pressure to said member.

15. The combination of a tuning fork having tines connected together by a yoke and means for varying the pitch of the fork comprising a split collar member disposed to engage the inclined faces of the yoke and means for supplying a variable pressure arranged to engage said member for applying said variable pressure therethrough to said inclined faces.

16. The combination of a tuning fork having a stem and tines connected together by a yoke, an abutment on the stem, and a sleeve surrounding the stem and extending between said button and the yoke, said stem and sleeve having different coefficients of expansion, the relative coefficients of expansion and lengths of the stem and sleeve being proportioned to apply a correcting condition to the fork suitable to compensate for variation in pitch of the fork due to temperature changes.

In testimony whereof, I affix my signature.

WILLIAM D. BUCKINGHAM.