Sept. 17, 1957 B. F. GRIB 2,806,400

TUNING FORKS

Filed March 10, 1954

Fig. 1.

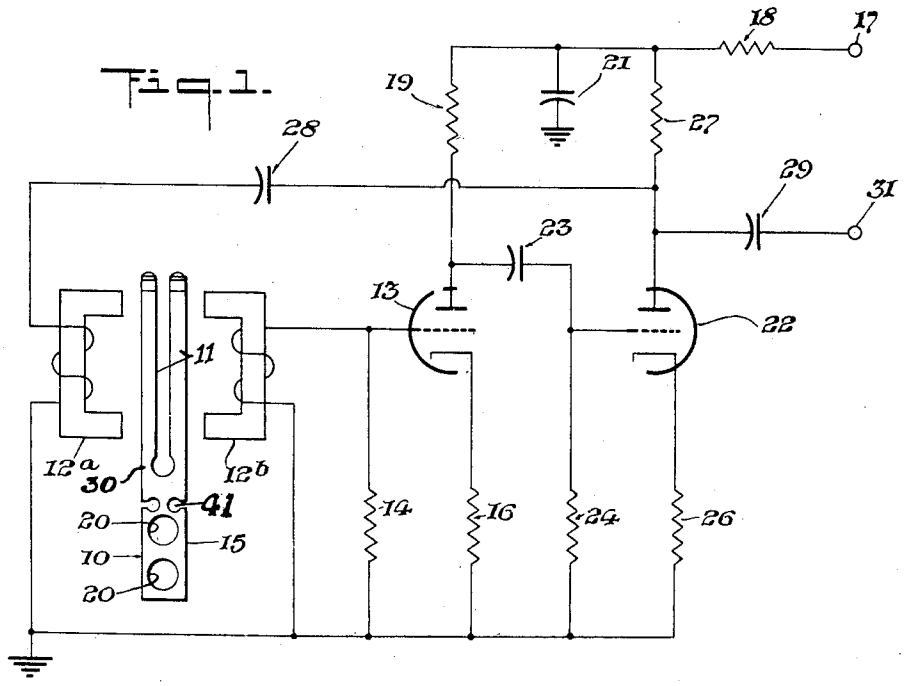
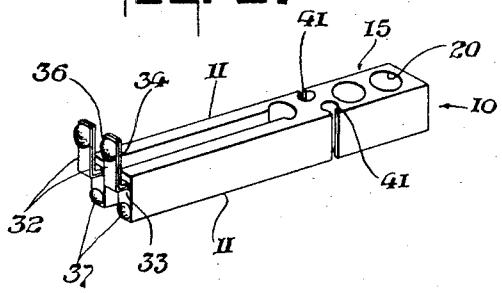


Fig. 2.



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TUNING FORKS

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Application March 10, 1954, Serial No. 415,318

9 Claims. (Cl. 84—457)

The present invention is a continuation-in-part of my copending application Serial No. 171,480, filed June 30, 1950, now Patent No. 2,732,748, dated January 31, 1956 for Tuning Forks.

The present invention relates to improvements in tuning forks and more particularly to improvements in the construction of tuning forks adapted to be electrically vibrated, such as tuning forks which serve as frequency-determining elements for electrical oscillation generators.

As is well known, a tuning fork constitutes a resonant system and its vibrations can be utilized to determine the frequency of electrical oscillations produced by an electrical or electronic circuit suitably coupled to the tuning fork. In producing oscillations in this manner, an important problem has been that of isolating the vibration of the fork tines from the mount which supports the fork. If the fork tines are unbalanced or improperly mounted, vibration is transmitted to the mount. This results in a decrease in the energy available for vibrating the tines themselves and constitutes a form of damping for the system which reduces the effective Q of the system in an undesired manner. In addition, when vibrations are transmitted to the mount, often some portion of the mount or other elements affixed to it are also set into vibration which is transmitted back to the tines through the medium of the atmosphere, in the cases where the tuning fork is not vacuum mounted. This creates a type of feedback which also alters the frequency of oscillation of the tines undesirably.

According to the present invention, special arrangements are provided for minimizing this transmission of vibration to the mount. I have discovered that when initially struck a tuning fork emits a tone of a frequency different from that produced during steady vibration. This tone I have termed the "reed" frequency as distinguished from the fork frequency during steady vibration. I have further discovered that the undesirable effects of the transmission of vibration to the mount can be avoided by proper design of the fork so as to produce a reed frequency less than the fork frequency but more than half the fork frequency. As a practical matter, I have found that the reed frequency should be between 60 and 85% of the fork frequency.

I have also discovered that the reed frequency can be varied without substantial change in the fork frequency by reducing the cross-section of the tuning fork at the base of the tines. By the present invention simple ways of restricting the cross-section of the fork base are utilized, specifically designed according to this invention to produce a reed frequency in the range specified so as to provide improved results.

These and other features and objects and advantages of the present invention will become more apparent from consideration of the following specification and the appended drawings, wherein

Figure 1 is a schematic representation of my improved tuning fork and an associated electronic circuit; and

Figure 2 is a perspective view of my improved tuning fork.

Referring to the drawing, Figure 1 shows a tuning fork **10** and one form of associated circuit. The tuning fork **10** has a pair of tines **11** joined to a base **15** by respective narrowed necks **30**. As is well known, the cross sectional area of each of these necks **30** determines the stiffness of the respective tine **11** and thereby influences both the frequency and amplitude of vibration of the tines. Since this circuit forms no part of the present invention, it will not be described further here, reference being made to the above-identified parent application Serial No. 171,480 for a fuller description. It is sufficient to state here that the tines **11** are caused to vibrate by driving and pickup coils **12***a*, **12***b*, suitably connected in the circuit. As shown in Fig. 1, the base **15** of fork **10** is apertured at **20** for mounting. For the purpose of temperature compensation, affixed at the end of each tine **11** is a bi-metallic element **32** bent in a right angle to form two legs **33** and **34**. One leg **33** is affixed at the end of the tine **11** as an extension thereof, as shown most clearly in Figure 2, so that the other leg **34** extends transversely of the length of the tine **11**. Each leg **34** carries a weight **36** near the end thereof. This structure provides temperature compensation in the manner more fully described in the said parent application Serial No. 171,480.

For the purpose of improving the isolation of the vibrating tines from the mount, recourse is had to the slots **41** placed between the mounting holes **20** of the base **15** and the vibrating tines **11**. These slots **41** are formed most simply by drilling holes symmetrically about the center line or longitudinal axis of the fork, and then sawing out the outer faces of these holes as indicated. Alternatively, they may be sawn, ground, or milled from the edges of the fork body, or in any other way, forming slots or holes as may be desired. The size of these holes or slots and their spacing determines the reed frequency mentioned above. The size of the holes or slots is determined experimentally for a given size of a tuning fork, and fine adjustments may be made by filing the edges or bottoms of these slots **41** to provide a reed frequency between 60 and 85% of the fork frequency, which has been determined as the value necessary to isolate the fork tine vibrations from the base or mount.

It will be seen that the slots **41** are separated from the narrowed tine necks **30** by a distance at least as great as the width of each of the necks **30**. In this way, the slots **41** do not influence the vibration of the individual tines **11** and have effect only in determining the reed frequency. To make the reed frequencies have the desired relationship of 60 to 85% of the fork or tine frequency, the thickness of the base material remaining between the slots **41** should be approximately the same percentage of the sum of the thicknesses of the tine necks **30**, in a case such as the present where the height of the fork is uniform, thereby giving the indicated relationship between the cross sectional areas at these portions of the fork.

It will be understood that values at the center of the range of reed frequencies given are the best, since if the reed frequency approaches too closely the fork frequency, intercoupling appears to take place between these two frequencies which reduces the isolation desired. In addition, if the reed frequency approaches a sub-harmonic (for example, half) of the fork frequency, similar interaction appears to take place. It is therefore necessary that the reed frequency avoid both the fork frequency and sub-harmonics thereof. A value of substantially 75% has been found optimum.

While an illustrated form of the invention has been shown, it is to be understood that the invention is not to be considered limited thereto, because many ap-

parently divergent embodiments of the invention can be easily conceived within the spirit thereof. Therefore the invention is to be limited only as defined in the appended claims.

What is claimed is:

1. A tuning fork comprising a base adapted for mounting said fork and a pair of vibratory tines integral with said base, each of said tines being joined to said base by a respective narrowed tine section which together with the dimensions of said tines determines the resonant frequency of vibration of said tines, said base being formed with a narrowed portion adjacent the juncture of the tines with the base, said latter narrowed base portion being separated from and independent of said narrowed tine sections, and having a cross-sectional area less than the sum of the cross-sectional areas of said narrowed tine sections, said narrowed base portion providing a reed frequency between 60 and 85% of the resonant frequency of vibration of said tines.

2. A tuning fork as in claim 1, wherein said reed frequency is substantially 75% of the tine resonant frequency.

3. A tuning fork as in claim 1, wherein said base has a rectangular cross section and said narrowed portion is formed by apertures extending transversely of said base symmetrically on either side of the center line thereof and spaced from said tine narrowed sections, each of said apertures opening on the side of said base.

4. A tuning fork as in claim 3, wherein said reed frequency is substantially 75% of said tine resonant frequency.

5. Tuning fork apparatus comprising a tuning fork having means for mounting said fork and a pair of vibratory tines, each of said tines having a respective narrowed neck determining its natural resonant frequency of vibration, said tines being connected to said mounting means by a common narrowed section spaced from said necks and providing a reed frequency between 60 and 85% of the natural resonant frequency of vibration of said tines.

6. A tuning fork as in claim 5, wherein said reed frequency is substantially 75% of said tine frequency.

7. A tuning fork as in claim 5, wherein said narrowed section is formed by slots on either side of the body of said fork.

8. A tuning fork as in claim 7, wherein said slots communicate with holes symmetrically located on opposite sides of the axis of said fork.

9. A tuning fork as in claim 7, wherein said slots have parallel sides extending perpendicularly to the axis of said fork.

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