June 10, 1958 W. J. HOLT, JR 2,838,698

TUNING FORK ASSEMBLY

Filed Aug. 8, 1955

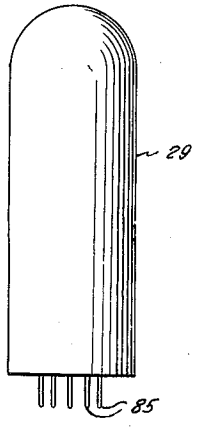

Fig. 1

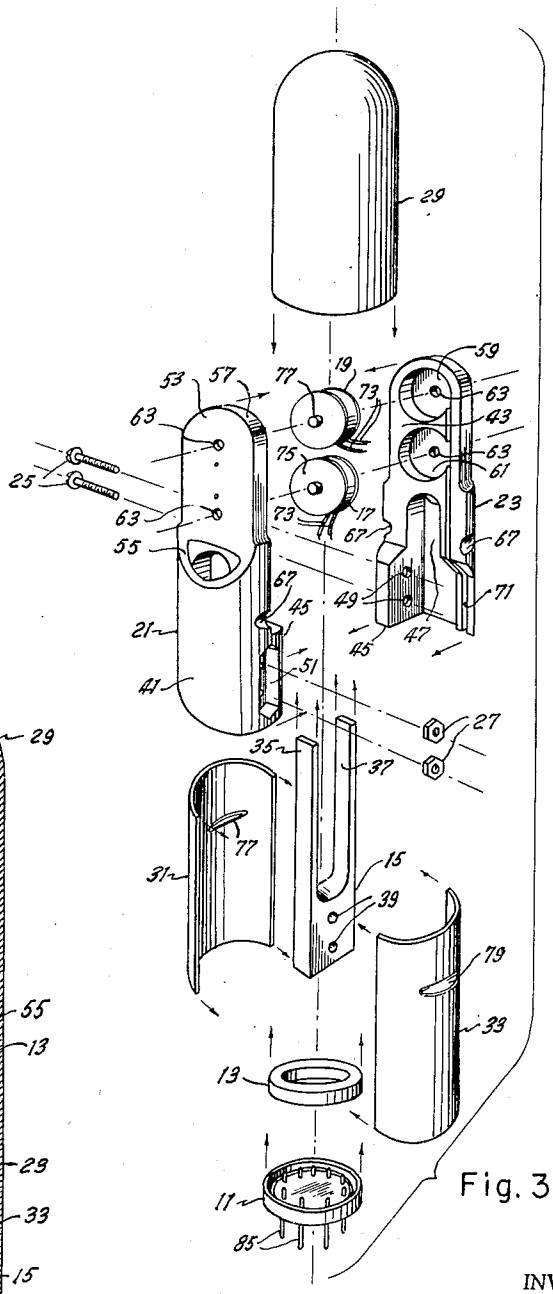

Fig. 3

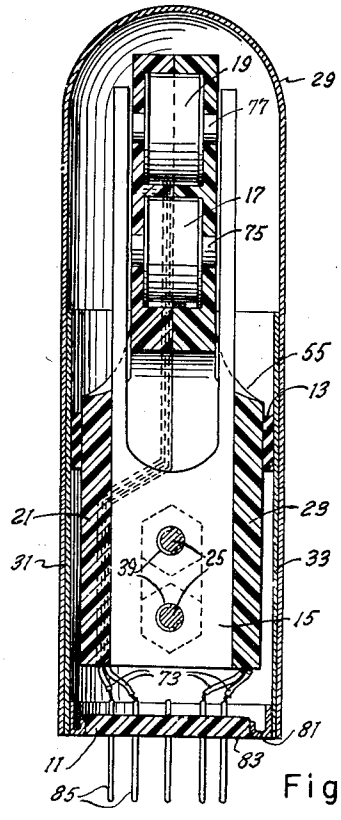

Fig. 2

INVENTOR

William J. Holt, Jr.

BY Wm. T. Wofford

ATTORNEY

United States Patent Office 2,838,698
Patented June 10, 1958

2,838,698

TUNING FORK ASSEMBLY

William J. Holt, Jr., Garland, Tex., assignor to Varo Mfg. Co., Inc.

Application August 8, 1955, Serial No. 526,894

15 Claims. (Cl. 310—25)

My invention relates to the construction and arrangement of tuning fork assemblies, and more particularly to tuning fork assemblies of the type designed to function as elements of constant frequency electronic oscillators.

An important problem in the construction of tuning fork assemblies has always been that of dealing with the adverse effects of external vibrations. In many instances in the prior art of which I am aware, substantial sacrifices have been made in the Q of tuning fork assemblies in order to circumvent the problems of external vibrations. It has been known that solid base type forks have a high Q, if they are dynamically balanced. However the dynamic balancing has in itself presented serious problems. In addition to the problems above-mentioned, there have been increasing demands for tuning fork assemblies that are more rugged, more dependable, smaller in size, and susceptible to more economical manufacture.

It is accordingly an object of my invention to provide an improved tuning fork assembly which shall obviate the above-mentioned problems.

It is another object of my invention to provide a tuning fork assembly having high Q, and which is insensitive to effects of external vibrations.

It is another object of my invention to provide a tuning fork assembly utilizing a solid base type fork in an arrangement which allows convenient dynamic balancing of the fork.

It is another object of my invention to provide a tuning fork assembly which is smaller in size and more economical to manufacture than those heretofore available.

These and other objects are effected by my invention, as will be apparent from the following description, taken in accordance with the accompanying drawings, in which:

Figure 1 is an elevational view of a completed tuning fork assembly;

Figure 2 is a center longitudinal section view of the tuning fork assembly; and

Figure 3 is an exploded view showing all of the parts of a complete tuning fork assembly.

Referring now to the drawings and particularly to Figure 3, it will be seen that the tuning fork assembly comprises a base plug **11**, a resilient ring **13**, a fork **15**, a driving coil **17** and a pick-up coil **19**, a two-piece fork and coil housing including identical matching left hand and right hand parts **21, 23**, housing bolts **25** and nuts **27**, a three-piece assembly envelope including a cap **29**, and identical matching left hand and right hand skirts **31, 33**.

The fork is of the solid base type made from a metal bar of rectangular cross-section. A deep U-shaped slot is formed in the bar so that the metal remaining at the slot sides constitutes the fork tines **35, 37**. The fork **15**, has a pair of longitudinally aligned mounting holes **39**, in its base portion.

The matching fork and coil housing pieces **21, 23**, are made of molded non-conducting material. The lower outside surface **41** of each housing piece is cylindrical. The inner faces of the housing pieces are complementary, with the upper face portion in each case presenting a plane surface **43** and the lower portion having a projection **45** at one side comprising a first plane surface sloping

downwardly and outwardly from the upper portion and a second plane surface extending downwardly and parallel to the upper portion. The other side of the lower portion of the housing inner face has a first plane surface extending downwardly and inwardly from the upper portion, and a second plane surface extending downwardly from the first and parallel to the upper portion. A deep U-shaped groove **47** is formed in the lower inside surface of each housing piece. This groove is centered on the longitudinal axis of the respective housing piece and extends to approximately the middle of the housing length. The depth of the groove on the projection side is substantially equal to the width of the fork base, while the width of the groove is substantially equal to the fork width. Each housing piece projection **45** carries a pair of transversely extending longitudinal bolt holes **49** which are located to register with the bolt holes **39** in the fork base when assembled. The projection on each housing piece has a recessed portion **51** on its outer surface for receiving the bolt heads and nuts. The upper portion of each housing piece has a plane outer face **53** parallel to the inner face. Each housing piece has an additional surface **55** sloping downwardly and outwardly from the lower portion of the outer plane face **53**. The last mentioned surface **55** intersects the upper portion of the housing piece groove **47** so as to provide a passage for the respective fork tine from the groove to the housing outside upon assembly. The outer surface **57** of the upper portion of each housing piece between the upper inner and outer faces **43, 53** has an inverted U-shaped contour. The thickness of the housing upper portion between the inner and outer upper faces is slightly less than one half the distance between the fork tines for a reason to be hereinafter explained. The upper portion of the inner face of each housing piece has a pair of cylindrical wells **59, 61** formed therein. The wells are centered on the housing piece longitudinal axis, and have a diameter substantially equal to the coil diameter and a depth substantially equal to one half the coil width.

There is a transversely extending hole **63** through the housing piece at the center of each well having a diameter substantially equal to the coil core diameter. Each housing piece **21, 23** has a pair of small holes **65** communicating between the inner and outer upper faces of the piece for a purpose to be hereinafter explained. Each housing piece has a pair of oppositely disposed inwardly extending dimples **67—69** at the marginal edges of their outer surfaces. These dimples are located longitudinally of the housings at a point corresponding to the center of gravity of the fork, housing, and coil assembly for a purpose to be hereinafter explained. Each housing piece **21, 23** has a small groove **71** in its inner face which communicates with both coil wells and provides a channel for the coil leads **73** from the coils out through the bottom of the housing pieces, and also a passage for filler material.

The drive coil **17** and pick-up coil **19**, which are identical, are in the form of short cylindrical bobbins, each having a single winding thereon. The coil cores **75, 77** are cylindrical pins of magnetic material which extend through registering holes **63** in the housing wells, **59, 61.**

The envelope skirts **31, 33** are identical halves of a thin metal cylinder each having an inwardly extending dimple **79** in its upper portion.

The resilient ring **13** is simply a heavy rubber band designed to fit closely over the cylindrical end of the coil and fork housing upon assembly. The base plug **11** is a metal ring **81** having a disc **83** of non-conducting material fixed to its inner periphery with plug pins **85** fixed to the disc. The base plug outer diameter is such that the plug will fit snugly inside the lower end portion of the envelope skirts upon assembly. The cap **29** is a

hollow thin metal cylinder with one end rounded and closed.

To assemble the device, the pick-up coil 19 is placed in the upper well 59 of one housing piece 23, while the drive coil 17 is placed in the lower well 61 of the other housing piece 21 and the coil leads 73 are laid in their respective housing channels 71 to extend from the bottom thereof. The housing pieces 21, 23 are then fitted together and the coil core pins 75, 77 inserted. Next, the fork 15 is inserted so that its tines 35, 37 extend up through the appropriate housing openings with the inner faces of the tines closely adjacent the respective outer plane faces 53 of the housing pieces. The bolts 25 are then passed through the registered holes 49 in the housing piece projections 45 and the fork base and secured by the nuts 27.

Next, impregnating material is injected through the small holes 65 in the housing piece upper portions until the coil and fork housing is completely filled. The impregnating material hardens so that the coils, their cores, the fork base and the bolts and nuts are all held rigid, and the entire assembly is completely sealed. Next, the resilient ring 13 is slipped on the cylindrical portion of the housing and centered on the housing dimples 67, 69. Next, the envelope skirts 31, 33 are assembled on the housing with their inwardly extending dimples 79 centered on the resilient ring 13 and registered with corresponding dimples 67, 69 on the housing. Then the cap 29 is placed over the upper end of the housing and down over the skirts 31, 33, making a tight friction fit over the skirts and clamping them together in matched relation. Then the coil leads 73 are connected to appropriate base plug pins 85, and the base plug 11 is inserted inside the bottom portion of the skirts 31, 33, making a snug fit therewith. The assembly is completed by soldering the base plug ring 81 to the envelope skirts.

It is evident that the arrangement and construction of the tuning fork assembly of my invention provides a large measure of compactness and ruggedness. In addition, the coil and fork housing assembly is shockmounted at its center of gravity by means of the dimples on the housing and the envelope skirts, in co-operation with the resilient ring. This means that external vibrations have minimum effect on the fork. Furthermore, the co-axial construction of the device with the coils between the fork tines not only lends itself to small size and compactness, but also balances out the effects of external vibrations. Thus, if one fork tine is caused by an external shock to vibrate further away from one side of the coils than normal, the other fork tine will at the same time vibrate closer to the other side of the coils than normal by a like amount, thereby balancing out the adverse effect. Another important attribute of the arrangement and construction of my invention is that it permits precise and convenient dynamic balancing of the fork under actual operating conditions with the fork and coils and their housing completely assembled and sealed in final form. This is true because the fork tines are exposed in the final assembly so that test equipment can be readily applied and the metal necessary for precise dynamic balance can be readily removed from the fork tines. A further advantage of my construction and arrangement is that it lends itself to more economical manufacture. It has been found in actual practice that assemblies embodying my invention can be manufactured for as little as one half the cost per unit of assemblies heretofore manufactured.

While I have shown my invention in only one form, it will be apparent to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

I claim:

1. A tuning fork assembly comprising, a solid base type tuning fork having tines, a drive coil, a pick-up coil, a housing presenting a cylindrical outer surface at its lower portion tapering to spaced parallel plane outer surfaces at its upper portion, a cavity in the lower inside portion of said housing for receiving the base of said fork with the fork tines extending exteriorly of the housing with their inner faces parallel to and closely adjacent said spaced parallel housing outer surfaces, cavities in the upper portion of said housing centered on the housing longitudinal axis for receiving said coils, means for rigidly securing the base of said fork and said coils within said housing, and means for sealing the assembly.

2. A tuning fork assembly comprising, a solid base type tuning fork having tines, a drive coil, a pick-up coil, a housing presenting a cylindrical outer surface at its lower portion tapering to spaced parallel plane outer surfaces at its upper portion, a cavity in the lower inside portion of said housing for receiving the base of said fork with the fork tines extending exteriorly of the housing with their inner faces parallel to and closely adjacent said spaced parallel housing outer surfaces, cavities in the upper portion of said housing and centered on the housing longitudinal axis for receiving said coils, means for rigidly securing the base of said fork and said coils within said housing, and means for shock mounting the assembly at its center of gravity.

3. A tuning fork assembly comprising a solid base type tuning fork having tines, a drive coil, a pick-up coil, a housing presenting a cylindrical outer surface at its lower portion tapering to spaced parallel plane outer surfaces at its upper portion, a cavity in the lower inside portion of said housing for receiving the base of said fork with the fork tines extending exteriorly of the housing with their inner faces parallel to and closely adjacent said spaced parallel housing outer surfaces, cavities in the upper portion of said housing and centered on the housing longitudinal axis for receiving said coils, means for rigidly securing the base of said fork and said coils within said housing, inwardly extending dimples disposed on opposite sides of said housing outer surface at the assembly center of gravity, a resilient ring girding said housing and centered over the housing dimples, a three piece envelope comprising a pair of identical semi-cylindrical metal skirts each having all inwardly extending dimple centered at its upper portion, a cylindrical cap closed at one end, said skirts being assembled on said housing cylindrical portion and extending downwardly therefrom with the dimples registered over respective housing dimples, the cap covering the upper portion of said housing and making a friction fit over the upper portions of said skirts, a base plug making a friction fit inside the lower portions of said skirts and having plug piece, and electrical connection between said coils and said pins.

4. A housing for a tuning fork assembly, said housing comprising a pair of substantially identical matching pieces, each piece having a cylindrical outer surface at its lower portion tapering to a plane surface at its upper portion, a plane surface at the piece inner face with an outwardly extending projection at one side of the lower portion and an inwardly extending recess at the other side, a deep U-shaped groove centered on the inner face and extending upwardly between said projection and recess to intersect the tapered portion of the housing piece outer surface forming an opening through the housing, a cavity in said lower portion of said housing piece inner face and centered on its longitudinal axis for receiving tuning fork base, a pair of transversely extending cylindrical openings being wells in said housing piece for receiving coil cores, a groove in said housing piece inner face communicating between said wells and the lower end of said housing piece, and means for holding said housing pieces in matched rigid relation.

5. A tuning fork assembly comprising a tuning fork having a base and tines, a drive coil, a pick up coil and a housing, said housing having upper and lower portions, said upper portion adapted to hold said coils firmly be-

tween said tuning fork tines so that the said tines extend exteriorly of said upper portion of said housing and said lower portion adapted to hold the said tuning fork base firmly in said lower portion of the housing.

6. A tuning fork assembly comprising a tuning fork having a base and tines, a drive coil, a pick up coil and a housing, said housing having upper and lower portions, said upper portion adapted to hold said coils firmly between said tuning fork tines so that the said tines extend exteriorly of said upper portion of said housing and said lower portion adapted to hold the said tuning fork base firmly in said lower portion of the housing, said housing being comprised of a pair of matched housing pieces which join together to make a unitary housing.

7. A tuning fork assembly comprising a tuning fork having a base and tines, a drive coil, a pick up coil and a housing, said housing having upper and lower portions, said upper portion adapted to hold said coils firmly between said tuning fork tines so that the said tines extend exteriorly of said upper portion of said housing and said lower portion adapted to hold the said tuning fork base firmly in said lower portion of the housing, said housing being comprised of a pair of matched housing pieces which join together to make a unitary housing and means for shock mounting the assembly to minimize external shock vibrations.

8. A tuning fork assembly comprising a tuning fork having a base and tines, a drive coil, a pick up coil and a housing, said housing having upper and lower portions, said upper portion adapted to hold said coils firmly between said tuning fork tines so that the said tines extend exteriorly of said upper portion of said housing and said lower portion adapted to hold the said tuning fork base firmly in said lower portion of the housing and means for shock mounting the assembly to minimize external shock vibrations.

9. A tuning fork assembly comprising a tuning fork having a base and tines, a drive coil, a pick up coil and a housing, said housing having upper and lower portions, said upper portion adapted to hold said coils firmly between said tuning fork tines so that the said tines extend exteriorly of said upper portion of said housing and said lower portion adapted to hold the said tuning fork base firmly in said lower portion of the housing, an enclosure for said tuning fork assembly and means to shock mount said tuning fork assembly in said enclosure.

10. A tuning fork assembly comprising, a tuning fork having a base and tines, a drive coil, a pick up coil, a housing presenting a cylindrical outer surface at its lower portion tapering to spaced parallel plane outer surfaces at its upper portion, a cavity in the lower inside portion of said housing for receiving the base of said fork with the fork tines extending exteriorly of the housing with their inner faces parallel to and closely adjacent said spaced parallel housing outer surfaces, said upper portion having a cavity for receiving said coils, means for rigidly securing the base of said fork and said coils within said housing, and means for sealing the assembly.

11. A tuning fork assembly comprising, a tuning fork having a base and tines, a drive coil, a pick up coil, a housing presenting a cylindrical outer surface at its lower portion tapering to spaced parallel plane outer surfaces at its upper portion, a cavity in the lower inside portion of said housing for receiving the base of said fork with the fork tines extending exteriorly of the housing with their inner faces parallel to and closely adjacent said spaced parallel housing outer surfaces, the upper portion of said housing having a cavity for receiving said coils, means for rigidly securing the base of said fork and said coils within said housing, and means for shock mounting the assembly.

12. A tuning for assembly comprising tuning fork having a base and tines, a drive coil, a pick up coil, a housing presenting a cylindrical outer surface at its

lower portion tapering to spaced parallel plane outer surfaces at its upper portion, a cavity in the lower inside portion of said housing for receiving the base of said fork with the fork tines extending exteriorly of the housing with their inner faces parallel to and closely adjacent said spaced parallel housing outer surfaces, said upper portion of said housing having a cavity for receiving said coils, means for rigidly securing the base of said fork and said coils within said housing, inwardly extending dimples disposed on opposite sides of said housing outer surface at substantially the assembly center of gravity, a resilient ring girding said housing and centered over the housing dimples, a three piece envelope comprising a pair of identical semi-cylindrical metal skirts each having all inwardly extending dimple centered at its upper portion, a cylindrical cap closed at one end, said skirts being assembled on said housing cylindrical portion and extending downwardly therefrom with the dimples registered over respective housing dimples, the cap covering the upper portion of said housing and making a friction fit over the upper portions of said skirts, a base plug making a friction fit inside the lower portions of said skirts and having plug piece, and electrical connection between said coils and said pins.

13. A housing for a tuning fork assembly, said housing comprising a pair of substantially identical matching pieces, each piece having a cylindrical outer surface at its lower portion tapering to a plane surface at its upper portion, a plane surface at the piece inner face with an outwardly extending projection at one side of the lower portion and an inwardly extending recess at the other side, a deep U-shaped groove centered on the inner face and extending upwardly between said projection and recess to intersect the tapered portion of the housing piece outer surface forming an opening through the housing, a cavity in said lower portion of said housing piece inner face and centered on its longitudinal axis for receiving tuning fork base, a cavity in said upper portion of said housing piece for receiving coil cores, a groove in said housing piece inner face communicating between said upper portion cavity and the lower end of said housing piece, and means for holding said housing pieces in matched rigid relation.

14. A tuning fork assembly comprising a tuning fork housing, a tuning fork having a base and spaced legs extending therefrom, a pick up coil, a driving coil, said housing having an upper portion adapted to hold said coils between the legs of the tuning fork and a lower portion to hold the tuning fork base, a shock absorbing means positioned about said tuning fork housing and an enclosure adapted to enclose said tuning fork housing and said shock absorbing means whereby the tuning fork housing and tuning fork are effectively protected from external shock vibrations to the enclosure.

15. A tuning fork assembly comprising a tuning fork housing, a tuning fork having a base and extending tines, a pick up coil, a driving coil, said housing having an upper portion adapted to hold said coils between the tines of the tuning fork, a lower portion to hold the tuning fork base and a plurality of indentations on the outer periphery of said housing, a shock absorbing means positioned about said tuning fork housing, a plurality of spacing plates having protuberances adapted to provide a fixed relationship of the said plates and fork housing by virtue of the said indentations and an enclosure adapted to enclose said spacing plates and said tuning fork housing whereby external shock vibrations to the enclosure are minimized in the tuning fork.

References Cited in the file of this patent

UNITED STATES PATENTS

1,906,985	Marrison	May 2, 1933
2,530,759	Collins et al.	Nov. 21, 1950
2,678,360	Bellis	May 11, 1954