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DRAWINGS ATTACHED

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(54) DOUBLE HAIRSPRING CLAMPING DEVICE

(71) We, TIMEX CORPORATION, a Corporation organised under the laws of the State of Delaware, United States of America, of Waterbury 20, Connecticut, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to horology, and more particularly to a hairspring clamping device.

One type of electric powered horological instrument employs a coil carried on a balance wheel. The coil passes through one or more magnetic fields, receives a pulse of current from an electronic circuit connected to a current source, and impulses the balance wheel. This type of instrument requires some method of conducting current to the moving coil. Generally, the current is conducted to the coil by two separate hairsprings, both of which conduct current. One hairspring is connected to the electronic circuit and the other to electrical ground, generally a frame member of the instrument. It is important that the two hairsprings remain electrically isolated from each other.

It has been suggested that the outer ends of the two hairsprings be individually clamped by separate hairspring clamping mechanisms, one of which would be grounded and the other insulated and connected with the electronic circuit. However, that system requires a number of parts and the skilled labour to clamp each hairspring.

It is an objective of the present invention to provide a hairspring clamping device, which device will clamp the outer ends of two hairsprings, will be relatively low in cost and utilize relatively few parts.

In accordance with the present invention, a hairspring clamping device is provided which clamps the outer ends of two hairsprings. The device consists of first and second electrically conductive clamping bushes insulated

one from the other and each having a slit for receiving a respective hairspring end, and means insulated from the first bush and adjustable to clamp the bushes relative to each other and simultaneously clamp both hairspring ends in the respective slits.

In one embodiment the two bushes are of metal and are provided with deformable slits. The adjustable means, such as a screw, connects the two bushes and is insulated from one of the bushes. The adjustable means, after the outer ends of the two hairsprings are inserted in their respective slits, may be adjusted to narrow the slits and clamp both hairsprings. Both hairsprings are clamped simultaneously and with the same force.

In another embodiment the two bushes are separated axially by a collar made of a sufficiently soft plastic resin, and the hairsprings protrude from their respective bushes into the collar, so that the adjustable means forces the hairspring ends into the plastic collar, which acts to retain them in place.

In a further embodiment a wall of each slit is made relatively thin. A hard insulator positioned between the bushes is constructed with slanting wedge faces. Upon tightening the adjustable means, the wedge faces of the insulator force the thin walls to move and close the slits, thereby gripping the hairspring ends.

Within an electronic instrument, the employment of the clamping device of the invention can maintain the electrical isolation of the two hairsprings from each other, can ground one of the hairsprings and provide a connection between the other hairspring and the electronic circuit, and will require only a single adjustment to clamp both hairsprings.

The invention will be further described with reference to the accompanying drawings, in which:—

Fig. 1 is a side cross-sectional view of a portion of a watch mechanism showing the use of a clamping device embodying the present invention;

[Price 25p]

Fig. 2 is an enlarged side view, partly in cross-section of the clamping device shown in Fig. 1;

Fig. 3 is an underneath view of the device of Fig. 2;

Fig. 4 is an enlarged side view, partly in cross-section, of a second embodiment of clamping device;

Fig. 5 is an enlarged side view, partly in cross-section of a third embodiment of clamping device;

Fig. 6 is an underneath view of the device of Fig. 5;

Fig. 7 is an enlarged side view, partly in cross-section, of a fourth embodiment of clamping device; and

Fig. 8 is a cross-sectional view taken along the line A-A of Fig. 7 and looking in the direction of the arrows.

Whereas the clamping device of the present invention is shown in Fig. 1 as being used in an electronic watch it will be understood that it may also be used in other horological instruments.

In Fig. 1 a balance wheel 9 carrying a coil 2 is mounted on a staff 3 which pivots between bearings mounted in a frame plate 4 and a balance bridge 11. A magnet 1, mounted on a shunt, is positioned beneath the path of movement of the coil 2, and an upper shunt 5 is mounted above that path and above the magnet 1. A regulator 8 is rotatably mounted on the bridge 11. The inner ends of two electrically conductive hairsprings 12 and 13 are fixed into hubs 6 and 7, respectively, the hubs 6 and 7 being mounted on the staff 3, and the two inner ends are electrically connected to the coil 2. A hairspring clamping device 10, described in detail below, clamps the outer ends of the hairsprings.

As shown in Figs. 2 and 3, the hairspring clamping device 10 is located on the balance bridge 11. The first hairspring 12 and the second hairspring 13 are located between the balance bridge 11 and the balance wheel 9. The clamping device 10 consists of a screw 14 having a head 15 with a slit 16 and a threaded shank 17. The head 15 is insulated from the bridge by an insulative washer 29.

A top first clamping bush 18, having an internal bore 19, surrounds the upper portion of the shank 17. The first clamping bush 18 has an annular flange portion 21 which fits within a cavity 22 of the balance bridge.

The first clamping bush 18 has a slit 23. A plane passing through the slit 23 would be perpendicular to the axis of the bore 19. The clamping bush 18 is of an electrically conductive material, for example, brass or other metal, and is sufficiently flexible that the slit 23 may be narrowed when pressure is applied to the bottom of the bush 18. A second clamping bush 25 has a threaded bore portion 26. It also has a slit 27, the slit also being perpendicular to the axis of

the bore 26. The second clamping bush is also of an electrically conductive material, for example brass or other metal and is sufficiently flexible that pressure on its top 28 will narrow the slit.

The shank 17 is partly surrounded by a tubular insulator 20, for example, of a hard plastics, having an enlarged bottom portion which separates the two bushes 18 and 25. The shoulders of the enlarged bottom portion fit into an annular groove in the bottom of bush 18 and a similar annular groove in the top of bush 25. The shoulders of the enlarged bottom portion fit tightly into the grooves and accurately locate the bushes. The outer ends of the hairsprings 12 and 13 are bent at 12' and 13', so that their ends are at a 90° angle relative to their bodies. The bending is required by the orientation of the slits 23 and 27. Assembly of the device proceeds by positioning the ends 12' and 13' in the slits 23 and 27 respectively, and tightening down the screw 14 to clamp the ends. After assembly and clamping of the hairspring ends, the space between the bushes 18 and 25 is filled in with an insulative material 24. A suitable filler material is a room temperature curing epoxy resin.

A wire or strip 31, connected to the electronic circuit of the watch (not shown) is positioned between the screw head 15 and the insulative washer 29. The screw 14 conducts current from wire 31 to the second bush 25 and to the hairspring 13. The other hairspring 12 is grounded by being connected to the first bush 18 which is in good contact with balance bridge 11.

The hairspring clamping device 35, shown in Fig. 4, is similar in many respects to the hairspring clamping device 10 shown in Figs. 2 and 3. It also consists of a screw 14a whose shank passes through a hole in the balance bridge 11a, and is screwed into screw threads in a second clamping bush 25a. An insulative separator is positioned between the second clamping bush 25a and the first clamping bush 18a and also insulates the screw 14a from the bush 18a as with the clamping device 10. The clamping device 35, however, is placed on a flange 36 (support leg) of the balance bridge 11a and consequently its orientation with respect to the hairsprings is different. With the device 35 it is not necessary to bend the ends of the hairsprings as the flat hairsprings 12a and 13a may be directly positioned in their respective slots 23a and 27a.

An alternative hairspring clamping device is shown in Figs. 5 and 6. The balance bridge 11b has a hole 41 through which the shank 17b of screw 14b protrudes. An insulating washer 8b is positioned between the screw head 15b and the balance bridge 11b. The top first clamping bush 42 and the bottom second clamping bush 43 each have a first slit 44 and 45, respectively. The slits 44

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and 45 are less deep than the height of the hairsprings which they are adapted to hold. These slits are parallel to the axis of the shank 17b, that is, a plane through the slits would be parallel to that axis. An annular plastics insulator 46, positioned between the bushes, is of a thermoplastic material, for example polyethylene, which is sufficiently soft that it may be cold pressed or cold flowed around the ends of the hairsprings 47 and 48, which protrude from the slits 44 and 45, when the screw 14b is tightened down. A harder insulator 49, which may also be of a plastics material, is in the form of a tubular bush. The insulator 49 is positioned within the circumference of the annular insulator 46. The top shoulder of insulator 49 fits within an annular depression 50 in the clamping bush 42 and its bottom fits within an annular depression 51 in the clamping bush 43. The dimensions of the insulator 49 and the annular depressions 50 and 51 are closely controlled so that the insulator 49 serves to position the clamping bushes 42 and 43 when the screw 14b is tightened. The current connection may be by means of a wire or strip 52 which is spot-welded at 53 to the conductive clamping bush 43.

A still further embodiment of the present invention is shown in Figs. 7 and 8.

As in the previously described embodiments, the clamping device 60 includes a screw having a shank 17c which protrudes through a hole in the balance bridge 11c. The upper portion of the shank is surrounded by a unitary washer and tubular insulator 62, the washer portion of which may be considered a flange of the tubular member. The current connection to the electronic circuit is by means of a wire or strip 61, whose end is positioned between the head of the screw and the top of the washer portion of the insulator 62. A first top clamping bush 63 is arranged with its raised annular flange portion within the hole of the balance bridge 11c. The bottom portion of the first bush 63 has a cavity 65, for example, of a square shape. A slit 64 is cut in the hub 63 such that a plane through the slit would be parallel to the axis of the bore of the hub 63. A second slit parallel to slit 64 intersects the cavity 65 to define between the cavity and slit 64 a wall 66 which may be bent under pressure.

The bottom second bush 67 is similarly constructed with a cavity 70, a slit 68 and a bendable wall 69. The shank 17c screws within the bore of the bush 67. An insulator 71 of hard plastics material is positioned between the bushes 63 and 67. The insulator has a top slanting wedge face 72 which is positioned against the free end of the wall 66. The insulator 71 has a second slanting wedge face 73 which is positioned against the free edge of the wall 69. The hairsprings 12c and 13c are placed in their respective slits 64

and 68. Then the screw is turned, bringing the bushes 63 and 67 closer together. Simultaneously, the free ends of the walls 66 and 69 are bent by the wedging action of the slanting faces 72 and 73, respectively. The bending of the walls clamps the hairsprings 12c and 13c.

WHAT WE CLAIM IS:—

1. A device for clamping the outer ends of two hairsprings in a horological instrument, comprising first and second electrically conductive clamping bushes insulated one from the other and each having a slit for receiving a respective hairspring end, and means insulated from the first bush and adjustable to clamp the bushes relative to each other and simultaneously clamp both hairspring ends in the respective slits.

2. A clamping device as claimed in claim 1, wherein each slit is a deformable slit and the adjustable means are operable to deform and close the slits around the hairspring ends.

3. A clamping device as claimed in claim 2, wherein the first and second bushes each have an axial hole therethrough and the plane of the respective slit therein is perpendicular to the axis of the hole, and the adjustable means is a screw passing through the hole in the first bush but spaced from contact therewith, and threadedly engaging the hole in the second bush.

4. A clamping device as claimed in claim 3, including a tubular insulator surrounding the portion of the screw within the first bush.

5. A clamping device as claimed in claim 4, wherein the tubular insulator has an enlarged end portion which axially spaces and locates the two bushes.

6. A clamping device as claimed in claim 1, wherein the first and second bushes each have an axial hole therethrough and the plane of the respective slit therein is parallel to the axis of the hole, the adjustable means is a screw passing through the hole in the first bush but spaced from contact therewith and threadedly engaging the hole in the second bush, and a collar of deformable insulative plastic resin material is positioned axially between the two bushes.

7. A clamping device according to claim 6, wherein the hairspring ends project axially from the respective slits and become partially embedded in the deformable collar when the screw is tightened.

8. A clamping device as claimed in claim 6 or claim 7 wherein a hard tubular insulator surrounds the portion of the screw within the deformable collar.

9. A clamping device as claimed in claim 2, wherein the first and second bushes each have an axial hole therethrough and the plane of the respective slit therein is parallel to the axis of the hole, the adjustable means is a screw passing through the hole in the first

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A still further embodiment of the present invention is shown in Figs. 7 and 8.

As in the previously described embodiments, the clamping device 60 includes a screw having a shank 17c which protrudes through a hole in the balance bridge 11c. The upper portion of the shank is surrounded by a unitary washer and tubular insulator 62, the washer portion of which may be considered a flange of the tubular member. The current connection to the electronic circuit is by means of a wire or strip 61, whose end is positioned between the head of the screw and the top of the washer portion of the insulator 62. A first top clamping bush 63 is arranged with its raised annular flange portion within the hole of the balance bridge 11c. The bottom portion of the first bush 63 has a cavity 65, for example, of a square shape. A slit 64 is cut in the hub 63 such that a plane through the slit would be parallel to the axis of the bore of the hub 63. A second slit parallel to slit 64 intersects the cavity 65 to define between the cavity and slit 64 a wall 66 which may be bent under pressure.

The bottom second bush 67 is similarly constructed with a cavity 70, a slit 68 and a bendable wall 69. The shank 17c screws within the bore of the bush 67. An insulator 71 of hard plastics material is positioned between the bushes 63 and 67. The insulator has a top slanting wedge face 72 which is positioned against the free end of the wall 66. The insulator 71 has a second slanting wedge face 73 which is positioned against the free edge of the wall 69. The hairsprings 12c and 13c are placed in their respective slits 64

and 68. Then the screw is turned, bringing the bushes 63 and 67 closer together. Simultaneously, the free ends of the walls 66 and 69 are bent by the wedging action of the slanting faces 72 and 73, respectively. The bending of the walls clamps the hairsprings 12c and 13c.

WHAT WE CLAIM IS:—

1. A device for clamping the outer ends of two hairsprings in a horological instrument, comprising first and second electrically conductive clamping bushes insulated one from the other and each having a slit for receiving a respective hairspring end, and means insulated from the first bush and adjustable to clamp the bushes relative to each other and simultaneously clamp both hairspring ends in the respective slits.

2. A clamping device as claimed in claim 1, wherein each slit is a deformable slit and the adjustable means are operable to deform and close the slits around the hairspring ends.

3. A clamping device as claimed in claim 2, wherein the first and second bushes each have an axial hole therethrough and the plane of the respective slit therein is perpendicular to the axis of the hole, and the adjustable means is a screw passing through the hole in the first bush but spaced from contact therewith, and threadedly engaging the hole in the second bush.

4. A clamping device as claimed in claim 3, including a tubular insulator surrounding the portion of the screw within the first bush.

5. A clamping device as claimed in claim 4, wherein the tubular insulator has an enlarged end portion which axially spaces and locates the two bushes.

6. A clamping device as claimed in claim 1, wherein the first and second bushes each have an axial hole therethrough and the plane of the respective slit therein is parallel to the axis of the hole, the adjustable means is a screw passing through the hole in the first bush but spaced from contact therewith and threadedly engaging the hole in the second bush, and a collar of deformable insulative plastic resin material is positioned axially between the two bushes.

7. A clamping device according to claim 6, wherein the hairspring ends project axially from the respective slits and become partially embedded in the deformable collar when the screw is tightened.

8. A clamping device as claimed in claim 6 or claim 7 wherein a hard tubular insulator surrounds the portion of the screw within the deformable collar.

9. A clamping device as claimed in claim 2, wherein the first and second bushes each have an axial hole therethrough and the plane of the respective slit therein is parallel to the axis of the hole, the adjustable means is a screw passing through the hole in the first

bush but spaced from contact therewith and threadedly engaging the hole in the second bush, and a hard plastic insulator is positioned axially between the two bushes.

- 5 10. A clamping device as claimed in claim 9, wherein the insulator has a top wedge face and a bottom wedge face which are at an angle to the axis of the screw.

- 10 11. A clamping device as claimed in claim 10, wherein the bushes each have a cavity separated by a thin wall from their slit, the said wedge faces being positioned against said thin walls.

- 15 12. A clamping device as claimed in any one of claims 9 to 11, including a tubular insulator surrounding a portion of the screw within the first bush.

- 20 13. A horological instrument including a frame member, a source of electric current, an electric circuit connected to the current source, a balance wheel assembly including a

balance wheel fixed to a balance wheel staff, the said balance wheel staff being pivotally mounted on said frame member, a coil carried by said balance wheel, two electrically conductive hairsprings connected electrically at their inner ends to the coil, and a clamping device as claimed in any one of the preceding claims clamping both hairsprings at their outer ends, the adjustable means being mounted on the frame member.

14. A clamping device for clamping the outer ends of two hairsprings in a horological instrument, substantially as hereinbefore described with reference to Figs. 1 to 3, Fig. 4, Figs. 5 and 6 or Figs. 7 and 8 of the accompanying drawings.

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