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VIBRATOR MOTORS FOR ELECTRIC DRY SHAVERS

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FIG. 1.

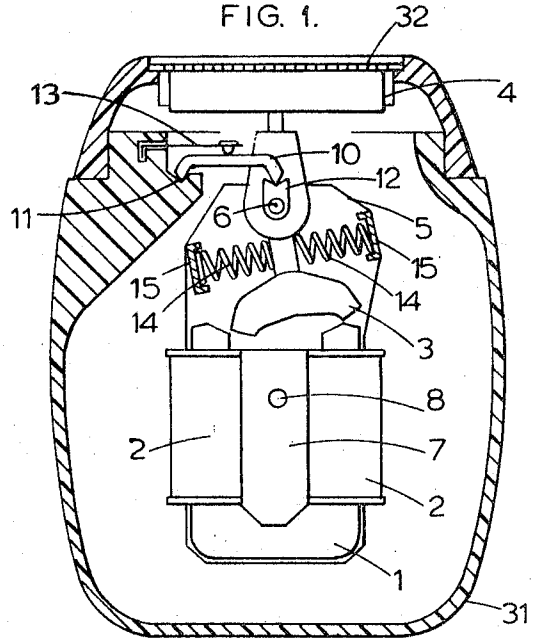
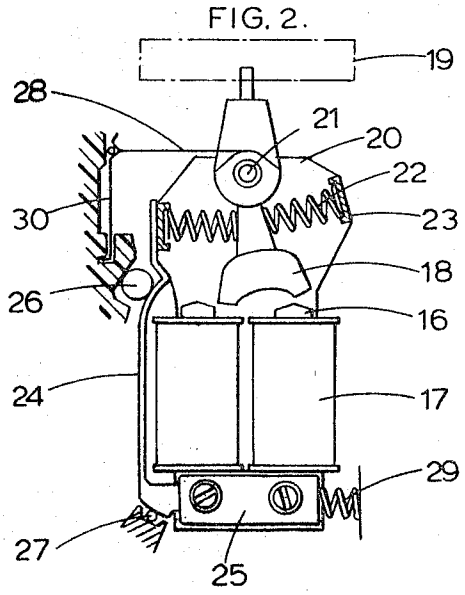


FIG. 2.



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VIBRATOR MOTORS FOR ELECTRIC DRY SHAVERS

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8 Claims. (Cl. 310—29)

This invention relates to vibrator motors for electric dry shavers and other electro-mechanical devices.

Known forms of electric dry shavers have one or more reciprocating cutters driven by a vibrator motor. The vibrator motor consists of an electro-magnet more or less rigidly fixed to the case and one or two oscillating armatures connected mechanically to the cutters.

A disadvantage of known forms of vibrator motor with one armature is that movement of the armature reacts on the case and sets up a vibration which is transmitted to the hand of the user.

In order to reduce the vibration of the case and make it more comfortable to hold in the hand a known form of vibrator motor has two armatures, the cutter being mechanically connected to one of them. The two armature assemblies have substantially equal polar moments of inertia about their respective pivots and are constrained by a mechanical linkage to move substantially equally in anti-phase. The result is that the reactions on the case caused by the oscillations of the two armature assemblies substantially balance each other out and only the small residual difference is transmitted to the hand of the user.

According to the present invention there is provided a vibrator motor comprising an electro-magnet assembly, an armature assembly, pivotal mountings for both said electro-magnet assembly and said armature assembly, mechanical coupling means from said electro-magnet assembly to said armature assembly to cause said electro-magnet assembly and said armature assembly to move in anti-phase about their pivotal mountings the one with respect to the other under the constraint of said mechanical means when said electro-magnet is energized in such a way that the relative angular movements of said armature assembly and said electro-magnet assembly are predetermined by said mechanical means.

One form of shaver vibrator motor according to the present invention has the electro-magnet and the armature assembly including the cutter pivoted about their respective centres of gravity. Normally the polar moment of inertia of the armature assembly about its pivot is much less than that of the electro-magnet. A mechanical linkage is arranged so that the ratio between the angular movements of the armature assembly and the electro-magnet is the same as the ratio between the moments of polar inertia about their pivotal axes of the electro-magnet and the armature assembly. The result is that the reactions on the case caused by the oscillations of the electro-magnet and the armature assembly substantially balance each other out, and only the small residual difference is transmitted to the hand of the user.

For practical reasons it may not be convenient to pivot the armature assembly and the electro-magnet about their respective centres of gravity. However, with their respective pivotal mounting suitably located it is still possible to attain a good degree of balance and this system is the one most likely to be required in practice.

In order that the present invention may be clearly understood and readily carried into effect it will now be described with reference to the accompanying drawings, in which:

FIGURES 1 and 2 illustrate vibrator motors for an

electric dry shaver according to two examples of the present invention.

The electro-magnet assembly of the vibrator motor shown in FIGURE 1 has a laminated and U-shaped magnetic core **1**, on the limbs of which are mounted two coils **2**. The armature assembly has the armature magnetic laminations **3** adjacent to the poles of the electro-magnet and is mechanically connected to a cutter represented by the rectangle **4**. The cutter operates in conjunction with a shear plate **32**.

The armature is pivotally mounted on a frame **5** by means of a pin **6** projecting from the frame **5**. The electro-magnet is mounted rigidly on the frame **5**.

Fixed to the electro-magnet is an I-beam **7** made of insulating material. A metal pin **8** passes through the I-beam **7**, and is fixed to it, being insulated within the web from the electro-magnet coils, and projects beyond the flange faces of the I-beam **7** and beyond the frame **5**. The ends of the pin **8** are mounted in bearing fixed to the case **31** of the shaver. Thus the frame **5** and all parts mounted on it can pivot in the case on the pin **8**.

The armature is also mechanically connected to the case by the bridge piece **10** which has knife edges that bear in V-grooves. One V-groove is moulded in the case at **11** and the other is formed in the porous sintered metal bush **12**. The cantilever spring **13** has a flat bottomed depression formed in it which allows limited movement of a small ball bearing. The spring **13** forces the ball bearing against the bridge piece **10** so locating the bridge piece knife edges at the bottom of their respective V-grooves.

The springs **14** bear at their outer ends against lugs **15** integral with the frame **5**. At their inner ends they bear against the armature so that its static equilibrium position is at approximately the mean of its normal operative travel. Approximately the greatest amplitude of oscillation is normally obtained with the equilibirium position arranged so that the corners of the armature and the electro-magnet laminations are adjacent, as shown in the figure.

Examination of FIGURE 1 shows that for small angles of movement of the armature the right hand knife edge of the bridge piece is virtually stationary relative to the case. This means that relative to the case the armature virtually rotates about the bridge piece right hand knife edge while the electro-magnet rotates on the pin **8**. It is also clear that for small angular movements of the armature the angular velocity ratio relative to the case between movements of the electro-magnet and the armature is virtually equal to the ratio between the distance from the bridge piece right hand knife edge to the centre of the pin **6** and the distance between the centres of the pins **6** and **8**.

The shaver vibrator motor illustrated in FIGURE 1 has the centres of gravity of the electro-magnet and armature assemblies some distance below their respective pivots, described above, relative to the case. This corresponds to the general conditions referred to in the preamble as being the one most likely to be required to practice.

For the shaver vibrator motor illustrated in FIGURE 1 the conditions for balance within the terms of the present invention may conveniently be calculated as described below for small angles of movement. Some slight adjustments may be desirable in practice to obtain the best results with the normal angular movement of the armature.

The electro-magnet is assumed to have unit angular acceleration and moments are taken about the two pivot points described above relative to the case for the inertial

reactive torques exerted by the disparate moving parts. Normal use is made of the well known parallel axes theorem. Due account is taken of the condition that the shaver cutter reciprocates without rotation while the other major moving components oscillate about their pivoted axes. Due account is also taken of the velocity ratios existing between the moving components.

It is important to note that for the purposes of these particular calculations neither pivot point is assumed to transmit any force at all.

The two equations obtained may conveniently be manipulated by assuming figures for all the possible variables except the two distances controlling the angular velocity ratio. Then, for each of the two equations, the value of one distance for given values of the other may be plotted an a graph. The point where the two lines cross gives the solution.

FIGURE 2 illustrates a layout which is a modification of that shown in FIGURE 1, but which is similar in principle to that shown therein. It illustrates typical variations which lie within the scope of the present invention.

The electro-magnet assembly of the vibrator motor shown in FIGURE 2 has a laminated and U-shaped magnetic core **16**, on the limbs of which are mounted two coils **17**. The armature assembly has the armature magnetic laminations **18** adjacent to the poles of the electro-magnet and is mechanically connected to a cutter represented by the chain dotted rectangle **19**. The cutter operates in conjunction with a shear plate (not shown).

The armature is pivotally mounted on a frame **20** by means of a pin **21** projecting from the frame **20**. The electromagnet is mounted rigidly on the frame **20**.

The springs **22** bear at their outer ends against lugs **23** integral with the frame **20**. At their inner ends they bear against the armature.

A metal pressing or die casting or plastic moulding **24** is fixed (by means not shown for clarity) to the left hand lug **23** at one end. At the other end it is fixed by a clamping plate **25** to the electro-magnet. Ball or roller bearings **26** and **27** are located between tracks formed in the part **24** and in the case, which is indicated by shading. These tracks are all concentric with a line which is the axis of oscillation of all parts rigidly fixed to the frame **20**.

The armature is also mechanically connected to the case by the metal tape **28** which with all operatively possible positions of the armature meets a cylindrical surface provided for it on the armature, tangentially. Both ends of the tape **28** are reinforced and made so that they can swivel at their attachment points allowing the tape to seat evenly on the cylindrical surface. The tape **28** is kept taut by the action of the spring **29** bearing at one end against the plate **25** and at the other end against the case. This spring **29** also forces the tracks in the part **24** against the ball or roller bearings **26** and **27** and the latter against the tracks in the case. The cantilever spring **30** normally holds one end of the tape **28** against the case, indicated by the shaded area, so that the tape connection between the armature and the case is sufficiently rigid. Undue loads on the tape, however, such as due to impacts between the case and the floor, are relieved by flexing of the cantilever spring **30** away from the adjacent part of the case.

The spring **29** and the two springs **22** are arranged so that the static equilibrium position of the armature is at approximately the mean of its normal operative travel. Approximately the greatest amplitude of oscillation is normally obtained with the equilibrium position arranged so that the corners of the armature and electro-magnet laminations are adjacent, as shown in the figure.

Examination of FIGURE 2 shows that for normal angles of movement of the armature the parts rigidly fixed to the frame **20** oscillate about the axis with which the tracks for the ball or roller bearings **26** and **27** are concentric. The armature, meanwhile, oscillates in the opposite sense about the pin **21** which is fixed to the frame **20**. It is also clear that for normal angular movements of the armature the angular velocity ratio relative to the case between the electro-magnet and the armature is virtually equal to the ratio between the radius of the cylindrical surface on the armature under one end of the tape **28** and the distance between the centre of the pin **21** and the axis with which the tracks for the ball or roller bearings **26** and **27** are concentric.

What I claim is:

1. A vibrator motor comprising an electro-magnet assembly, an armature assembly, pivotal mountings for both said electro-magnet assembly and said armature assembly, mechanical coupling means from said electro-magnet assembly to said armature assembly to cause said electro-magnet assembly and said armature assembly to move in anti-phase about their pivotal mountings the one with respect to the other under the constraint of said mechanical means when said electro-magnet is energised in such a way that the relative angular movements of said armature assembly and said electromagnet assembly are predetermined by said mechanical means.

2. A vibrator motor according to claim **1** further comprising a containing case, a frame mounted for small angle oscillatory movement in said case and to which frame said electro-magnet is rigidly secured and said armature is pivoted, and a further yielding pivot for said armature connected to said case, the pivoting of said armature to said frame providing the mechanical coupling from said electromagnet to said armature.

3. A vibrator motor according to claim **2**, said yielding pivot comprises a bridge piece having two knife edge bearings, a V seating for one of said bearings attached to said case, a V seating for the other of said bearings attached to said armature, and spring means urging said knife edge bearings into said V seatings.

4. A vibrator motor according to claim **2**, comprising tracks on said frame and said case and bearings operating on the tracks to permit the small angle oscillatory movement of said frame, and spring loads means bearing on said frame and said case.

5. A vibrator motor according to claim **4** said yielding pivot comprising a tape attached resiliently to said frame and attached to said armature and wrapped round an arcuate surface on said armature.

6. A vibrator motor according to claim **1** wherein in operation whereof the amplitude of the movements of said electro-magnet and said armature are inversely proportional to their respective polar moments of inertia.

7. An electric shaver including a vibrator motor according to claim **3**, a cutter, said case comprising a shear plate in operational juxtaposition with said cutter, said armature being in driving connection with said cutter.

8. An electric shaver including a vibrator motor according to claim **5**, a cutter, said case comprising a shear plate in operational juxtaposition with said cutter, said armature being in driving connection with said cutter.

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