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R. GOLDSCHMIDT

2,078,845

SAFETY RAZOR AND VIBRATORY MOTOR THEREFOR

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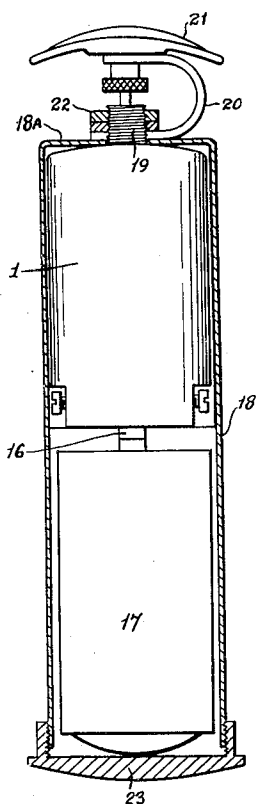


Fig. 2

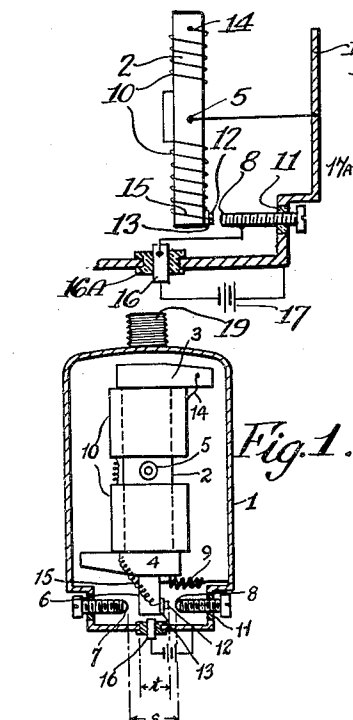


Fig. 1.

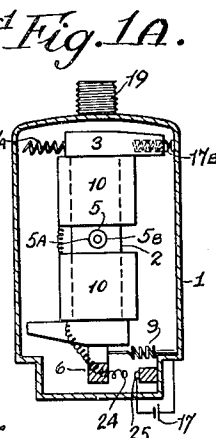


Fig. 1A.

Fig. 7.

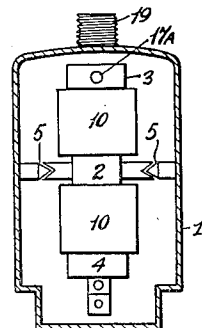


Fig. 8.

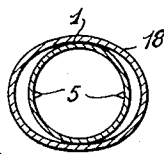


Fig. 9.

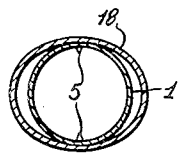


Fig. 10.

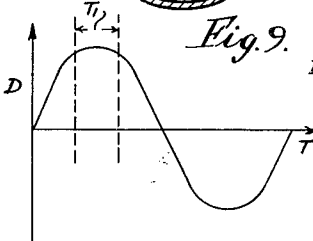


Fig. 4.

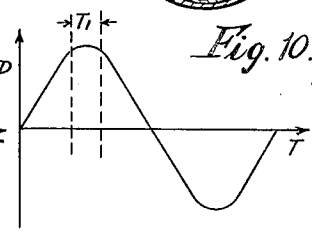


Fig. 6.

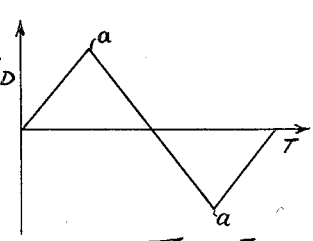


Fig. 5.

INVENTOR
RUDOLF GOLDSCHMIDT,

By John Q. Brady
Attorney

UNITED STATES PATENT OFFICE

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SAFETY RAZOR AND VIBRATORY MOTOR
THEREFOR

Rudolf Goldschmidt, London, England

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12 Claims. (Cl. 30—45)

The present invention relates to vibratory motors for safety razors.

It is known to impart to the blade of a safety razor a vibratory motion having at least a substantial component in a direction parallel to the cutting edge of the blade.

It is also known to use for this purpose electromagnetically operating motors in which an armature is set in vibration relatively to a body portion on which it is mounted, but the vibrations of the armature serving to set the body portion (which carries the razor blade) in vibration.

Hitherto electric devices of this kind have either required leads for conducting current to the motor from a battery or from the mains or else a dry cell battery has been attached to the handle. In the former case the leads have been found cumbersome and in the latter case the total weight and size has been increased beyond desirable limits.

It is the principal object of this invention to provide an electric safety razor in which these disadvantages are overcome or greatly reduced.

To this end the present invention provides means whereby both the cutting efficiency and the efficiency of the vibratory motor itself may be increased, thus enabling the weight of the parts, including principally the vibratory motor and battery, to be reduced.

The efficiency of the motor for a given weight can be increased according to the present invention by arranging the exciting coils of the electromagnet upon the armature (that is, upon the free member which sets the razor in vibration by reactive forces). In this way the mass of the armature portion of the magnetic circuit of the motor can be made comparable with (for example not less than one half) the mass of the other part of the magnetic circuit (namely the body portion to which the razor blade is fixed). In view of the relatively large mass of the armature portion, this portion is preferably mounted upon the body portion in such a manner that it is constrained to vibrate about an axis passing through or near to its centre of gravity. In this way the behaviour of the motor is little affected by the position in which it is held.

The cutting efficiency has been found to be increased if the cutting edge is vibrated impulsively and at a high frequency, in order to cope with yielding of the hair and skin. Clearly if the cutting edge is moved sufficiently rapidly and impulsively (as in reaping for example)

the hair will be cut before it has had time to yield under the impact of the cutting edge.

Further, as will hereinafter be explained, when the vibration is impulsive the fraction of the total time during which the blade has little transverse or slicing motion is reduced.

A further and purely geometrical consideration is that it is not necessary that the amplitude of vibration imparted to the cutting edge should exceed considerably the pitch of the serrations of the cutting edge. The serrations referred to are of course those which, as is well known, can be observed in any cutting edge under a microscope. It is therefore only necessary, in order to obtain the best results, to provide an impulsive vibration of an amplitude somewhat greater than the pitch of these serrations.

The invention will be described by way of example with reference to the accompanying drawing, in which

Fig. 1 is a view in sectional elevation of a vibratory motor according to the invention,

Fig. 1A is a schematic diagram of the electrical connections in the vibratory motor,

Fig. 2 shows the assembly of the motor of Fig. 1 in a single casing containing the operating battery and carrying a safety razor head,

Fig. 3 shows a detail of Fig. 2 in part sectional plan view,

Figs. 4, 5 and 6 are diagrams illustrating one feature of the invention,

Figs. 7 and 8 are diagrammatic sectional views in front and side elevation respectively of a modified form of motor according to the present invention, and

Figs. 9 and 10 are diagrammatic cross sectional views of the device in Fig. 2 showing how adjustment may be effected.

It is to be understood that the following description is given by way of example only and many different constructions lie within the scope of the invention as defined in the appended claims.

Referring now to Fig. 1, a tubular motor body portion 1 of iron has within it an armature 2 having pole pieces 3 and 4. The armature 2 is mounted on pivots 5 so as to be capable of vibration. The axis of vibration is arranged to pass through or near to the centre of gravity of the armature so that the vibration of the armature relatively to the body portion 1 is little affected by gravity and therefore by the position in which the body portion is held.

The armature has a projecting lug 6 which

extends between two abutments 7 and 8 threaded through the body portion 1 so as to be adjustable in position. A weak spring 9 is provided to hold the armature lug 6 normally in contact with the abutment 8. Energizing coils 10 are mounted upon the armature 2 for vibration therewith and can be regarded as forming part of the armature portion of the magnetic circuit. The abutment 8 is in the present example used as an electric contact for a make-and-break device and is accordingly insulated from the body portion 1 by an insulating inset 11. Similarly a contact 12 on the lug 6 is insulated by insulating material 13 from the lug 6. The electrical connections in the vibratory motor can be best understood by reference to Fig. 1A. The coils 10 are connected in series and one end of the upper coil is connected at 14 to the armature and thence through the pivots 5 to the body portion 1 while the free end of the other coil is connected at 15 to the contact 12. The terminal 16 is insulated by grommet 16A from the body portion 1, and connected to the abutment 8 which is disposed for coaction with contact 12. It will thus be clear that when a battery 17 is connected between the terminal 16, and the body portion 1, the armature will be set in vibration.

The abutting faces on the abutments 7 and 8 and the lug 6 are made of hard material such as hard metal. The travel of the armature 2 is determined by the clearance between the abutments 7 and 8 and the lug 6 and is indicated by $s-t$. This travel is made very small, for example $\frac{1}{3}$ mm. or less. Under these conditions the natural frequency of vibration f_1 is higher than that which would be given by the spring 9 in the absence of the abutments 7 and 8, this frequency being determined by the nature of the abutting surfaces and the travel $s-t$. The frequency of vibration can be adjusted by adjusting this value $s-t$ by turning either of the abutment screws 7, 8. Care must be taken not only to make the impacting surfaces hard but also to make the connection between these surfaces and the body portion and the armature, respectively, sufficiently rigid so that the wave form of the motion of the armature is highly peaked.

There is a tendency for a second natural frequency of vibration f_2 to exist owing to the effect of the spring 9, which may be regarded in practice as furnishing a substantially constant restoring force. This may lead to irregular working if the distance $s-t$ is too great so that this natural frequency f_2 is nearly equal to f_1 , for then beats may occur. Further, any control of the wave-form of vibration by the spring 9 is undesirable because the wave form then tends to be more nearly sinusoidal and less peaked. These difficulties can be overcome by adjustment of the value $s-t$ to a sufficiently small value.

Since the motor described operates to drive a razor blade device attached to the body portion by reactive forces, it is necessary, in order to obtain high efficiency, that the effective mass of the armature should be comparable with that of the body portion. It is mainly in order to increase the mass of the armature, that is, the hammering part of the magnetic circuit, without increasing the mass of the device as a whole that the coils 10 are mounted upon the armature. Satisfactory results can usually be obtained so long as the mass of the magnetic circuit of the motor, that is, the flux carrying parts and the energizing coils is so sub-divided that the mass

of the armature 2 and coils 10 (that is, the free or hammering part of the magnetic circuit) is not less than one half of the mass of the body portion 1 (that is, the part of the magnetic circuit which is connected to the device to be vibrated).

In view of the relatively high mass of the armature portion, the importance of pivoting the armature on a line passing near to its centre of gravity will be appreciated.

The amplitude of vibration is usually made very small, not only to obtain the desired high frequency of vibration but also so that small air gaps can be provided in the magnetic circuit with the result that the requisite strong magnetic field can be obtained with few ampere turns and therefore with a small current consumption. All these features combine to render possible the construction of a light and efficient electric razor.

If desired, instead of arranging the abutments 7 and 8 at the same end of the armature they may be arranged at opposite ends and on the same side thereof.

The advantage of imparting an impulsive movement to the cutting edge will be appreciated from Figs. 4 to 6 of the accompanying drawing in which are shown curves of transverse displacement D , which may be imparted to the cutting edge, plotted against time T . In Fig. 4 the vibratory motion is sinusoidal and during $\frac{1}{3}$ of each half cycle, indicated by T_1 , the velocity of the transverse motion is less than one half the maximum velocity. The ideal case is illustrated in Fig. 5 where at no time does the transverse velocity fall below the maximum excepting instantaneously at the reversal points a . A practical case may be arranged to have a curve as shown in Fig. 6 where the time T_1 , during which the transverse velocity is less than one half the maximum, is less, and preferably substantially less, than 30% of the total time of a half period.

In Fig. 2 the motor of Fig. 1 is shown mounted within a casing 18 which constitutes the handle of a safety razor. A dry battery 17 is also arranged in the handle as shown. A threaded projection 19 on the body portion 1 of the motor projects through an aperture in the top of the casing 18. A member 20 supporting a safety razor head 21 has a fork at its lower end and this fork embraces the projection 19 and the member 20 is clamped in position by nuts 22. The projection 19 may be provided with flats as shown in Fig. 3, so that the razor head can only be mounted in the correct position relatively to the motor. This position is usually that in which the axis of vibration of the armature 2 is approximately perpendicular to the cutting edge so that the cutting edge is given a vibration having a strong component in a direction along its length.

The motor may be arranged to fit loosely in the casing 18 so that the only contact thereof with the casing is around the projection 19, except, if desired, for a few small projections (not shown) which may be provided upon the outside of the body portion 1 or the inside of the casing 18. These projections serve to keep the motor central in the casing. To prevent these projections from interfering seriously with the freedom of movement of the motor within the casing, they may be of yielding material or they may contact with flexible parts of the casing 18. To reduce the area of contact, the upper end of the body portion 1 may be slightly domed. In this way it is possible to arrange that vibrations be transmitted from the body portion 1 through the end wall 18A of the casing 18 by flexure of this end

wall. It is then not necessary that the whole of the casing 18 and battery 17 should be set in vibration to the full extent. The battery 17 may be made to fit loosely in the casing so that it can execute a rolling movement on its domed base when the body portion 1 vibrates relatively to the casing 18.

A screw end cap 23 which is removable to permit changing of the battery may be arranged to constitute the switch for starting and stopping the motor. When the cap 23 is slightly unscrewed contact between the battery and the other parts is broken.

The body portion 1 of the motor shown in Fig. 1 may be made watertight to prevent the entrance of moisture which might interfere with the operation thereof. Further, the casing 18 of Fig. 2 may also be made relatively watertight so that leakage from the battery 17 is minimized.

Instead of mounting the armature 2 on pivots it may be mounted on spring supports, bearings or in any other suitable manner.

In Figs. 7 and 8 is shown a modified arrangement according to the present invention. Like parts are in these figures given the same references as in Fig. 1. In the present example, the desired peaky wave form is obtained by providing a suitable small amount of play at the pivots 5. The amplitude of vibration of the armature 2 at the fundamental frequency is limited by relatively stiff springs 17A and 17B. The armature however, vibrates not only about an axis through the pivots, but also in a direction perpendicular to the paper in Fig. 8, the pivots 5 performing the function of the abutments 7 and 8 in Fig. 1, and peaked vibrations of high frequency are produced superimposed on vibrations of lower frequency. The value $s-t$ is in this case represented by the distance through which the armature can be displaced bodily in a direction perpendicular to the paper in Fig. 8, this distance being of course determined by the amount of play allowed. Thus in Fig. 7 one side 5A of each pivot may be regarded as constituting one abutment and the other side 5B as constituting the other abutment.

In the present case a spring contact 24 co-operating with a fixed contact 25 constitutes the make-and-break device.

The armature assumes, under the influence of the unidirectional magnetic impulses, a mean position in which the contacts 24, 25 remain automatically near to the "breaking point" and in which the magnetic air gap is very small.

By providing means for adjusting the amount of play in the pivots 5, the frequency of vibration of the armature 2, between the abutments, can be adjusted. This can be done by arranging that the pivots are threaded through the body portion 1 but preferably the pivots 5 are fixed in the body portion and the adjustment is effected as follows: The motor of Figs. 7 and 8 may have the same outer appearance as that of Fig. 1 and this motor having a circular cross-section may be mounted as shown in Fig. 2. The inside of the casing 18 is however made of oval shape as shown exaggerated in Figs. 9 and 10. When the motor is in the position indicated in Fig. 9 relatively to the casing 18, as indicated by the position of the pivots 5, the body portion 1 is distorted by pressure of the casing 18 in such a way that the distance between the pivots 5 (and consequently the play) is increased. When the positions are as shown in Fig. 10, the play will be a minimum. To change the relative positions

from that of Fig. 9 to that of Fig. 10, the portion 1 may be rotated within the casing 18 with the aid of the member 20 in Fig. 2. In this way a very fine adjustment of the small clearances which are usually provided can be obtained. The distortion of the body portion necessary to effect this adjustment may be carried out in any other suitable manner if desired.

In all the arrangements described, the abutments are so adjusted that, upon impact, there still remains a small air gap in the magnetic circuit. The possibility of magnetic adhesion is thus prevented.

The distance between the abutments 7 and 8 of Fig. 1 can if desired be adjusted by distortion of the body portion 1, for example as described in connection with Figs. 9 and 10 or otherwise.

I claim:

1. An electromagnetic vibratory motor for setting the blade of a safety razor in vibration, said motor comprising a magnetic circuit consisting of an armature portion and a body portion, said armature portion being mounted for vibration relatively to said body portion, a coil for setting said armature in vibration in response to current passed therethrough, said coil being mounted upon said armature portion for vibration therewith relatively to said body portion, means for attaching a safety razor blade to said body portion, and means for transmitting vibrations of said armature to said body portion to produce vibration of said blade in directions substantially parallel to the cutting edge thereof, the mass of said armature portion including said coil being at least one-half of the mass of said body portion.

2. An electromagnetic vibratory motor for setting the blade of a safety razor in vibration, said motor comprising a body portion, an armature mounted for vibration relatively to said body portion about an axis passing near to the centre of gravity of said armature, a coil for setting said armature in vibration in response to current passed therethrough, means for attaching a safety razor blade to said body portion and means for transmitting vibrations of said armature to said body portion, the mass of said armature portion being at least one half of the mass of said body portion.

3. An electromagnetic vibratory motor for setting the blade of a safety razor in vibration, said motor comprising a body portion, an armature mounted upon said body portion, coil means for actuating said armature mounted upon said armature for vibration therewith, said armature being capable of vibration relatively to said body portion about an axis passing near to the centre of gravity of said armature and coil means, and means for attaching a safety razor blade to said body portion.

4. An electromagnetic vibratory motor for setting the blade of a safety razor in vibration, said motor comprising a body portion, an armature mounted for vibration relatively to said body portion, coil means for actuating said armature mounted upon said armature for vibration therewith relatively to said body portion, means for attaching a safety razor blade to said body portion and means for transmitting vibrations of said armature to said body portion to produce vibration of said blade in directions substantially parallel to the cutting edge thereof, the mass of said armature portion being at least one half of the mass of said body portion.

5. An electromagnetic vibratory motor for set-

ting the blade of a safety razor in vibration, said motor comprising a body portion, an armature mounted for vibration about an axis passing substantially through the centre of gravity thereof and capable of executing forward and return strokes of vibration relatively to said body portion, a coil for setting said armature in vibration in response to current passed there-through, abutment surfaces upon said armature and body portion positioned to impact with one another on said forward and return strokes and constituted to make the reversal period, during which the velocity of said armature is less than one half the maximum velocity thereof, substantially less than one third of one half cycle of said vibration.

6. A safety razor comprising a blade carrying member, a hollow tubular handle, a vibratory motor connected to said blade carrying member for imparting vibrations thereto, said motor being yieldingly mounted within said handle so as to be capable of vibration relatively to said handle, and a battery for operating said motor rockably disposed within said handle and adapted to rock in accordance with the vibrations of said motor relatively to said handle.

7. A safety razor comprising a blade carrying member, a hollow tubular handle having a yieldable end wall, a vibratory motor connected to said blade carrying member for imparting vibrations thereto, said motor being yieldingly mounted on said end wall and within said handle so as to be capable of vibration relatively to said handle, and a battery for operating said motor rockably disposed within said handle and adapted to rock in accordance with the vibrations of said motor relatively to said handle.

8. A safety razor comprising a blade carrying member, a handle and a vibratory electromagnetic motor, said motor comprising a body portion connected to said member for the transmission of vibration thereto, an armature portion mounted for vibration relatively to said body portion, and coil means mounted on said armature for setting said armature into vibration relatively to said body portion in response to current passed therethrough, said coil means increasing the mass of said armature relative to

the mass of said body portion, said body portion being yieldingly mounted upon said handle.

9. A safety razor comprising carrier means for supporting a razor blade and an electromagnetic motor for setting said carrier in vibration, said motor comprising a body portion of magnetic material attached to said carrier means, an armature of magnetic material mounted for vibration relatively to said body portion and positioned to impact with said body portion during vibration, coil means mounted on said armature for actuating said armature, and make-and-break switch means associated with said coil and operative upon relative vibration between said armature and body portion to interrupt the circuit of said coil.

10. An electromagnetic vibratory motor for setting the blade of a safety razor in vibration, said motor comprising a body portion, an armature portion, a coil included in one of said portions for setting said armature in vibration in response to current passed therethrough, means for attaching a safety razor blade to said body portion, and means for supporting said armature portion for vibration about an axis passing substantially through the centre of gravity of said armature portion, whereby the operation of said motor is not substantially effected by changes in position of said motor.

11. A safety razor comprising a blade carrying member, and a handle resiliently attached thereto, a vibratory electromagnetic motor contained in said handle and comprising a body portion rigidly connected with said blade carrying member and vibratable with respect to said handle, an armature portion mounted within said body portion and vibratable with respect to said body portion, and electromagnetic means for setting said armature in vibration.

12. A safety razor as set forth in claim 11 and including also an electric battery rockably mounted between said vibratory motor and a portion of said handle, said battery being electrically connected to the electromagnetic means for setting said armature in vibration, and rockable in accordance with the vibrations of said vibratory motor.

RUDOLF GOLDSCHMIDT.