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Krainer

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[54] **DRY SHAVER**

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[52] **U.S. Cl.** **30/43.92;** 30/42; 310/29

[51] **Int. Cl.**[2] **B26B 19/02;** B26B 19/28; H02K 33/00

[58] **Field of Search** ..... 30/42, 45, 272 A, 43.91, 30/43.92; 310/29

[56] **References Cited**

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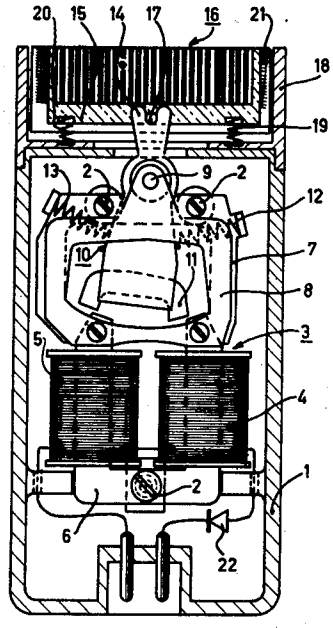
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Assistant Examiner—Gary L. Smith
Attorney, Agent, or Firm—Frank R. Trifari

[57] **ABSTRACT**

Dry-shaver provided with a vibrator-type motor suitable for connection to an electric current supply system and with control means which enable the dry-shaver to operate substantially equally satisfactorily at electric current frequencies of 50 Hz and of 60 Hz. The control means provide a frequency of motion of the armature of the vibrator-type motor which is equal to the frequency of the applied voltage, and achieve a mechanical resonant frequency of the motor which is higher than the highest of the frequencies likely to be used.

8 Claims, 3 Drawing Figures



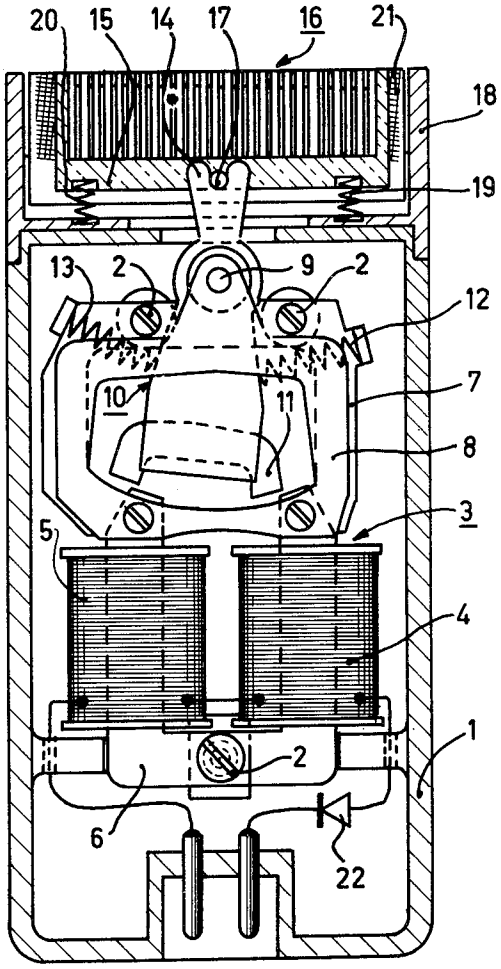

20
15
14
17
16
21
18
19
13
2
9
2
12
10
11
7
8
3
5
4
1
2
6
22

Fig.1

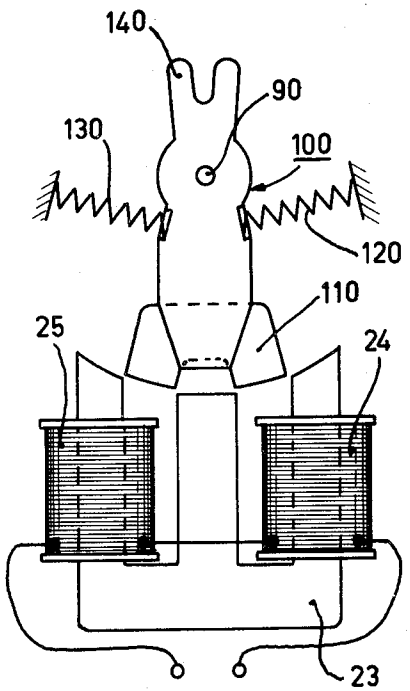

140
90
130
100
120
110
25
24
23

Fig.2

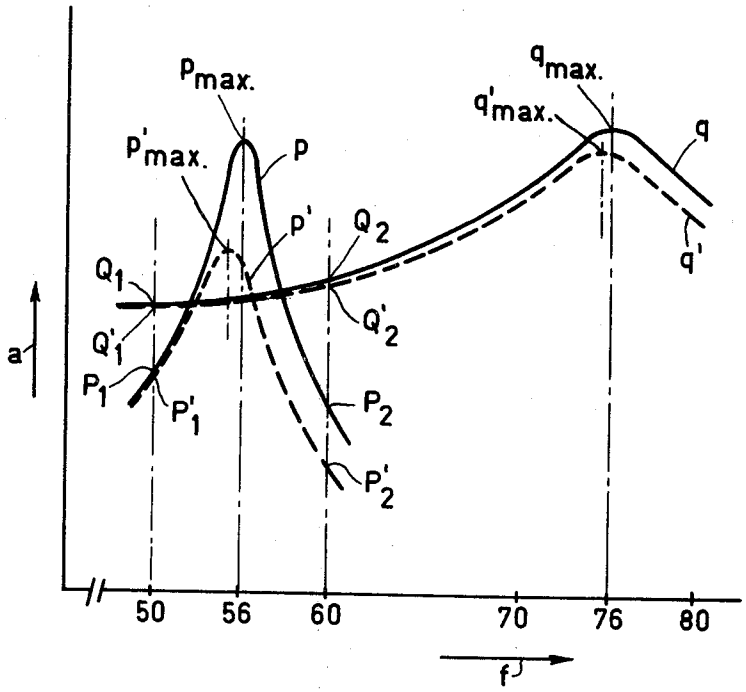

$P_{max.}$
$P'_{max.}$
P
P'
Q_2
Q_1
Q'_1
Q'_2
P_1
P'_1
P_2
P'_2
$q_{max.}$
$q'_{max.}$
q
q'
a
50
56
60
70
76
80
f

Fig. 3

DRY SHAVER

BACKGROUND OF THE INVENTION

The invention relates to a dry-shaver having at least one shaving assembly the lower blade of which is adapted to be reciprocated by a vibrator-type motor, the resonant frequency of the mechanical vibratiry system having a value such that the dry-shaver is suitable for connection to AC electrical supply systems having different frequencies without mechanical changeover of the resonant frequency.

Dry-shavers intended for example for travelling use frequently have to satisfy the requirement that they have to be capable of operating at different AC supply frequencies, while maintaining the shaving capability as equal as possible under the different conditions. A known solution of this problem is to adapt the resonance setting of the mechanical vibration system to the particular supply frequency by weights being added to, or removed from, the armature by means of a change-over device. Such a change-over device, however, is comparatively complicated. Hence dry-shavers have been manufactured which can be connected to **50** Hz and **60** Hz supply without change-over. This is achieved in that the resonant frequency of the mechanical vibrating system is set at a value about midway between the possible oscillation frequencies of the drive. Because the vibration frequency of a conventional vibrator motor is equal to twice the supply frequency, for connection to **50** Hz and **60** Hz supply, the value of the resonant frequency is chosen to be between **100** Hz and **120** Hz, so that when the frequency of the supply to which the dry-shaver is connected is **50** Hz the operating point will lie on one edge, and in the case of **60** Hz on the other edge, of the resonance curve. However, such an arrangement is not entirely satisfactory because on connection of the dry-shaver to AC supplies of different frequencies considerable differences in shaving capability will still occur.

The resonance curve is not symmetrical about the maximum and is comparatively steep. In practice it is substantially not possible to adjust the value associated with the maximum, the resonant frequency, between the frequency values associated with the two supply frequencies so that at these frequencies exactly equal powers are produced. However, even if this were possible differences will occur, for the shape of the resonance curve is not invariable but depends upon the degree of damping of the mechanical vibratory system. This is highly dependent upon the friction produced between the cutter assembly and the shear foil during shaving and hence upon the load imposed upon the motor during use. The influence exerted by the load variations on the stroke of the cutter assembly is greater at a supply frequency of **60** Hz than at a supply frequency of **50** Hz. This is due to the fact that at **60** Hz the resonance curve has a steeper slope than at **50** Hz and moreover with increasing damping the maximum of the curve shifts toward the lower frequencies.

SUMMARY OF THE NEW INVENTION

It is an object of the present invention to obviate the above-described difficulties in a simple manner. According to the invention, in a known manner a driving system is used in which the oscillation frequency of the vibrator-type motor is equal to the supply frequency wherein, the value of the resonant frequency of the mechanical vibratory system exceeding the highest value of the supply frequencies of the AC supplies may be used to feed the dry-shaver. The invention utilizes the fact that a driving system in which the vibrator-type motor has an oscillation frequency equal to supply frequency has a more level resonance curve than a system in which the vibrator-type motor oscillates at twice the supply frequency, so that firstly, the vibration amplitudes associated with the operating points are less sensitive to variations in adjustment of the resonant frequency, and secondly, variations in position of the operating points on the resonance curves under load conditions will give rise to smaller variations of the respective oscillation amplitude. Furthermore according to the invention the known step is used, whereby to obtain stable operation of the motor, the oscillation frequency advantageously is lower than the resonant frequency; for this purpose the value of the resonant frequency of the mechanical vibratory system of the dry-shaver is chosen so as to exceed the highest value of the frequencies of the AC supplies from which the dry-shaver is likely to be fed. Only the combination of the two above provisions ensures that in practice the dry-shaver will always have a sufficiently equal and satisfactory shaving capability when being fed from AC supplies of different frequencies without the need for mechanical switching.

As is known, a driving system in which the oscillation frequency of the vibrator-type motor is equal to the supply frequency can be implemented in various manners. A vibrator-type motor may be provided with an E-shaped stator. As an alternative, however, the magnetic circuit of a vibrator-type motor which as such vibrates at twice the supply frequency may be polarized and simply include a permanent magnet, resulting in the vibration frequency being divided by two. However, according to the invention, in order to simply and advantageously obtain a driving system having an oscillation frequency of the vibrator-type motor equal to the supply frequency a diode is connected in known manner so as to precede the energizing winding of a vibrator-type motor which in itself vibrates at a frequency twice the supply frequency.

In a dry-shaver intended for connection to AC supplies having a frequency of **50** Hz or of **60** Hz, with a view to particularly slight changes in the vibration amplitude and satisfactory stability of the system, it has been found to be particularly advantageous for the resonant frequency to lie between **73** Hz and **79** Hz and preferably at about **76** Hz.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of a dry-shaver in which the oscillation frequency of the vibrator-type motor is made equal to the supply frequency by electrical means,

FIG. **2** shows a vibrator-type motor the armature of which vibrates at the supply frequency owing to the E-shape of the stator, and

FIG. **3** is a graphical representation of the resonance curves of two comparable vibrator-type motors one of which is constructed according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. **1**, a dry-shaver has a casing **1** in which a vibrator-type motor **3** is mounted by means of screws **2**. The vibrator-type motor has a U-shaped stator **6** which carries two energizing windings **4** and **5** and to the pole ends of which two frame-shaped supports **7** and **8** are secured in which a shaft of a vibrator lever **10** is journalled. At the end of the vibrator lever facing the stator a likewise U-shaped armature **11** is mounted the pole ends of which co-operate with the poles of the stator. Two springs **12** and **13** are enclosed between the support **7** and the vibrator lever **10**. The end **14** of the vibrator lever **10** more remote from the stator is forked and serves to reciprocate a lower blade **15** of a shaving assembly **16** of the dry-shaver. For this purpose a pin **17** provided on the blade **15** engages in the forked end **14** of the vibrator lever **10**. The blade **15** is mounted for reciprocatory movement on a shaving-head support by means of coil springs **19** and **20** secured to the support **18**. The support **18** further carries a shear foil **21**, and the blade **15** is urged by the springs **19** and **20** into engagement with the arched lower surface of the shear foil. The shaving-head support **18** can be slipped on the casing **1**.

The moving components of the dry-shaver, i.e. the vibrator lever **10** and the blade **15**, together with the vibrator springs **12** and **13** form a damped mechanical vibration system having a given resonant frequency. In a vibrator motor as described above the driving frequency of the motor is equal to twice the supply frequency. As FIG. **1** shows, the series-connected energizing windings **4** and **5** are preceded by a diode **22**, with the result that in known manner the oscillation frequency of the driving system is equal to the AC supply frequency. By a suitable choice of the respective masses and spring constants the resonance of the mechanical vibration system is adjusted so that the resonant frequency is higher than the highest supply frequency of the AC supply from which the dry-shaver is likely to be fed. Most commonly used AC supplies have frequencies of **50** or **60** Hz. In such a case the resonant frequency is to be chosen to exceed **60** Hz, a resonant frequency of about **76** Hz having been found to be highly advantageous.

Unexpectedly it has been found that a dry-shaver of the above described construction and values is highly suitable for connection to mains having different frequencies, because the dry-shaver will always have substantially the same shaving capability, i.e. frequency and amplitude of mechanical oscillation.

FIG. **2** shows a vibrator-type motor which provides a drive at an oscillation frequency of the vibrator which is equal to the supply frequency owing to the fact that the stator **23** is E-shaped. The two outer limbs of the stator each carry an energizing winding **24** and **25** respectively which are electrically connected in series, the supply voltage being directly applied to the series combination. Obviously, as an alternative a single energizing winding on the central limb of the stator may be used. The stator **23** co-operates with a U-shaped armature **110** secured to a vibrator lever **100**. In the rest position of the armature the ends of the armature poles each face a gap between two pole ends of the stator. Starting from the rest position such an armature first vibrates to one outer pole of the stator, then reverses direction, again passes through the rest position and swings to the other outer pole of the stator, whereupon the direction of movement is again reversed. The vibration frequency of such a vibrator-type motor is equal to the supply frequency.

If in a dry-shaver having a vibrator-type motor as described above, the resonant frequency of the mechanical vibratory system is made higher than the highest frequency of the supply from which the dry-shaver is likely to be fed, such a dry-shaver when connected to such supply, will always give substantially the same shaving capability at both **50** Hz and **60** Hz.

A further possibility of providing a driving system having an oscillating frequency of the vibrator-type motor equal to the supply frequency consists in that in the embodiment shown in FIG. **1** the diode **22** is omitted and a permanent magnet is included in the magnetic circuit of the stator and the armature. This may be effected in that, for example, a permanent magnet is mounted on the central part of the armature **11** carrying the poles. Such a vibrator-type motor also when used in a dry-shaver in which the resonant frequency of the mechanical vibratory system exceeds the highest frequency of the AC supply from which the dry-shaver is likely to be fed provides the advantage that the dry-shaver can be fed from AC supplies of different frequencies while retaining the same shaving capability.

The theoretical background of the invention will be discussed with reference to FIG. **3**. In this Figure the frequency of the applied alternating voltage is plotted on the abscissa and the associated vibration amplitude or stroke *a* of the cutter of the dry-shaver is plotted on the ordinate.

A curve *q* shows the relationship between the stroke *a* of the cutter and the frequency *f* of an applied alternating voltage in a motor of the type shown in FIG.**1** with the use of the diode **22**. A curve *p* shows this relationship for the same motor with, however, the diode omitted and the springs **12** and **13** replaced by suitable springs of greater spring constants to adapt the motor for operation at a vibration frequency equal to twice the supply frequency. The two curves *p* and *q* relate to operating conditions in which no external load is imposed on the cutter **15** of the dry-shaver.

The Figure clearly shows that the curve *p* has considerably steeper slopes than the curve *q*. To ensure that operating points P_1 and P_2 for operation at supply frequencies of **50** Hz and **60** Hz respectively be situated approximately at the same level, these points must be made to lie on different sides of the maximum p_{max} of the curve. This can be obtained by a suitable choice of the spring constants of the spring. Small displacements of p_{max} to the left or the right greatly influence the relative locations of the operating points P_1 and P_2. In practice this means that suitable adjustment of the motor is difficult, because the motor is critically sensitive to inaccuracies and manufacturing tolerances.

The curve *q* is considerably more level. Because the oscillation frequency of the lower cutter blade is one half of that of the motor as shown by the curve *p*, springs **12** and **13** can be used which have spring constants of about half the values of those used in the preceding case. As a result, the product of the spring constant and the mass of the vibratory system is reduced to about one half, which is the cause of the more level variation of the curve *q*.

According to the invention this levelling is utilized by causing the peak q_{max} of the curve to be situated not intermediate the operating points Q_1 and Q_2 but to the right thereof. Making q_{max} equal to about **76** Hz causes the curve to be so level at the frequencies of **50** Hz and **60** Hz that the operating points Q_1 and Q_2 are at substantially the same level. Their relative situation is not very sensitive to small displacements of q_{max} to the left or to the right.

Under operational conditions the curves will be slightly modified by the change in damping of the vibratory system due to the friction between the moving cutter blade **15** and the shear foil **16.** The dashed curves p' and q' indicate the direction in which the changes take place. The peaks of the two curves are lowered and displaced to the left. This far more affects points situated on the right-hand edges than points situated on the left-hand edges of the curves. In particular the position of P_2' considerably differs from that of P_2. Points Q_1' and Q_2' lie little lower than points Q_1 and Q_2.

I claim:

1. In an electric shaver operable with an AC supply variable between **50**Hz and **60**Hz, and including a vibrator type electric motor having a stator with wire windings thereon, and a damped mechanical vibration system comprising an armature, spring means, and a reciprocatable cutter, said system having a normal oscillation frequency of twice the supply frequency, the improvement wherein said vibration system has a resonant frequency higher than **60** Hz, and said apparatus comprises means for establishing the oscillation frequency of the vibration system as equal to the supply frequency.

2. Apparatus according to claim **1** wherein said means comprises a diode connected in series with said windings.

3. Apparatus according to claim **1** wherein said stator normally has a U-shape with two stems and windings on each stem, said means of the improvement comprising a third stem intermediate said two stems forming an E-shape, with windings on only the two outer stems.

4. Apparatus according to claim **1** wherein said vibration system has a resonant frequency in the range of **73** Hz to **79** Hz.

5. Apparatus according to claim **4** wherein said vibration system has a resonant frequency of approximately **76** Hz.

6. Apparatus according to claim **1** wherein amplitude variation of said vibration system is very small over a range of frequency of **50** Hz to **60** Hz.

7. Apparatus according to claim **1** wherein a plot of amplitude of said vibration system vs. frequency indicates substantially straight and slightly upward sloping line for frequencies thereof from **50** Hz to **60** Hz.

8. In an electric shaver operable with an AC supply variable between first and a higher second magnitude, and including a vibrator type electric motor having a stator with wire windings armature, spring means, and a reciprocatable cutter, said system having a normal oscillation frequency of twice the supply frequency, the improvement wherein said vibration system has a resonant frequency higher than said second magnitude, and said apparatus comprises means for establishing the oscillation frequency of the vibration system as equal to the supply frequency.

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