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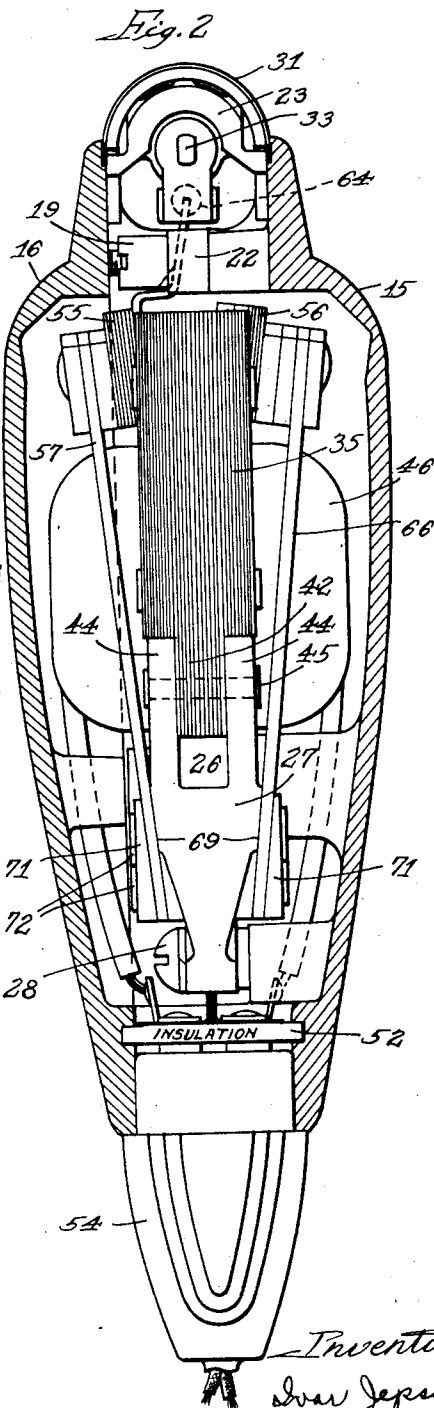
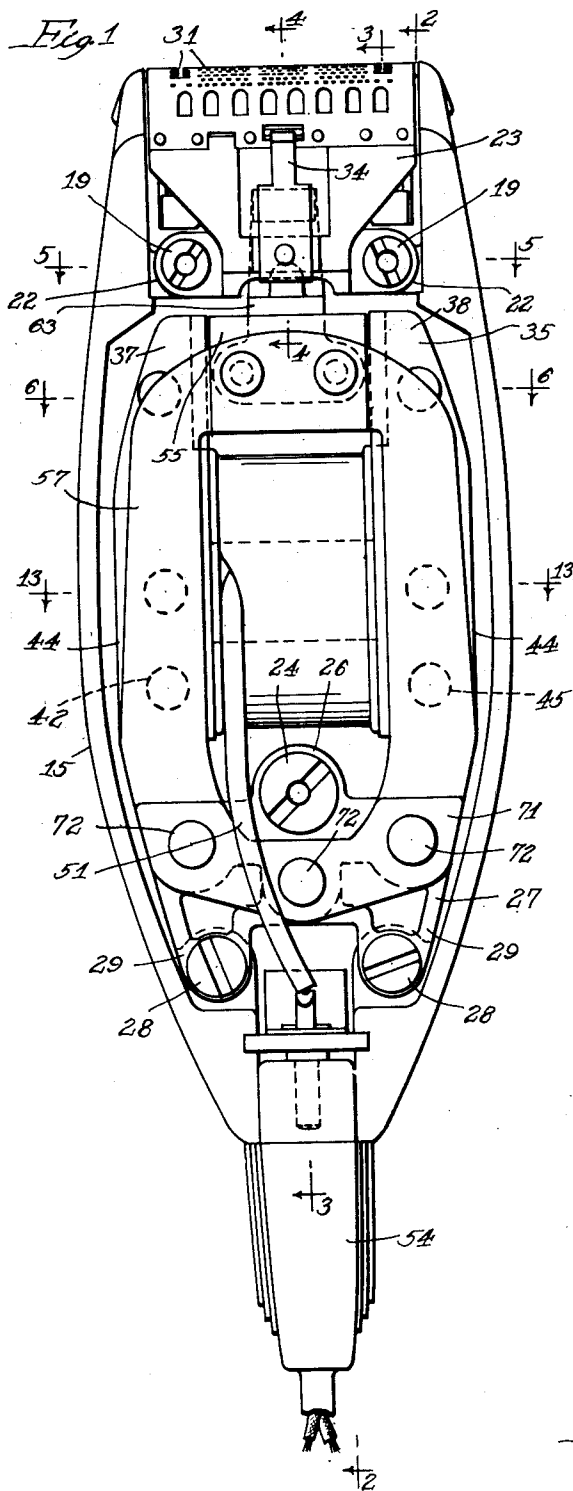
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2,299,952

VIBRATORY MOTOR FOR DRY SHAVER AND THE LIKE

Filed March 18, 1940

3 Sheets-Sheet 1



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VIBRATORY MOTOR FOR DRY SHAVER AND THE LIKE

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3 Sheets-Sheet 2

Fig. 4

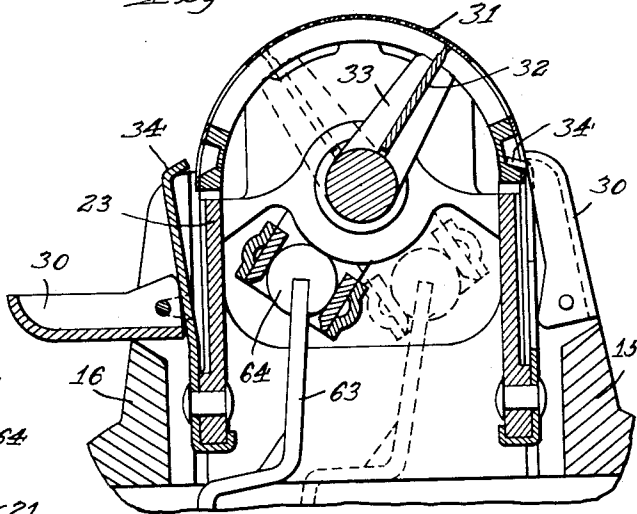


Fig. 3

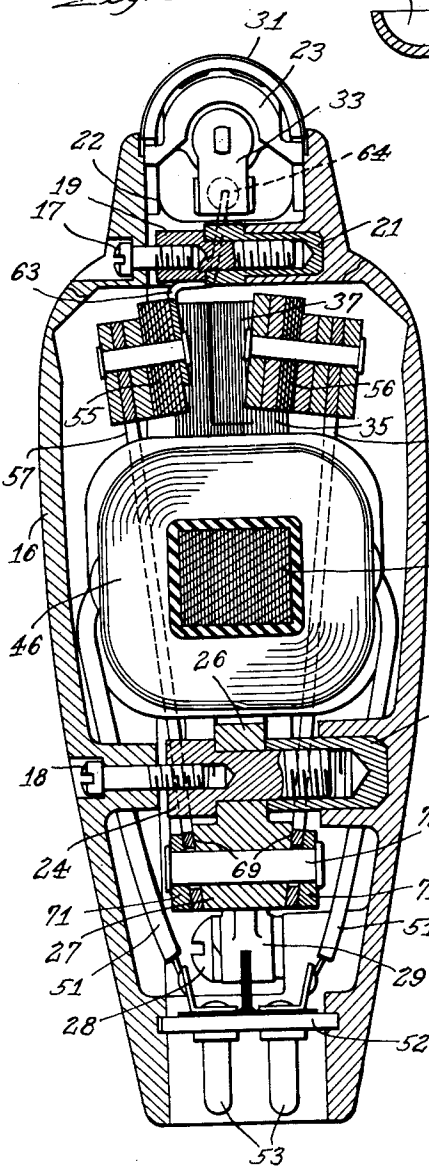


Fig. 5

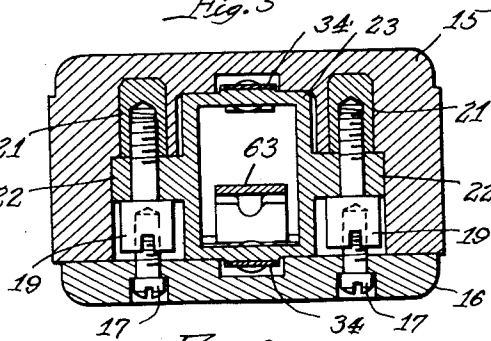
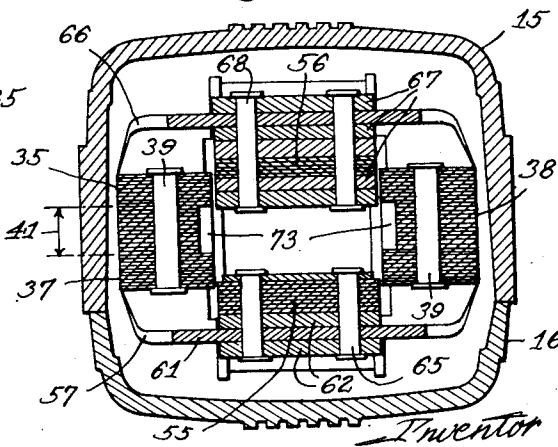


Fig. 6



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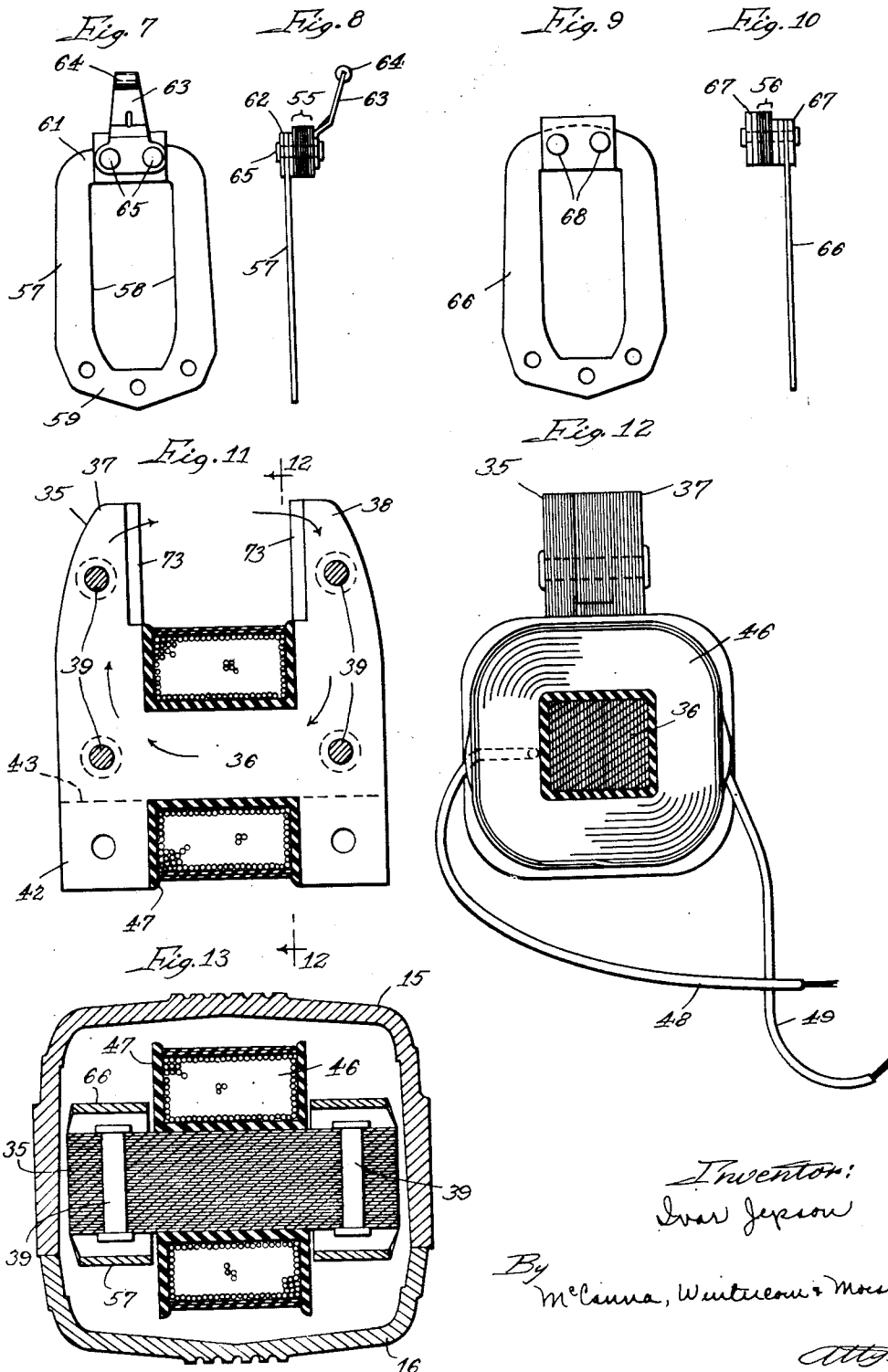
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2,299,952

VIBRATORY MOTOR FOR DRY SHAVER AND THE LIKE

Filed March 18, 1940

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,299,952

VIBRATORY MOTOR FOR DRY SHAVERS
AND THE LIKEIvar Jepson, Chicago, Ill., assignor to Chicago
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Application March 18, 1940, Serial No. 324,599

25 Claims. (Cl. 172-126)

This invention relates to vibratory electromagnetic motors and has more particular reference to motors of this type adapted for use in small hand tools or implements such, for example, as dry shavers.

Heretofore, motors of this type have been made for dry shavers in which the movable cutter had a comparatively short operating stroke, but such motors were not suitable for shavers of a kind requiring a long operating stroke. Also, in such prior constructions efforts have been made to attain the desired length of operating stroke by the use of additional mechanical means designed to multiply the comparatively small amplitude of movement transmitted by the armature so that the resultant movement will be sufficient for operating the cutter. Also, in such prior vibratory motors the current consumption was comparatively high. The prior art has not disclosed, so far as I am aware, a vibratory motor suitable for embodiment in a dry shaver of the type contemplated for use in the present invention; nor has the prior art disclosed an available solution of the problem of providing a motor of this type which will deliver an adequate, controlled, power stroke with minimum current consumption and no objectionable noise or vibration, and which is so constructed as to permit of economical production manufacture.

One of the objects of my invention is, therefore, to provide an improved vibratory electromagnetic motor for general application, but particularly adapted for the problems in small hand tools and implements such as dry shavers.

Another object is to provide a motor of this type which will transmit a comparatively long stroke with small power consumption without objectionable noise or vibration and which will have comparatively long life.

Another object of my invention is to provide an improved method of manufacturing a vibratory electromagnetic motor of the character described.

Another object of my invention is to provide an electric dry shaver having improved means for operating the movable cutter.

Other objects deal with improved features of construction both in reference to the motor and the shaver and the combination thereof.

In furtherance of these general objects I have provided certain improvements, the nature of which is disclosed in the following description and drawings and set forth more particularly in the appended claims.

Referring to the drawings:

Figure 1 is a side elevation of an electric dry

shaver embodying my invention with the front cover removed, showing the shaver approximately twice actual size;

Fig. 2 is a longitudinal section through the shaver taken substantially on the section line 2-2 of Fig. 1;

Fig. 3 is a longitudinal sectional view taken substantially on the section line 3-3 of Fig. 1 with the cutting head assembly in elevation;

Fig. 4 is an enlarged sectional view taken substantially on the section line 4-4 of Fig. 1 showing the cutter moved to one end of the stroke;

Figs. 5 and 6 are enlarged cross-sections taken substantially on the section lines 5-5 and 6-6, respectively, of Fig. 1;

Figs. 7 and 8 are face and side views, respectively, of the driver armature and vibratory spring removed from the motor, shown on a reduced scale;

Figs. 9 and 10 are face and side views, respectively, of the idler armature removed from the motor, shown on a reduced scale;

Fig. 11 is a longitudinal sectional view through the coil and field assembly removed from the motor;

Fig. 12 is a section taken on the section line 12-12 of Fig. 11; and

Fig. 13 is a cross-sectional view taken substantially on the section line 13-13 of Fig. 1.

Before entering into a detailed description of the structure shown in the drawings, it should be observed that my invention relates generally to the art of electric dry shavers of the type adapted to be operated by a vibratory, electromagnetic motor, and specifically to problems involving motor construction and function peculiar to the operation of a dry shaver. However, my invention in its broader aspects is not limited to a vibratory motor for operating a dry shaver, but is adapted for other applications particularly in small hand tools where a comparatively long working stroke or armature motion is desired. My invention also contemplates certain improvements in respect to the motor housing and to certain features co-acting between the housing and the shaving head structure.

In the example here shown for purpose of illustration the vibratory motor is carried in a housing which carries a shaver head at one end and also constitutes a handle of such size that it may be held in the palm of the hand for manipulating the shaver head. The housing comprises a base part 15 and a cover 16, preferably of molded Bakelite or any suitable composition material. The cover is detachably secured to the base part

of the housing by screws 17 and 18, Fig. 3. As shown in Figs. 3 and 5 there are two screws 17 each of which is threaded into an adaptor screw 19 which in turn is threaded into a metal insert 21 in the base part 15. As shown in Fig. 5 the head of each adaptor screw 19 is pulled down tight against the wing extensions 22 formed integral with a die cast frame unit designated generally by 23 constituting the main frame structure upon which the co-acting shaver parts are mounted or assembled, the whole constituting a shaver head assembly which will be presently more fully described. The third screw 18 is threaded into a similar but larger adaptor screw 24 which in turn is threaded into a metal insert 25 in the base part 15, as best shown in Fig. 3. The head of this adaptor screw 24 is pulled tight against the portion 26 of a bracket designated generally by 27 upon which the vibratory motor is mounted. This bracket in turn is fixedly mounted on the base part 15 of the housing by means not only of the adaptor screw 24 but by two additional screws 28 which clamp against depending extensions 29 integral with the lower end of bracket 27.

The shaver shown operates on the principle covered in Patent No. 2,081,694 granted May 25, 1937, to John Bruecker and includes features claimed in the application of John Bruecker, Serial Number 178,221, filed December 6, 1937. This shaver is known under the trade-marks Sunbeam Shavemaster. Briefly, the shaver head assembly comprises a removable comb 31, a cutter blade 32, a blade holder 33 and the frame unit 23 above mentioned, together with spring clamps 34 for securing the comb in position on the head. As best shown in Figs. 1 and 4, each spring clamp 34 is fixed at its lower end to a side wall of the frame unit 23 as by means of riveting and interfitting with the bottom edge of the side wall. Each spring 34 normally tends to assume a retracted position, as shown at the left in Fig. 4, in which position the detent at the outer end of the spring is withdrawn from a complemental locking recess in the comb structure. To engage the spring detent in the locking position I employ a clamping member 30 pivoted on an extension of the housing structure and having a cam surface at its inner end co-acting with the spring to be urged thereby in either of two positions, the locked position shown at the right in Fig. 4 and the released position shown at the left. Each clamping member 30 is preferably of sufficient width to straddle the spring 34 and conceal it from view when in the locked position. To unlock and release the comb the operator may engage his fingernail or any small object beneath the outer edge of each member 30 to swing it outwardly, in which case the cam at the inner end of such member releases the spring 34 which retracts to the released position. The comb 31 has an extremely thin skin-engaging portion, in this instance semi-circular, provided with small hair-receiving perforations. The blade holder 33 is mounted on trunnions journaled in the end portions of the die cast frame 23. The blade holder is adapted to be rapidly oscillated by means of the vibratory motor to move the cutter back and forth across the underside of the perforated portion of the comb, in this instance through an arc of approximately sixty degrees. As a consequence of this rapid oscillation, the cutter blade is urged outwardly by centrifugal force into intimate shearing engagement with the inner side of the comb and by this action serves to cut off the

hairs which protrude through the small openings. My invention provides for oscillating the cutter blade in a stroke of the desired length by novel means capable of economic production and adapted for satisfactorily performing this work. The stroke here desired is several times longer than in other types of shavers and the working load is greater. Furthermore, it is desired to control the length of the stroke to a fine degree of accuracy to obtain predetermined co-action between the cutter and the hair-receiving perforations. Also, voltage and frequency variations have an important bearing on the problems. The suppression of vibration and noise is a further problem in the present invention.

My invention will be better understood by considering in a preliminary way certain of the operating conditions. It is desired to operate the motor with the commonly used alternating current furnished by electric power companies. The current characteristics differ in some localities but generally the current supplied by the electric power companies is 60 cycle alternating current of 110 to 120 volts. While it is the general practice of these power companies to maintain the rated cycle at such uniform frequency that electric clocks may be operated there are, nevertheless, at times some slight variations in frequency within plus and minus one-half cycle and variations in voltage of about 10 volts. With the present invention the motor will operate satisfactorily regardless of frequency and voltage variations such as normally occur in these power circuits. In the operation of a dry shaver in accordance with my invention the cutter blade makes one complete stroke across the comb and back for each peak of the alternating current wave. Since there are two peaks during each cycle, the cutter blade makes 7200 complete oscillations each minute using 60 cycle alternating current, making 14,400 strokes across the comb per minute. In circuits using 50 cycles alternating current and 220 volts, corresponding changes will be made in the motor to take care of the difference in frequency and voltage as will be understood by those skilled in this art as the invention becomes better understood.

Referring now to the motor constructions, it will be observed that the electromagnet comprises a specially designed coil and field assembly best shown in Figs. 11 and 12. The field structure designated generally by 35 comprises laminations of U-shape, having a central portion 36 which carries the field winding and spaced parallel portions 37 and 38 which constitute opposed pole pieces. The laminations are clamped together by rivets 39. The central group of laminations shown by the dimension 41 in Fig. 6 are extended downwardly at 42 beyond the lower end 43 of the outer laminations to provide additional lugs which are clamped between upstanding parts 44 integral with the bracket 27. These bracket parts 44 are rigidly clamped to the interposed laminations 42 by suitable means such as rivets 45. In this manner the field assembly is fixedly mounted on the bracket 27 which in turn is fixedly secured to the back part 15 of the motor housing as above described. The bracket 27 is of non-magnetic material and the laminated field structure is of soft steel suitable for flow of the magnetic flux which is created by the field magnet. The field coil designated generally by 46 is wound upon a spool 47 of insulated material. In commercial practice I prefer to mold the spool 47 around the field structure. The

ends 48 and 49 of the coil are suitably connected to conductor wires 51 which in turn are connected to a suitable busbar 52 having terminal posts 53 adapted for connection with a suitable current supply plug 54.

My invention contemplates the provision of a vibratory motor having certain structural and functional characteristics which enable the obtaining of a comparatively long motion transmitting stroke, comparatively small and compact arrangement of parts, low wattage, and reduction of vibration and noise. These objectives are attained in part by the novel motor construction which includes counteracting armatures or a driving armature and a counteracting weight member, together with vibratory spring members of novel construction and function which carry the armatures or the driving armature and the weight member. My invention provides for so constructing these vibratory spring members that either one or both serves to carry an armature. In the embodiment shown in the drawings one spring member carries a driving armature and the other an idler armature in parallel in the magnetic circuit. However, as explained hereinafter, the idler member need not function as an armature. I also provide that the driving armature shall have less reluctance than the idler armature. I further provide that the spring of the driving member shall be tuned substantially higher than the spring of the idler member. The purpose of the foregoing is to maintain the field mass as well as the housing mass to which the field is fixed, practically free from vibrations and noise, and also to control the length of the stroke of the working spring members and armature to a close degree. In the present embodiment, a driving armature 55 and an idler armature 56 are shaped for co-action between the pole pieces by movement toward and from each other in the space between the pole pieces under attraction of the magnetic flux flowing in the general path shown in Fig. 11 and dividing into parallel paths as each will be later described with reference to Fig. 6. Each armature is mounted on the outer end of a vibratory spring which in turn is mounted at its opposite end on the non-magnetic bracket 27. The driver armature shown in Figs. 7 and 8 comprises a flat spring 57 having elongated sides 58 joined by inner and outer end portions 59 and 61 respectively, the armature laminations before mentioned, a number of laminations 62 of non-magnetic material such as brass for providing additional controlled mass, and a drive transmitting arm 63 terminating in a cylindrical shaped end 64, these parts being fixedly clamped together by rivets 65. The idler assembly comprises a spring 66 of shape similar to the spring 57 but preferably of different vibration characteristics as will be presently described, the armature laminations 56 before mentioned, a number of non-magnetic laminations 67 for additional controlled mass, and rivets 68 fixedly clamping the parts together. As shown in Figs. 2 and 3 the springs 57 and 66 are clamped at their lower ends to opposite sides 69 of bracket 27, which sides are disposed in planes converging downwardly toward the center line of the motor. An angular clamping plate 71 is applied to the outer side of each spring for clamping the springs to the bracket 27, suitable means such as rivets 72 being employed for applying the clamping pressure. As best shown in Figs. 1, 7, and 9, there are three rivets spaced lengthwise of the lower end 59 of

the springs so as to rigidly clamp this end of the springs to the bracket 27. By making the clamping plates wedge-shaped so that their outer faces are in parallel planes, the rivet heads will be supported in said parallel planes, thereby facilitating manufacture and insuring a very rigid assembly. It will also be observed that the normally flat springs are disposed in planes converging downwardly toward the center line of the motor with the upper ends spaced apart sufficiently to allow free movement of the driver and idler armatures or the driver armature and idler weight as the case may be, and spaced in close proximity at the mounting end for space saving and to bring the center of gyration of the armature closer to the center line of the motor. The springs are preferably punched to shape from flat, blue, spring steel, and in this embodiment they are of a Rockwell hardness of approximately 49-50 "C" scale. As above stated, the springs are tuned to different frequencies, the driving member being tuned from 1,000 to 2,000 complete vibrations per minute higher than the idler member. In actual practice in the embodiment here illustrated the driving member is tuned to a natural frequency of from 9,100 to 9,400 and the idler member from 7,300 to 7,600. These natural frequencies are, of course, higher than the line frequency which for 60 cycles alternating current is 7200. It may also be stated that the spring member of the driver has a spring constant of a predetermined or controlled degree larger than the spring constant of the idler spring member. In actual practice, I obtain these structural and functional characteristics of the spring members by precision grinding them to the desired fractional dimensions wherein the range of difference in thickness between the driving and idler spring members is from 5 to 15 per cent. In actual commercial production of this motor for the purpose here shown, the limits I have used for the difference in thickness between the driving spring member and the idler spring member is from 7.8 per cent to 13.3 per cent.

Referring now to the operation, it will be observed that since the driver armature is connected to the shaver head for oscillating the cutter, mass is added to the armature and this has a tendency to lower the natural frequency of the driving system. The vibration energy of the driver armature is transmitted directly to the field mass and to the housing with the result that the reaction in vibration and noise would be very objectionable. This is remedied by my invention which provides an additional controlled mass for counteracting the reaction energy from the driver armature, thereby relieving the field mass and the housing from objectionable vibration. This is provided by the idler spring and the controlled weight or mass of the idler member. There are two distinct ways in which energy can be transmitted to this idler member. One is by energy transmitted from the field mass through the spring support directly to the idler member; the other is by energy transferred from the field, that is, by magnetic force to the idler armature when an armature is applied to the idler member. My invention may be practiced by utilizing only the energy directly transmitted to the idler member as through the spring support to sustain the desired counteracting vibrations, although in this form small vibration of the spring support and housing takes place. When the idler member is utilized as an armature the additional

energy more effectively serves to sustain vibration of the idler member in controlled relationship to the energy transmitted from the driver. As stated above, both the driver and idler vibratory members are tuned to a controlled natural frequency above the line frequency. This is a distinctive feature of my invention and it will be observed that if the vibratory members are tuned closely or exactly to the line frequency the amplitude of the vibratory members could become so large that the vibratory members or one of them might impinge against the housing or other stationary part and thus cause noise and probable damage, or if there was sufficient clearance to avoid such impingement the enlarged amplitudes would cause spring breakage. Also as stated, the driver armature is tuned substantially higher than the idler member. One reason for this is to counteract the mass which is added by connection to the shaver head, which tends to lower the natural frequency of the driving system. Under this condition the damping of the driver member is considerably larger than of the idler member. As a result, the phase angles for the two members are different relatively to the drive force. By increasing the spring constant and decreasing the mass (providing higher tuning), of the drive member and by increasing the mass and decreasing the spring constant of the idler member the two phase angles will be brought closer together. By adding only sufficient magnetic material to the idler member so that energy can be transferred from the field magnet to the idler armature to sustain the vibration as above mentioned, I am able to obtain substantially vibrationless operation, regardless of variations due to manufacturing tolerances and due to variations in the shaving load.

Also, according to my invention, the length of the working stroke is controlled by tuning the armature driving member to a natural frequency above the line frequency and by providing the flux carrying portion of the drive armature at a higher saturation so that normal changes in line voltage from the minimum to the maximum will not appreciably affect the stroke of the armature. In practice this is obtained by making the armature laminations 55 of such low reluctance as to produce to a higher degree of uniformity in the length of stroke regardless of said normal voltage variations. Also, in order to concentrate the flux in a controlled flow between the pole pieces, I have cut away the inner faces of the pole pieces as shown in 73, Figs. 6 and 11, leaving pronounced projecting pole pieces for concentrating the flow of the flux along separate planes for attraction of the driver armature and the idler armature respectively. However, as above stated, it is not essential to use the idler member as an armature, but instead this may be used to provide an additional controlling means functioning in co-action with the driver armature to maintain the field mass substantially free from vibration.

While I have shown several embodiments of my invention, it will be understood that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

I claim:

1. A vibratory electromagnetic motor having an inductance coil, field laminations passing through the coil and terminating in opposed pole

pieces, a drive armature and an idler armature in spaced relation between said pole pieces adapted to be drawn toward each other by the flow of the magnetic flux between the pole pieces, a flat vibratory spring supporting each armature, each spring being attached at one end to its armature and having an opening for location of the coil, and means fixedly supporting the springs with respect to the field laminations at the ends of the springs remote from the armatures and positioning the springs with opposite side portions of the coil extending through said openings.

2. In a vibratory electromagnetic motor, a field core having opposed portions forming pole pieces joined by a central supporting portion, a coil wound about said central portion and projecting laterally beyond opposite sides thereof, an armature for co-action with the pole pieces, a weight having a counteraction function in relation to the armature movement, and vibratory arms, one carrying the armature and the other the weight, said arms being mounted at one end in fixed relation to the field core and positioned at opposite sides thereof, each arm having a central opening through which the adjacent side of the coil winding projects, whereby the vibratory arms are mounted in relatively close proximity one with respect to the other.

3. In a vibratory electromagnetic motor, a field core and a coil in a cross formation transversely of the longitudinal axis of the motor, a motor housing of substantially rectangular cross section having relatively close fitting relation to the field core and coil, co-acting armature and weight members and opposed vibratory springs one carrying the armature and the other the weight member, the springs extending lengthwise of the motor in the restricted corner spaces afforded between the inner wall of the casing and the field core and coil, each spring having a central opening through which the adjacent side of the coil projects.

4. In a vibratory electromagnetic motor, a coil and field assembly having a given centerline and including pole pieces at opposite sides of said centerline, an armature member, a weight member at opposite sides of said centerline for coaction between said pole pieces, vibratory springs at opposite sides of said centerline one carrying said armature and the other said weight, said springs mounted at their ends opposite from the armature and weight in fixed relation to the coil and field assembly, the springs normally converging toward their mounting end to bring the center of gyration closer to the centerline of the motor, the coil and field assembly being mounted on a non-magnetic bracket which is interposed between the vibratory springs at their closer spaced end and has converging faces against which the springs are seated, headed fastening means passing through the springs perpendicular to the centerline of the motor, and angular clamping plates at the ends of the fastening means to support the headed ends thereof in parallel planes.

5. In a vibratory electromagnetic motor a field core having opposed parallel portions joined at one end by a central supporting portion and formed at the opposite end to provide opposed pole pieces, a field magnet coil wound on said central portion, a supporting member to which the field core is mounted at its end opposite from the pole pieces, a pair of vibratory members each of substantially flat spring material shaped to

provide longitudinal side portions joined at opposite ends by transverse portions, the transverse portions at one end being fixedly secured to the supporting member and arranged to position the opposite transverse portions in proximity to the pole pieces and with the longitudinal side portions straddling the field winding coil at opposite ends thereof, an armature fixed to the outer transverse portion of one of the spring members and arranged to be attracted by the flow of flux between the pole pieces, and a weight mounted on the outer transverse portion of the other spring member in predetermined reaction relation to the armature carrying spring member.

6. A vibratory electromagnetic motor as set forth in claim 5, including a hollow housing in which the described motor parts are supported through the intermediary of the supporting member, the supporting member being fixedly mounted to the hollow case at a point on the centerline of the motor located within the opening defined by the side and transverse portions of the spring members and further fixedly mounted to the casing at two points laterally spaced from said centerline and located beyond the mounted end of the spring members.

7. In a vibratory electromagnetic motor a field core having opposed parallel portions joined at one end by a central supporting portion and formed at the opposite end to provide opposed pole pieces, a field magnet coil wound on said central portion, a supporting member to which the field core is mounted at its end opposite from the pole pieces, a pair of vibratory members each of substantially flat spring material shaped to provide longitudinal side portions joined at opposite ends by transverse portions, the transverse portions at one end being fixedly secured to the supporting member and arranged to position the opposite transverse portions in proximity to the pole pieces and with the longitudinal side portions straddling the field winding at opposite ends thereof, an armature fixed to the outer transverse portion of one of the spring members and arranged to be attracted by the flow of flux between the pole pieces, and a predetermined weight mounted on the outer transverse portion of the other spring member, the spring members having predetermined vibration frequencies, that of the armature member being higher than the weight member.

8. A vibratory electromagnetic motor having a field core comprising laminations of U-shape having parallel arm portions joined by a central portion, a field magnet coil wound on said central portion, the parallel arms formed to provide opposed pole pieces, a supporting bracket to which the core is fixedly mounted at its end opposite from the pole pieces, a pair of flat vibratory spring members fixedly mounted at one end to the supporting bracket at opposite sides thereof and each having a central opening through which the adjacent end portion of the field coil projects, the springs being mounted in relatively close relation one with respect to the other, a driver armature fixed to the outer end of one of the spring members and a weight fixed to the outer end of the other, said spring members positioning the driver armature and the weight in opposed relation between the pole pieces.

9. A vibratory electromagnetic motor having a field core comprising laminations of U-shape having parallel arm portions joined by a central portion, a field magnet coil wound on said central portion, the parallel arms formed to pro-

vide opposed pole pieces, a supporting bracket to which the core is fixedly mounted at its end opposite from the pole pieces, a pair of vibratory spring members fixedly mounted at one end to the supporting bracket at opposite sides thereof, a driver armature fixed to the outer end of one of the spring members and an idler armature fixed to the outer end of the other, said spring members positioning the driver and idler armature in opposed relation between the pole pieces so as to be drawn toward each other by the magnetic flux.

10. A vibratory electromagnetic motor having a field core comprising laminations of U-shape having parallel arm portions joined by a central portion, a field magnet coil wound on said central portion, the parallel arms formed to provide opposed pole pieces, a bracket of non-magnetic material to which the field core is fixedly secured at its end opposite from the pole pieces, and vibratory spring members fixed at one end to opposite sides of the bracket, each spring member having a central opening and arranged in relatively close proximity to the field core with the adjacent side portion of the coil winding extending through its central opening, one of said spring members having at its opposite end an armature arranged to be attracted between the pole pieces and the other spring member having a weight fixed to its free end in predetermined reaction relation to the armature member.

11. A vibratory electromagnetic motor having a field core comprising laminations of U-shape having parallel arm portions joined by a central portion, a field magnet coil wound on said central portion, the parallel arms formed to provide opposed pole pieces, means fixedly clamping the laminations together, a central group of the laminations being extended at said arm portions at the ends opposite from the pole pieces to provide supporting lugs, a bracket having bifurcated end portions to receive said supporting lugs, means fixedly clamping the bracket end portions to the lug portions, the bracket serving to support the core and winding, and vibratory spring members fixed at one end to opposite sides of the bracket, one of said members having at its opposite end an armature arranged to be attracted between the pole pieces and the other member having a weight fixed to its free end in predetermined reaction relation to the armature member.

12. A vibratory electromagnetic motor comprising a housing member, field laminations shaped to provide spaced parallel portions joined by a central portion, and an inductance coil around the central portion, said parallel field portions extending beyond the coil and said extending portions providing opposed pole pieces, a portion of the field laminations extending from said central portion in a direction opposite from the portions providing pole pieces, a bracket of non-magnetic material shaped to receive and provide rigid support for the second mentioned lamination extensions, means fixedly connecting the last named lamination extensions to said bracket, vibratory spring members attached to opposite sides of said bracket and extending lengthwise of the field laminations substantially to the pole piece end thereof, an armature member fixed to the upper end of one of said spring members in a position for magnetic attraction between the pole pieces, a weight member fixed to the upper end of the other spring member in reaction relation to the armature member, the bracket being shaped to

provide a bottom extension below the point of attachment of the spring members thereto, said bracket and said parts attached thereto constituting a unit of assembly, and means fixedly connecting said bottom extension to said housing member to support said unit of assembly thereon, said housing member shaped to receive said unit of assembly without contact therewith except for the supporting contact with said bottom extension of the bracket.

13. A vibratory electromagnetic motor as set forth in claim 12, in which each spring member comprises spaced longitudinal side portions joined by a transverse end portion at the end remote from its fixed support, the armature and weight members being attached to said transverse end portions, the spaced side portions of each spring member providing an opening and the spring members being arranged in relatively close proximity to the laminating field and with opposite side portions of the coil extending through said openings, the longitudinal side portions of the spring members being fixed at their lower ends to the bracket, the bracket having an upward extension located between the spaced longitudinal side members, and means fixedly securing said upward extension to the housing member.

14. A vibratory electromagnetic motor as set forth in claim 12, including a head unit mounted on the housing member adjacent to the armature end of said unit of assembly, the head unit having an operating member oscillatable in a given arc, means on the armature member coacting with said operating member to oscillate the same in said arc by vibratory action, the coacting relation between said means and said operating member being determined by the relative position of the unit of assembly with respect to said head unit as determined by the mounting of said unit of assembly through said bracket.

15. A vibratory electromagnetic motor comprising a housing member, field laminations shaped to provide spaced pole pieces, an inductance coil coacting with the field laminations and carried thereby, a bracket of non-magnetic material shaped to provide rigid support for the field laminations and coil, means fixedly connecting the field laminations to said bracket, vibratory spring members attached to opposite sides of said bracket and provided with armature and weight members coacting with the pole pieces, said bracket and said parts attached thereto constituting a unit of assembly, means fixedly connecting said bracket to said housing member to support said unit of assembly thereon, said housing member shaped to receive said unit of assembly without contact therewith except for the supporting contact with said bracket, a head unit mounted on the housing member adjacent to the armature end of said unit of assembly and having an operating member coacting with one of the vibratory spring members to be operated thereby, an adapter screw connecting the head to the housing member, an adapter screw included in said means connecting the unit of assembly to the housing member, a cover for the housing member, and screws threaded into said adapter screws for connecting the cover to the housing member.

16. A vibratory electromagnetic motor including an inductance coil, a field having a core portion passing through the coil and spaced portions extending beyond the coil forming opposing pole pieces, a driver armature and an idler armature 75

disposed for operation between said pole pieces, and means individually supporting each armature comprising a flat spring having spaced longitudinal side portions joined by transverse end portions, each attached at one end portion to its armature and mounted at the opposite end portion in fixed relation to the field core at a point beyond the coil comprising a comparatively long spring support for the armature, the spaced relation of said longitudinal side portions and the transverse end portions providing a central opening in each flat spring, the coil projecting beyond opposite sides of the field core, said springs being disposed at opposite sides of the field core with said projecting sides of the coil extending through the central openings of the respective springs

17. In a vibratory electromagnetic motor, a U-shaped field structure, a field winding carried by the central portion of the field structure, the spaced portions of the field structure forming opposing pole pieces, a non-magnetic bracket upon which the field structure is mounted at its end opposite from its pole pieces, an armature, and a vibratory spring comprising a flat spring member having longitudinal side portions in laterally spaced relation joined at their ends by transverse end portions, the spaced relation of said longitudinal side portions and transverse end portions providing a central opening in the spring member, the spring member being mounted in a plane in close relation to the field structure with the adjacent side portion of the field winding extending through said central opening and with the armature in coacting relation to the pole pieces.

18. A vibratory electromagnetic motor having a field core comprising laminations of U-shape having parallel arm portions joined by a central portion, a field magnet coil wound about said central portion, the parallel arms formed to provide opposed pole pieces, a supporting bracket to which the core is fixedly mounted at its end opposite from the pole pieces, a pair of vibratory spring members fixedly mounted at one end to the supporting bracket at opposite sides thereof, and an armature fixed to the outer end of each of the spring members, said spring members positioning the armatures in opposed relation between the pole pieces so as to be drawn toward each other by the magnetic flux, the central portion of the face of each pole piece being cut away to provide spaced projecting pole pieces for concentrating the flow of flux along separate planes, one for attracting each armature.

19. A vibratory electromagnetic motor having a field core of laminations shaped to provide spaced pole pieces joined by a central portion, a field magnet coil around said central portion, the face of each pole piece being cut away lengthwise at the center to provide at each side a projecting pole piece, the projecting pole pieces at each side of the field core being coplanar and serving to concentrate the flow of flux in the plane thereof and separated by said lengthwise cutaway from the plane of the flow of flux concentrated by the projecting pole pieces at the other side, and an armature for the projecting pole pieces at each side of the field core mounted for movement in a plane at right angles to the adjacent flux plane and arranged to move inwardly between the adjacent projecting pole pieces toward the center of the core but restricted in such inward movement by attraction of

said flux tending to move the armature outwardly.

20. A vibratory electromagnetic motor as set forth in claim 19, in which the laminations extend lengthwise of the field core and each armature is composed of a vibratory spring member having a plurality of armature laminations attached thereto, said armature laminations being of a length corresponding substantially with the length of the projecting pole pieces and each set of said armature laminations being supported by its vibratory spring member for movement between its respective set of projecting pole pieces, one of said armatures having a work transmitting member, and the latter armature having a greater number of laminations than the other to provide less reluctance than said other armature.

21. A vibratory electromagnetic motor having a field core comprising laminations shaped to provide spaced pole pieces joined by a central portion, a field magnet coil around said central portion and projecting beyond opposite sides of the pole pieces, a support to which the laminated field is fixed at its end opposite from the pole pieces, a flat vibratory spring member at each said opposite side of the pole pieces, each spring member being fixed at one end to said support and extending lengthwise of the laminations substantially coextensive with the length thereof, each spring member having spaced longitudinal side portions joined by a transverse end portion at the end remote from its fixed support, the spaced side portions of each spring member providing an opening and the spring members being arranged in relatively close proximity to the laminated field with the oppositely projecting portions of the coil extending through said openings, an armature element on the transverse end portion of one of the spring members coacting with the pole pieces, and a weight element of predetermined mass on the transverse end portion of the other spring element in predetermined counteracting relation to the armature element.

22. A vibratory electromagnetic motor as set forth in claim 21, in which the spring members in their normal idle position are in planes converging toward the support.

23. A vibratory electromagnetic motor as set forth in claim 21, including a drive transmitting member attached to the armature carrying spring member at the armature end thereof, and in which the armature carrying spring member is

tuned to a frequency higher than the other spring member.

24. A vibratory electromagnetic motor having a support, an electromagnet mounted on the support, an armature member and an idler member, a flat vibratory spring for each said member fixed at one end to the support and carrying its respective member in coacting relation with the electromagnet, the parts being constructed and arranged so that the armature member is vibrated in response to magnetic attraction of the electromagnet and the idler member is vibrated at least in part in response to reaction forces from said armature member vibration, each flat spring member being ground substantially over its entire opposite flat side surfaces to a predetermined thickness to a high degree of precision to thereby provide in each member a predetermined vibration frequency, the armature member serving as a work transmitting member, and the flat spring of said armature member having a vibration frequency of a predetermined degree higher than the flat spring of said idler member effected by said surface grinding.

25. A vibratory electromagnetic motor having field laminations shaped to provide spaced parallel portions joined by a central portion, an inductance coil around the central portion, said parallel field portions extending beyond the coil and said extended portions providing opposed pole pieces, a support to which the field laminations are mounted at the end thereof opposite from the pole pieces, flat springs of substantially the same configuration each having a predetermined thickness different from the other to provide a predetermined vibration frequency, the flat springs being positioned at opposite sides of the field laminations substantially coextensive with the length thereof and each fixedly mounted at one end to said support at the lamination supporting end thereof, the opposite end of each spring being in coacting relation with the pole pieces at the adjacent side of the field laminations, and flat laminated armature and weight members fixed in superimposed relation to the flat sides of the spring members at the end thereof coacting with the pole pieces, said laminated members being substantially parallel with the flow of flux between the pole pieces and supported by the respective flat springs so as to move between the pole pieces in a plane transverse to said flow of flux.

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