April 23, 1968 A. R. SPOHR 3,379,906

ELECTRIC APPLIANCE WITH SELECTIVE MOTION CONVERSION MEANS

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Fig. 1

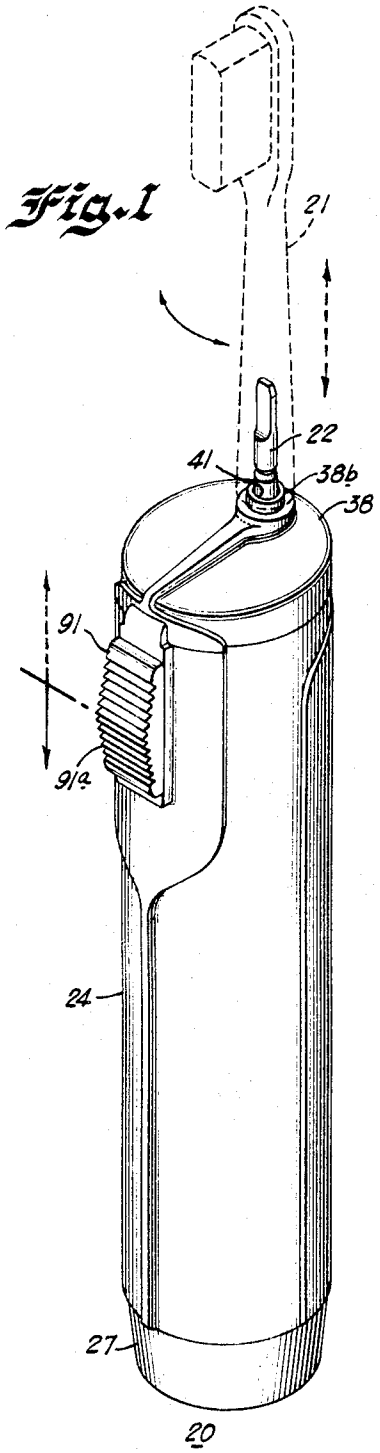

Fig. 2

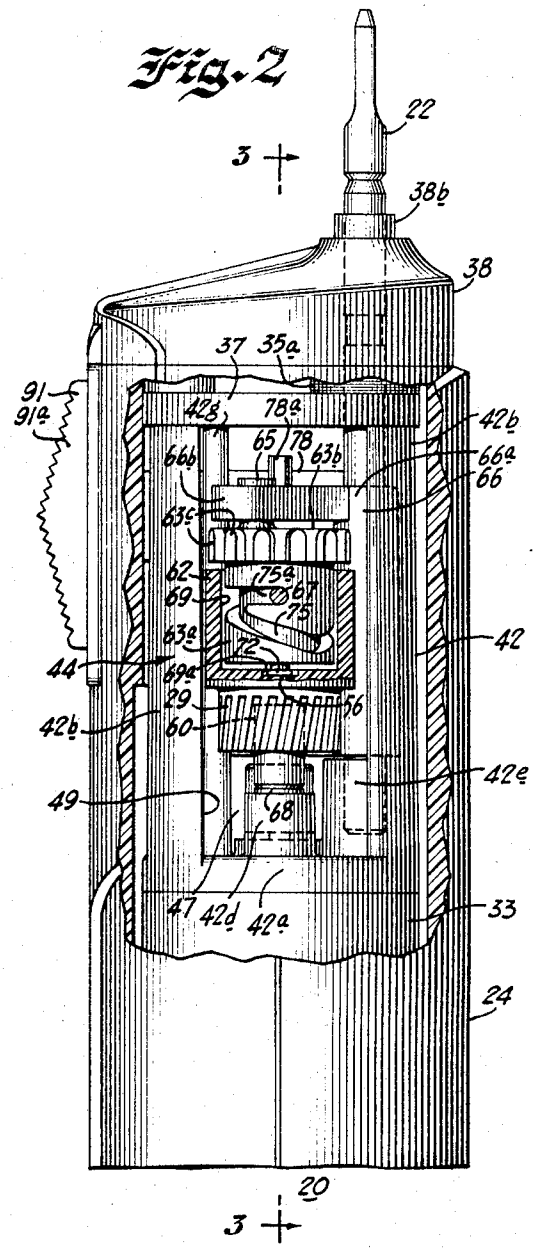

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Fig. 4

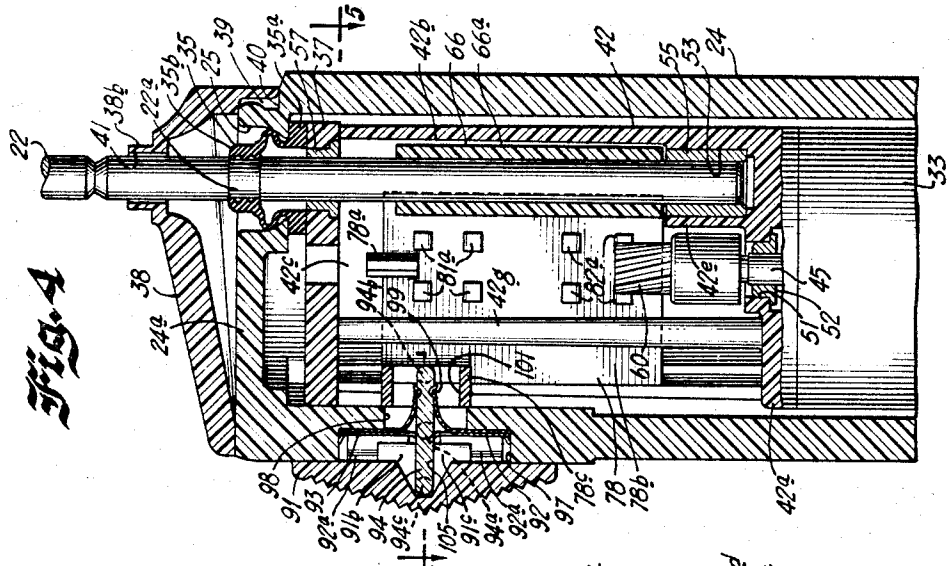


Fig. 3

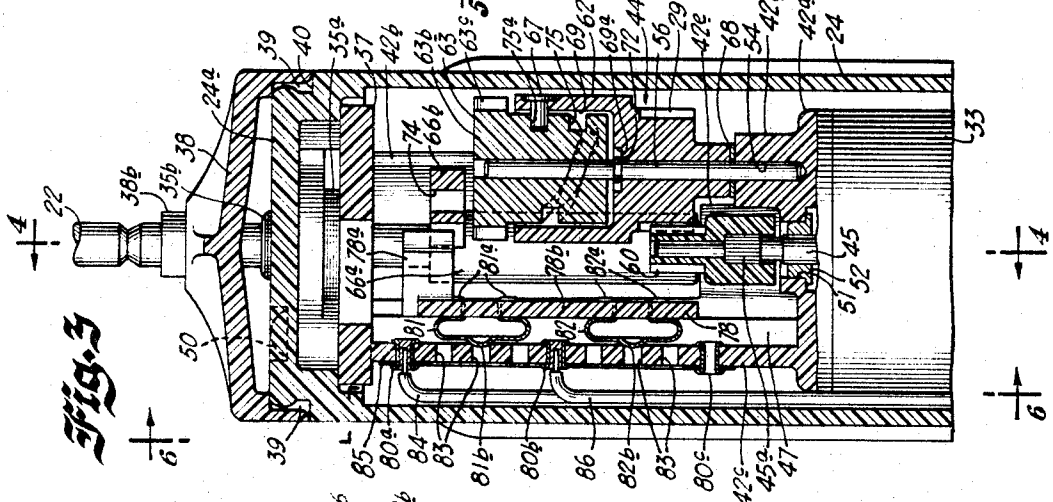
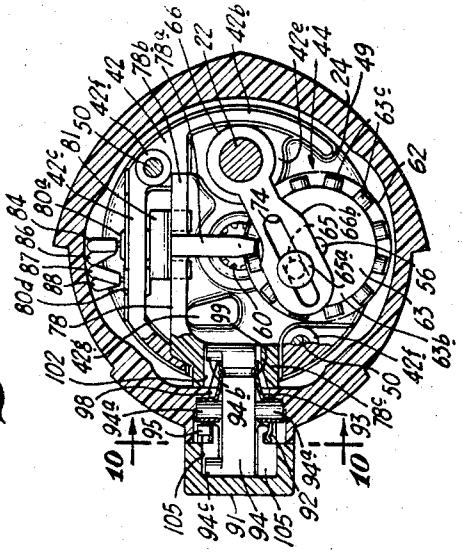


Fig. 5



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ELECTRIC APPLIANCE WITH SELECTIVE MOTION CONVERSION MEANS

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Fig. 11

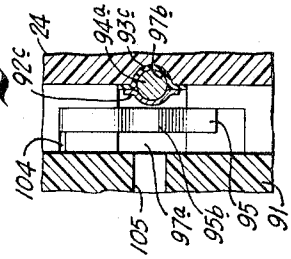


Fig. 12

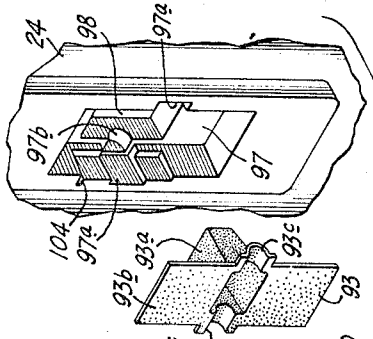


Fig. 13

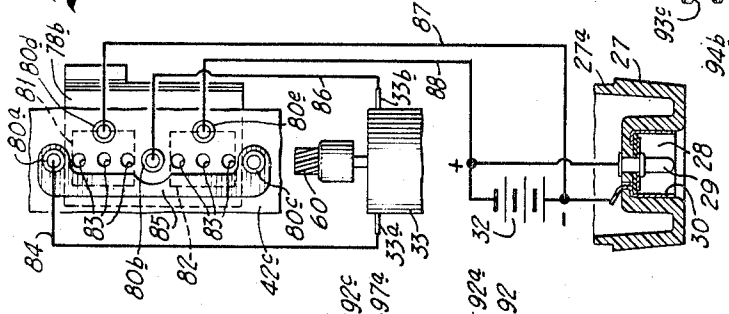


Fig. 10

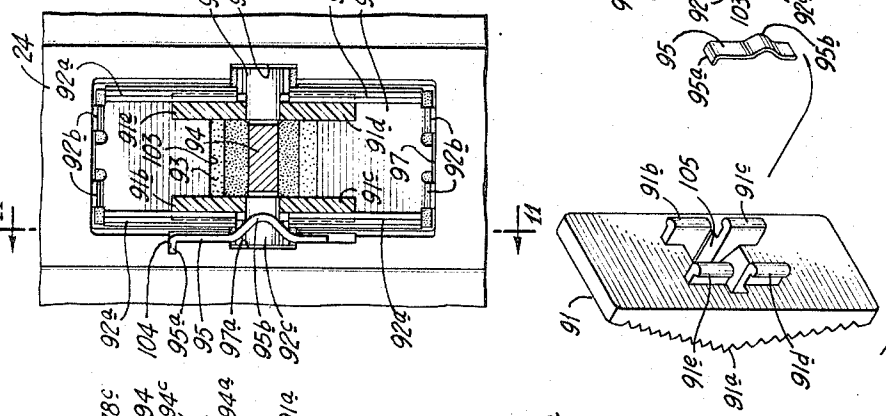
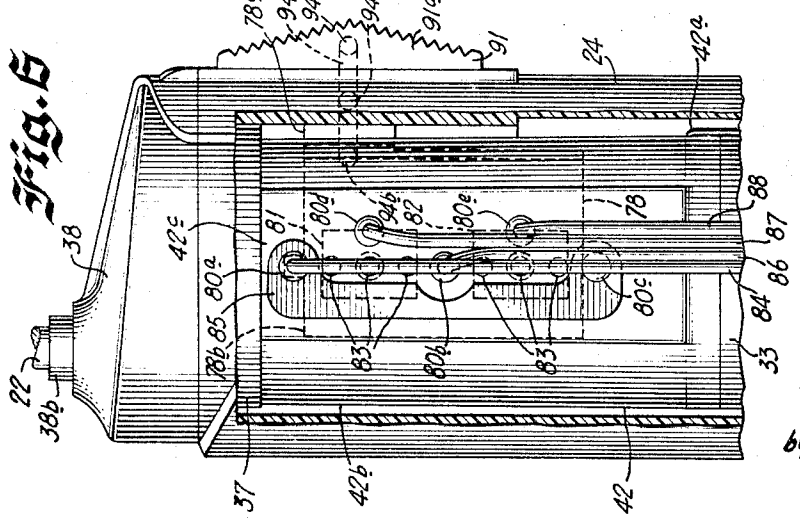


Fig. 15



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ELECTRIC APPLIANCE WITH SELECTIVE MOTION CONVERSION MEANS

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Fig. 7

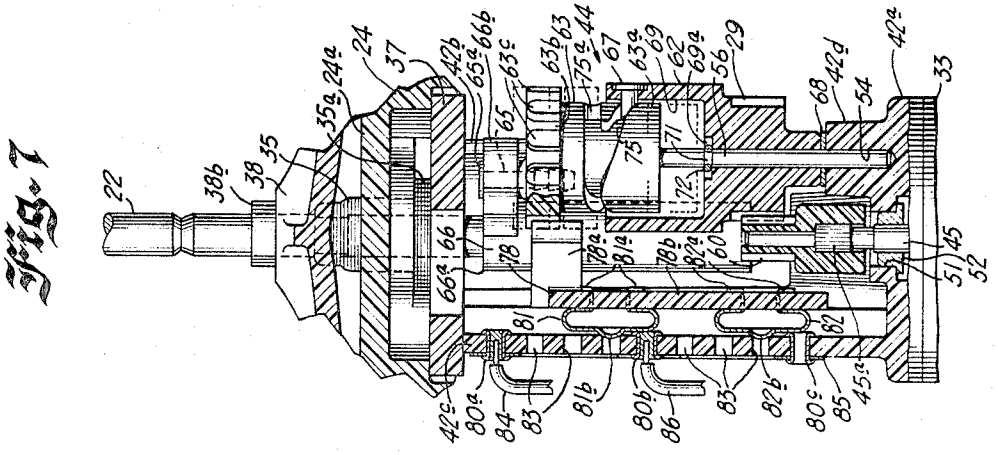


Fig. 8

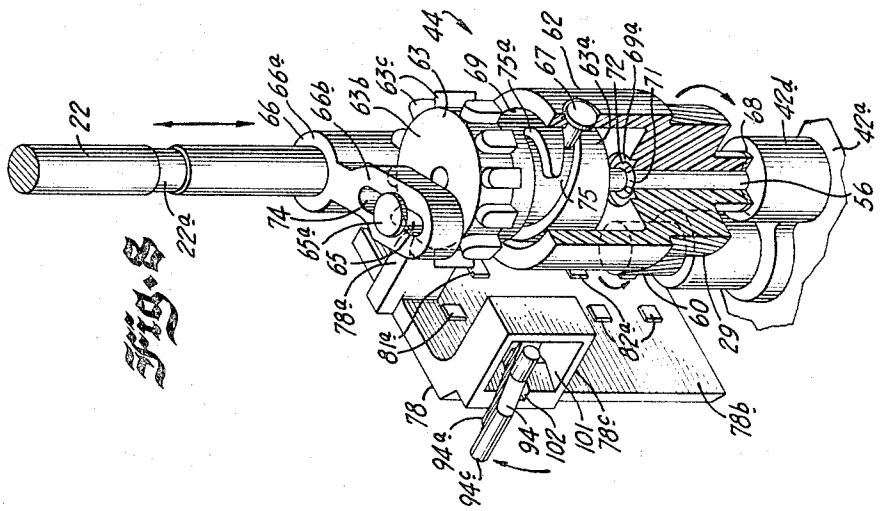
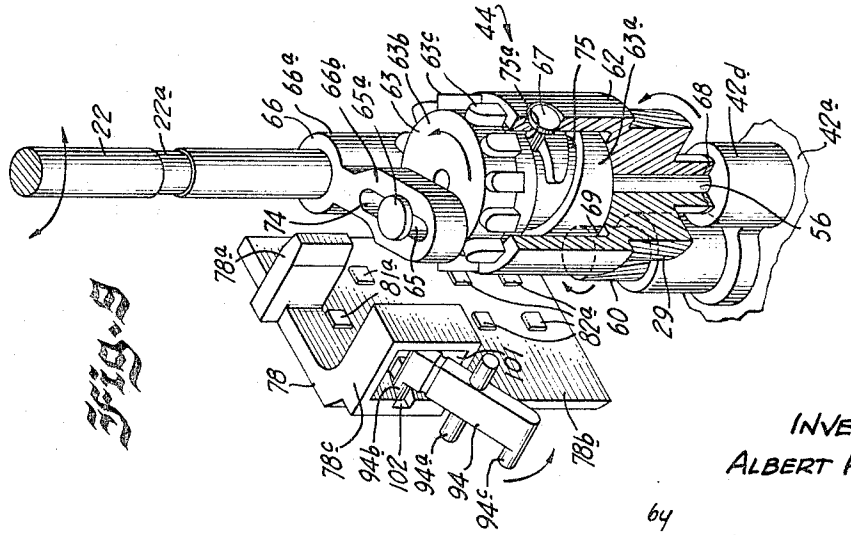


Fig. 9



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United States Patent Office 3,379,906 Patented Apr. 23, 1968

3,379,906

ELECTRIC APPLIANCE WITH SELECTIVE MOTION CONVERSION MEANS

Albert R. Spohr, Park Ridge, Ill., assignor to Sunbeam Corporation, Chicago, Ill., a corporation of Illinois

Filed Aug. 27, 1965, Ser. No. 483,061
18 Claims. (Cl. 310—50)

The present invention relates generally to an electrical appliance and, more particularly, to a rechargeable battery operated electric toothbrush having a plurality of selectively different brush motions.

Power driven toothbrushes for use in the home generally include a single hand held power unit and a plurality of detachable individual toothbrush attachments so that each individual member of a family may have a separate brush. When not in use, the power unit and the individual toothbrushes or brush attachments are stored in a stand or case having a charging unit therein for recharging a battery embodied in the power unit. One such arrangement is disclosed and claimed in copending Spohr application Ser. No. 353,327, filed Mar. 20, 1964, and assigned to the same assignee as the present application. Because of the separate charging unit, such toothbrushes are often referred to as cordless toothbrushes.

In one type of cordless toothbrush, the brush is driven by the power unit so as to oscillate about the axis of the brush shank through an angle of about ten to thirty degrees. In another type the power unit causes the brush to reciprocate in the direction of the axis of the shank. Some disagreement exists as to the relative merits of these two different brushing actions. Accordingly, it would be desirable to provide a cordless toothbrush capable of selectively providing either type of brushing action.

It is, therefore, an object of the present invention to provide an electric toothbrush capable of providing either an oscillatory brushing action or a reciprocating brushing action with simple means for selecting either type of brushing action as desired by the individual operator using the toothbrush.

Another object of the present invention resides in the provision of an electric toothbrush having new and improved selector means for selecting one or the other of two different types of brushing actions.

Yet another object of the present invention is the provision of a new and improved drive mechanism capable of selectively converting rotary motion to either reciprocal or oscillatory motion of a driven member.

It is a further object of the present invention to provide an electric appliance having a drive mechanism with new and improved selector means for selecting either reciprocal or oscillatory motion of an output member.

Still another object of the present invention is the provision of an electric toothbrush having reversible motor means operable in selected opposite directions for producing either reciprocal or oscillatory brushing action.

Yet another object of the present invention is the provision of an electric toothbrush having selector means movable to control the direction of rotation of a reversible motor and to positively select either reciprocal or oscillatory brushing action.

Further objects and advantages of the present invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the present invention, reference may be had to the accompanying drawings in which:

FIG. 1 is a perspective view of an electric toothbrush constructed in accordance with the present invention with the power unit shown in solid lines and the detachable toothbrush member illustrated in phantom and with the switch shown in the off position;

FIG. 2 is an enlarged fragmentary side elevational view of the upper portion of the power unit of FIG. 1 with certain portions broken away more clearly to illustrate the present invention;

FIG. 3 is a sectional view taken substantially along line 3—3 of FIG. 2 assuming that FIG. 2 shows the complete structure;

FIG. 4 is a sectional view taken substantially along line 4—4 of FIG. 3 assuming that FIG. 3 shows the complete structure;

FIG. 5 is a sectional view taken substantially along line 5—5 of FIG. 4 assuming that FIG. 4 shows the complete structure;

FIG. 6 is a partial sectional view taken substantially along line 6—6 of FIG. 3 again assuming that FIG. 3 shows the complete structure;

FIG. 7 is a view similar to FIG. 3 with certain portions of the casing omitted and with certain other portions not shown in section but showing the switch in a particular closed position thereof causing reciprocating type motion of the output shaft;

FIG. 8 is a perspective view with certain parts shown in section illustrating the drive mechanism of the power unit with the parts in the position of FIG. 7 for causing reciprocating motion of the output shaft;

FIG. 9 is a perspective view similar to FIG. 8 but showing the parts in the position for causing oscillating motion of the output shaft;

FIG. 10 is an enlarged fragmentary sectional view taken substantially along line 10—10 of FIG. 5 assuming that FIG. 5 shows the complete structure;

FIG. 11 is a sectional view taken substantially along line 11—11 of FIG. 10 assuming that FIG. 10 shows the complete structure;

FIG. 12 is an exploded perspective view of the selector switch means and a portion of the housing of the power unit; and

FIG. 13 is a schematic circuit diagram of the electrical circuit of the present invention with the switch in the open position, as shown in FIG. 1 of the drawings.

Briefly, the toothbrush of the present invention comprises a power driven unit having electric motor means with a motor armature selectively rotatable in either a forward or a reverse direction. A drive mechanism is included in the unit for converting rotation of the motor to either reciprocating or oscillating motion of an output shaft. The output shaft is intended to drive a toothbrush removably connected thereto. The drive mechanism provides reciprocal movement of the output shaft in response to rotation of the motor armature in one direction and oscillatory movement of the output shaft in response to rotation of the motor armature in the opposite direction. Selectively operable switch means are provided for selectively controlling the direction of rotation of the motor shaft to obtain the desired output.

The rechargeable battery operated toothbrush of the present invention is illustrated as having an exterior appearance substantially like that of the battery operated toothbrush disclosed in copending Spohr application Ser. No. 353,327 referred to above. Certain of the details of the copending application, such as, the arrangement of the battery and contacts, the construction of the output shaft, etc. are disclosed and claimed in the above-mentioned copending application and are only briefly described in this application. It will be understood that the charging unit disclosed in the above-mentioned copending application may be used to charge the battery in the power operated electric toothbrush, described hereinafter. Moreover, the power operated toothbrush of the present invention is adapted to be used with the identical charging unit, and

no description whatever of a charging unit is included in this application.

Referring now to the drawings, there is illustrated an electric power unit generally designated at **20** constructed in accordance with the present invention. This hand held power unit **20** is preferably a relatively compact device so that it may be held readily by the user, whether the user be an adult or child. In a device built in accordance with the present invention, the power unit **20** has an outer diameter of between an inch and a quarter and an inch and a half, and an over-all length of less than five inches. The power unit **20** is adapted to drive a suitable toothbrush, shown by dashed lines in FIG. 1 and designated by the reference numeral **21**, so as either to reciprocate or oscillate. The brush **21** forms no part of the present invention but is representative of the brushes which could be used with a power unit such as **20**. The brushes such as **21** are adapted to be drivingly secured to one end of a drive shaft **22** projecting from the hand held power unit **20**. The driving engagement between the brushes **21** and the drive shaft **22** of the power unit **20** may be that disclosed and claimed in copending application Ser. No. 313,898, filed Oct. 4, 1963, and also assigned to the same assignee as the present application.

Considering now the power unit **20** in a little more detail, as mentioned above, it is quite similar to that disclosed in copending application Ser. No. 353,327 referred to above, and that application should be referred to for some of the details which form no part of the present invention and are not further described herein. The power unit **20** comprises a housing **24** of cylindrical configuration open at the bottom and closed at the top by an integral wall portion **24***a* (FIGS. 3 and 4). Preferably, the wall **24***a* is provided with a pair of counterbored openings for suitable fastening means, described hereinafter, an an opening **25** through which the driving end of the drive shaft **22** projects (FIG. 4).

The details of the lower end of the power unit **24** and how the open lower end of the housing **24** is closed form no part of the present invention but are fully disclosed in the aforesaid copending Spohr application Ser. No. 353,327. With reference to FIGS. 1 and 13 of the drawings, the lower end of the housing **24** is closed by suitable molded end cap **27** which is illustrated as a cup-shaped member having an upper portion **27***a* of reduced diameter to be received snugly in the open lower end of the housing **24**. Upon final assembly a suitable cement is applied sealingly to secure the end cap **27** to the cylindrical housing **24**. The end cap **27** is illustrated as being provided with a reentrant portion defining a central recess **28** (FIG. 13) to accommodate a pair of concentrically arranged contacts **29** and **30** by means of which the power unit may be connected in a suitable recharging circuit. These contacts may be identical with those disclosed in the above-mentioned copending Spohr application Ser. No. 353,327.

In order to provide a source of electrical energy within the power unit **20**, there is disposed within the lower portion of the housing **24** a suitable rechargeable battery **32**, which is shown only schematically in FIG. 13 of the drawings and which is adapted to energize a low voltage direct current motor **33**, shown in FIGS. 2, 3, 4 and 13 of the drawings. The battery **32** and motor **33** form no part of the present invention except insofar as they are a part of the power unit **20** and are preferably identical with the corresponding battery and motor disclosed in copending application Ser. No. 353,327 referred to above. Suitable means will, of course, be provided to maintain the battery **32**, which is preferably of cylindrical configuration and disposed in the lowermost part of the housing **24**, and the motor **33** in suitably supported relationship within the housing **24**.

From the above description, it is apparent that the lower open end of the housing **24** is sealed against the entrance of moisture. Obviously, moisture should not enter the housing **24** through the opening **25** for the drive shaft **22**, and to accomplish this there is provided a drive shaft seal **35** (FIGS. 4 and 7) which is preferably of tubular configuration including an annular flange at the lower end thereof designated as **35***a*. This flange, as is clearly shown in FIG. 4 of the drawings, is adapted to be clamped between a surface defined on the inside of the top wall **24***a* of the housing **24** and a suitable disk or platelike bearing support member **37**, described in detail hereinafter, thereby sealing the opening **25** against the entrance of moisture. In order that moisture may not creep along the output or drive shaft **22**, the latter is provided with a portion **22***a* of reduced cross section (FIG. 4) snugly to receive therein a thickened annular portion **35***b* of the drive shaft seal **35**. It will be understood that the heads of any fastening means, described hereinafter, disposed in counterbored openings in the end wall **24***a* of the housing **24** must also be sealed against the entrance of moisture in a manner well understood by those skilled in the art.

To improve the appearance of the upper end of the housing **24** and, particularly, to conceal the fastening means, described hereinafter, and the drive shaft seal **35**, there is provided a flanged housing cap **38** preferably formed of somewhat resilient molded platic material. In order to secure the cap **38** in position, it is preferably provided with lugs, not shown, projecting inwardly from the flange thereof, which lugs are receivable in an annular groove **39** (FIG. 3) defined adjacent the closed end of housing **24**. Preferably, the housing **24** is provided with an annular shoulder **40** (FIGS. 3 and 4) adjacent groove **39** for engagement by the flange of the cap **38** whereby the cap **38** appears as a continuation of the housing **24**. Preferably, the cap **38** is provided with an annular projecting flange **38***b* (FIGS. 2, 3, 4 and 6) surrounding an opening **41** defined in the cap **38** through which the drive or output shaft **22** may extend.

In order to actuate the drive or output shaft **22** for either oscillating or reciprocal movement of the latter in response to the direction of rotation of the motor **33**, there is provided a subassembly including the electric motor **33** and a mechanism support **42** for supporting the mechanism of the present invention generally designated at **44** and best shown in FIGS. 2, 3, 5, 7, 8 and 9 of the drawings. The electric motor **33** may, of course, be any suitable low voltage direct current motor which has an output shaft **45** which may be rotated in either direction depending upon the energization of the electric motor **33**. The mechanism support **42** preferably closes or defines the upper end of the housing for the motor **33** whereby the motor **33** and the mechanism support **42** are more or less of an integral assembly. The mechanism support **42** may be a die casting, as was the case in the copending Spohr application Ser. No. 353,327 referred to above, or it may be molded from a suitable plastic material, in which case it also serves as an insulator for suitable electrical components, described hereinafter. The lower portion **42***a* of the mechanism support **42** preferably has a diameter of the order of the diameter of the casing for the motor **33** so that when the two are assembled the motor **33** is substantially a continuation of the lower portion **42***a* of the mechanism support **42**.

In order to support the driving mechanism **44** with which the present invention is particularly concerned and which is described in detail hereinafter, the mechanism support **42** immediately above the lower portion **42***a* thereof comprising an upwardly directed cylindrical portion generally designated at **42***b* defining a mechanism chamber **47** therein (FIGS. 2, 3 and 7) which is open at one side, as best shown in FIGS. 2 and 5 of the drawings, to define a sort of window **49**. The upstanding portion **42***b* is of generally cylindrical configuration except that it has a flat wall section **42***c*, as best shown in FIGS. 3, 5 and 7 of the drawings, to support the suitable switching

means, described hereinafter. Thus, the upstanding portion 42*b* defines the mechanism chamber 47 for housing the drive mechanism 44, described in detail hereinafter. Actually, the upstanding portion 42*b* of the mechanism support 42 is of somewhat horseshoe shape but flattened over a portion of the area of the bight portion of the horseshoe. The upper dege of the portion 42*b* of the mechanism support 42 is provided with a pair of more or less diametrically opposed tapped openings for accommodating suitable fastening means 50 (FIGS. 4 and 5) whereby the subassembly comprising the motor 33, the mechanism support 42 and the driving mechanism 44 may be secured within the housing 24 to the wall 24*a* thereof. The fastening means 50 are received in the counterbored openings referred to above.

So that the armature or motor shaft 45 may project into the mechanism chamber 47 defined by the mechanism support 42 to actuate the driving mechanism 44 from the motor 33, the lower end 42*a* of the mechanism support 42 is provided with a central opening 51 for accommodating an upper bearing 52 for the armature shaft 45. In addition to the opening 51 in the lower end 42*a* of mechanism support 42, there are provided two recesses 53 and 54 (FIGS. 3 and 4). The recess 53 (FIG. 4) is disposed in a projection 42*e* (FIGS. 2, 4 and 5) integral with mechanism support 42 and accommodates a sleeve bearing 55 for the lower end of the drive or output shaft 22. The recess 54 (FIG. 3), on the other hand, is disposed in a projection 42*d* (FIGS. 3, 7, 8 and 9) of the mechanism support 42 and is adapted to receive as by a force fit the lower end of a stationary gear spindle 56, the function of which is described hereinafter. In order to support the upper portion of the drive or output shaft 22, there is provided a flanged bearing 57 which is supported in a suitable opening in the plate 37.

So that this upper bearing support plate 37 is properly orientated with respect to the mechanism support 42 and also securely to relate the two elements, the top of portion 42*b* thereof is preferably provided with short circular projections 42*f* (FIG. 5) receivable in suitable recesses, not shown, formed in the lower surface of the support plate 37 coaxial with the fastening means 50. The fastening means 50, of course, clamp the plate 37 to the upper end of the mechanism support 42 as well as secure the motor 33, the mechanism support 42 and the mechanism 44 to the closed end 24*a* of housing 24. Additionally, the fastening means 50 clamp the flange 35*a* of the seal 35, as described above. The supporting plate 37 thus effectively becomes a part of the mechanism support and, of course, supports the flanged bearing 57, described above.

An important feature of the present invention is the driving mechanism 44 capable of converting rotatable motion of the armature shaft 45 to either oscillating motion of the output shaft 22 about its own axis or reciprocating motion of the shaft 22 longitudinally of this same axis. The output shaft 22, already described, and the stationary gear spindle 56 effectively comprise a part of the driving mechanism 44. This driving mechanism additionally comprises a pinion 60, a gear 62, a cam member 63, a drive pin 65, a drive fork 66 and a cam follower 67. The elements 60, 62, 63 and 66 are preferably molded of nylon or the like. As illustrated, the upper end of the armature shaft 45 projecting into the mechanism chamber 47 through the opening 51 is provided with a knurled portion 45*a* (FIGS. 3 and 7) whereby the pinion 60 may be pressed thereon thereby to be driven by the motor shaft 45. The gear 62 is rotatably mounted on the stationary gear spindle 56 in driving engagement with pinion 60. A suitable thrust washer 68 is interposed between the lower end of the gear 62 and the projection 42*d*, as best shown in FIGS. 3 and 7 of the drawings. In accordance with the present invention, the upper portion of the gear 62 is provided with a large cylindrical recess 69 for receiving therein a cylindrical extension 63*a* of the cam member 63. The cam member 63 is also rotatably mounted about the stationary gear spindle 56 and includes an enlarged dislike upper portion 63*b* from the periphery of which project a plurality of spaced integral lugs 63*c*, the purpose of which will be described hereinafter.

For the purpose of preventing the gear 62 from moving upwardly on the stationary gear spindle 56, the latter is provided with an annular recess 71 for receiving a spring clip 72 (FIGS. 3, 7 and 8). The spring clip 72 engages with the bottom of the recess 69 thereby to hold the gear 62 in the position shown in FIG. 7 of the drawings. Preferably, and as illustrated, the recess 69 is provided with a small depending extension 69*a* within which the spring clip 72 is disposed whereby the main body of the recess 69 is available for the receipt of the portion 63*a* of the cam member 63. In FIG. 7, different positions of the cam member 63, as will become apparent from the ensuing description, are shown in solid lines and dotted lines, respectively.

It will be understood that the drive fork 66 is provided to impart oscillatory motion to output or drive shaft 22. To this end and as best shown in FIGS. 2, 4, 5, 8 and 9 of the drawings, shaft 22 extends through a tubular portion 66*a* of the drive fork 66, the shaft 22 preferably being provided with a knurled portion or other means for making good driving connection with this tubular portion 66*a*. The drive fork 66 further includes a laterally projecting portion 66*b* integral with the tubular portion 66*a*. An elongated recess 74 is defined in the laterally projecting portion 66*b* for receiving the drive pin 65 which is secured in an ecentrically disposed recess in the upper surface of cam member 63. This drive pin 65 is shown in FIG. 7 of the drawings as of the type which may be driven into a suitable recess and provided with means whereby it cannot readily be removed once it has been inserted. Moreover, drive pin 65 is provided at the upper end with a head 65*a* so as to maintain the cam member 63 adjacent the laterally extending portion 66*b* of the drive fork 66. It will readily be understood that if the cam member 63 is rotated about the axis of stationary gear spindle 56 oscillation of the output shaft 22, as designated by the double-headed arrow in FIG. 9 of the drawings, will result.

For the purpose under certain conditions of having this same mechanism 44 cause reciprocating motion of the drive shaft 22, as designated by the double-headed arrow in FIG. 8 of the drawings, the periphery of the cylindrical portion 63*a* of cam member 63 receivable within the recess 69 is provided with an endless groove 75 for receiving therein the cam follower 67. This cam follower is supported by the wall of gear 62 defining the recess 69, as best shown in FIGS. 3, 7, 8 and 9 of the drawings. The groove 75 has a low point and a diametrically opposed high point relative to portion 63*a*, as viewed in FIGS. 2, 3, 7, 8 and 9 of the drawings, with the portions of the groove interconnecting these points having a uniform slope whereby a predetermined relative rotation of gear 62 and cam member 63 through three hundred sixty degrees about the axis of stationary gear spindle 56 would cause one complete cycle of reciprocation of cam member 63 along said axis. As will be described in greater detail hereinafter, cam member 63 is prevented from rotating whenever gear 62 is rotated in the direction of the arrow shown in FIG. 8 of the drawings (clockwise) whereupon cam member 63 will reciprocate into and out of the recess 69. Since this cam member is pinned to the drive fork 66 by the drive pin 65, the output shaft 22 will similarly be caused to reciprocate. It will be understood that not only is the drive shaft seal 35 sufficiently resilient to prevent such reciprocal movement but also the sleeve bearing 55 is sufficiently long also to permit such movement.

In accordance with the present invention, it is desired that rotation of gear 62 in the direction of the arrow

shown in FIG. 9 of the drawings (counterclockwise) will cause the cam **63** and gear **62** to operate as an integral unit. Accordingly, the groove **75** is provided adjacent the high point thereof with a short stub extension **75***a* (FIGS. 8 and 9) into which the cam follower **67** will move upon counterclockwise rotation of gear **62**, as viewed in FIG. 9 of the drawings. When the pin is at the end of this short stub extension **75***a* (as illustrated in FIGS. 2 and 9), continued counterclockwise rotation of the gear **62** will cause the cam **63** to rotate therewith in the same direction, and under these conditions, the gear **62** and cam **63** are effectively integral with the resulting oscillation of the shaft **22**. It will be apparent that for reciprocal or linear movement of the output shaft **22** the armature shaft **45** and the associated pinion **60** must rotate in a counterclockwise direction, as viewed in FIG. 8 of the drawings (see arrow associated with pinion **60**), whereas for oscillating movement of the output shaft **22**, the armature shaft **45** and the pinion **60** must rotate in a clockwise direction, as viewed in FIG. 9 of the drawings (see arrow associated with pinion **60**).

To hold the cam **63** stationary when reciprocation of the output shaft **22** along its longitudinal axis is desired, there is provided a slide member **78** which performs several functions, as described in detail hereinafter. First of all, it serves as a lock or stop for holding cam member **63** against rotation. To this end it includes a projection **78***a* receivable between adjacent lugs **63***c* of cam member **63**. It also functions as a movable contact support, as described hereinafter. As illustrated, slide member **78** is preferably formed of a molded insulating material and includes a flat platelike contact support section **78***b* from the upper end of which projects cam stop **78***a*. The flat portion **78***b* is adapted to be supported by the mechanism support **42** for reciprocal movement between an upper position (FIG. 9) which, as will become apparent, results in a particular energization of the motor **33** to cause oscillation of the output shaft **22**, and a lower position, shown in FIGS. 7 and 8 of the drawings, resulting in locking cam member **63** and also energization of motor **33** to cause reciprocation of output shaft **22** along its longitudinal axis. The slide member **78** is also adapted to be positioned in an intermediate position (FIGS. 3, 4, 6 and 13) wherein the motor **33** is deenergized but the stop **78***a* is free of lugs **63***c*.

As best shown in FIG. 5 of the drawings, the mechanism support **42** is so shaped as to guide the slide member **78** in its movement between its two extreme positions, described above. As viewed in FIG. 5, portions of the side of the slide member section **78***b* remote from projection **78***a* are engaged with guiding means defined on mechanism support **42**. The other side of slide member section **78***b* is guided by vertically extending support post **42***g* integrally formed with mechanism support **42**.

From the above description, it will be apparent that the driving mechanism **44** of the present invention for one direction of rotation of the armature shaft **45** while cam member **63** is held from rotating by stop **78***a* results in reciprocation of output shaft **22** along its longitudinal axis. Moreover, for the opposite direction of rotation of the armature shaft **45** when cam **63** is free to rotate about stationary gear spindle **56**, oscillation of the drive shaft **22** occurs. In accordance with the present invention, there is provided switch means including manual control means for actuating the same to insure the proper direction of rotation of the armature shaft **45** for the desired motion of output shaft **22**. It will be appreciated that this manual control means must be such as to correlate the effectiveness or ineffectiveness of the stop **78***a* with the direction of rotation of the armature shaft **45**.

In order to control the energization of the electric motor **33** to rotate in either a clockwise or a counterclockwise direction, there is provided a control switch suitably supported on the flat wall section **42***c* of the mechanism support **42** and on the flat section **78***b* of slide member **78**. Since mechanism support **42** and slide member **78** have been described as formed of insulating material, the switch components may be mounted directly thereto. It will be understood that in the event the mechanism support were a metal die casting suitable means would be required to insulate the electrical components, described hereinafter, from the mechanism support. As best shown in FIGS. 6 and 13 of the drawings, the control switch comprises a plurality of stationary contacts **80***a*, **80***b*, **80***c*, **80***d* and **80***e* mounted in spaced relationship on flat wall section **42***c* of mechanism support **42** and a pair of movable contacts **81** and **82** mounted on section **78***b* of slide member **78**. Preferably, the flat wall section **42***c* of the mechanism support **42** is provided with a plurality of spaced openings **83**, eleven such openings being shown in FIGS. 3, 7 and 13 of the drawings. As there illustrated, nine openings are arranged in one vertical row and two openings in a second vertical row. Tubular rivetlike members disposed within five of the eleven openings define the stationary contacts **80***a*, **80***b*, **80***c*, **80***d* and **80***e*. Contacts **80***a*, **80***b* and **80***c* are illustrated as disposed within the upper, middle and lower openings **83** of the row of nine such openings, while contacts **80***d* and **80***e* are disposed in the two openings defining the second row. The remaining openings **83** serve as detent openings for the movable contacts **81** and **82** to determine the three different switch positions. The contacts **80***d* and **80***e* are preferably disposed midway between the contacts **80***a* and **80***b* and the contacts **80***b* and **80***c*, respectively, and slightly displaced to one side thereof, as clearly shown in FIG. 13 of the drawings.

To complete the electrical connections between battery **32**, motor **33** and the control switch just described, one terminal **33***a* of the direct current motor **33** is effectively connected to both contacts **80***a* and **80***c* by conductors **84** and **85**. As illustrated, conductor **85** is actually a conducting strip of somewhat U shape which is secured to the flat wall section **42***c* by rivet contacts **80***a* and **80***c*. As best shown in FIG. 3 of the drawings, the use of such rivet contacts **80** permits one to insert the end of an associated conductor into the opening in the contact whereby a simple soldering operation completes the connection. The other terminal **33***b* of the motor **33** is connected by a conductor **86** to contact **80***b*. The negative terminal of the battery **32** is connected by a conductor **87** to the contact **80***d* while the positive terminal of the battery **32** is connected to the contact **80***e* through the conductor **88**. It will readily be apparent that if contacts **80***a* and **80***d* were electrically interconnected and simultaneously contacts **80***b* and **80***e* were electrically interconnected the negative terminal of the battery **32** would be connected to terminal **33***a* of motor **33** and the positive terminal of the battery **32** would be connected to terminal **33***b* of motor **33**. On the other hand, if contacts **80***b* and **80***d* were electrically interconnected and simultaneously contacts **80***c* and **80***e* were electrically interconnected, then the terminal **33***a* of motor **33** would be connected to the positive terminal of battery **32** and motor terminal **33***b* would be connected to the negative terminal of battery **32**.

For the purpose of selectively accomplishing the connections just described, the movable contacts **81** and **82** are each formed of resilient strip material of somewhat U shape with the legs of the U terminating in tabs **81***a* and **82***a*, respectively. These tabs are adapted to extend through suitable slits or openings in the section **78***b* of slide member **78** after which they are bent over, as indicated clearly in FIGS. 3 and 4 of the drawings. There is thus provided a simple means for securing contacts **81** and **82** to the slide member **78**. The bight portions of contact members **81** and **82** are also each provided with integral projecting detents **81***b* and **82***b*, respectively, for engaging with the detent openings **83** in flat wall section **42***c* of the mechanism support **42** not already occupied by stationary contacts **80**. The movable contacts

81 and 82 are of sufficient lateral extent, as clearly shown in FIGS. 3, 5, 6 and 13 of the drawings, to be capable of interconnecting contact 80*d* with either contact 80*a* or 80*b* and contact 80*e* with either contact 80*b* or 80*c*.

With the above-described arrangement, it is obvious that there has been provided a very simple three-position control switch forming a part of the mechanism support and permitting energization of the motor 33 for either direction of rotation thereof as well as providing a switch-off position. It will be understood that the middle detent opening 83 between the contacts 80*a* and 80*b* and the middle detent opening 83 between the contacts 80*b* and 80*c* receive the detents 81*b* and 82*b*, respectively, as shown in FIG. 3 of the drawings, when the control switch is in the open position. The two openings 83 immediately above the middle detent openings just described receive the detents 81*b* and 82*b*, respectively, when clockwise rotation of the motor armature 45, as viewed in FIG. 9 of the drawings, is desired with the resultant oscillating motion of the output shaft 22. The two openings 83 immediately below such middle detent openings receive the detents 81*b* and 82*b*, respectively (FIG. 7) when counterclockwise rotation of the motor armature 45, as viewed in FIG. 8 of the drawings, is desired with the resultant reciprocating motion of output shaft 22.

In order to actuate the switch comprising the stationary contacts 80*a*, 80*b*, 80*c*, 80*d* and 80*e* and the movable contacts 81 and 82 from the exterior of the housing 24, there is provided, in accordance with the present invention, a switch slide 91, a switch spring 92, a switch seal 93, a switch rocker arm 94 and a switch detent 95 which are adapted to be associated with a recess 97 defined near the upper end of the housing 24. As best shown in FIGS. 4 and 12, the recess 97 has a small opening 98 at the rear thereof leading to the interior of the housing 24. The switch seal 93 is adapted to be inserted into the bottom of the recess 24 and includes a somewhat tubular projection 93*a* which extends through the opening 98 and into the housing 24. Preferably, the switch seal is formed of neoprene rubber or similar stretchable material and includes a rectangular section 93*b* which is adapted to seal the bottom of the recess 97. The switch rocker arm 94 is adapted to be inserted next, and it includes a pair of centrally disposed trunnions 94*a* and a pair of end pins 94*b* and 94*c* for transmitting motion from the switch slide 91 to the slide member 78, described above. In order that the switch rocker arm 94 may be pivotally supported within the recess 97 about the trunnions 94*a*, the recess is provided with extensions 97*a* on either side thereof terminating in semicircular ends 97*b* (FIGS. 11 and 12) to accommodate such trunnions. Similarly, the switch seal 93 is provided with laterally projecting semicylindrical ears 93*c* receivable in the recesses 97*a* with the convex sides thereof engaging the portions 97*b* and the concave sides engaging the trunnions 94*a* in a manner clearly shown in FIG. 11 of the drawings. In order to make sure that no moisture can leak between the switch rocker arm 94 and the tubular portion 93*a* of the switch seal 93, the rocker arm 94 is provided with a groove 100 into which the tubular portion 93*a* is deformed by suitable clamping means 99.

So that the pivotal movement of the rocker arm 94 about its trunnions 94*a* causes movement of the slide member 78, the latter is provided with an integral boxlike projection 78*c*, best shown in FIGS. 8 and 9 of the drawings. The end of the rocker arm having the projection 94*b* is adapted to be received within a recess 101 defined by this boxlike projection 78*c*. Moreover, one wall of this recess is provided with a notch 102 for receiving therein the projection 94*b*, as best shown in FIG. 9 of the drawings. It will be obvious that pivotal movement of the rocker arm 94 about the axis of the trunnions 94*a* will cause the slide member 78 to move in a vertical direction, as viewed in FIGS. 8 and 9 of the drawings and as described in detail above.

For the purpose of holding the switch seal 93 in sealing relationship and also to support the switch slide 91, the switch spring 92, best shown in FIG. 12 of the drawings, is essentially a U-shaped spring member adapted to be pushed into the recess 97 with the bight portion of the spring member against the switch seal 93 and with the legs 92*a* of the U projecting outwardly along the walls of the recess 97, as best shown in FIG. 5 of the drawings. The switch spring 92 is provided at the upper and lower ends with spring fingers 92*b* which hold the switch spring within the recess 97 when it is forceably inserted therein. The spring fingers 92*b* engage and clamp against the upper and lower walls of the recess 97, as viewed in FIG. 12 of the drawings. The bight of the switch spring 92 is provided with an opening 103 to permit the rocker arm 94 to extend therethrough and is also provided with laterally projecting semicylindrical ears 92*c* shaped to conform to the trunnions 94*a*, as best shown in FIGS. 11 and 12 of the drawings. These trunnions 94*a* are, therefore, clamped between the ears 93*c* of the seal 93 and the ears 92*c* of the spring 92*a*, as best shown in FIG. 11 of the drawings.

For a purpose which will become apparent from the ensuing description, the switch detent 95 is an L-shaped member having one leg of the L 95*a* receivable in a slit 104 defined in one wall of the recess 97. The detent 95 has an intermediate resilient boss portion 95*b* which projects into the recess 97 to engage with the slide 91, as described hereinafter.

Considering now the switch slide 91, it comprises a main body portion 91*a* including a finger engaging portion on one side. The body portion 91*a* is of sufficient extent as to completely overlie the recess 97. The switch slide includes a plurality of spaced projections 91*b*, 91*c*, 91*d* and 91*e* from the face thereof opposite the finger engaging portion. A recess 105 (FIGS. 4, 5 and 11) is defined between the upper projections 91*b* and 91*e* and the lower projections 91*c* and 91*d* within which is received one end of the rocker arm 94 and specifically the projection 94*c*. The projections 91*b*, 91*c*, 91*d* and 91*e* are provided with enlargements at the inner ends thereof which are grasped by the spring fingers 92*a* of the switch spring 92, as best shown in FIG. 5 of the drawings. The detent portion 95*b* of the switch detent 95 is adapted to engage between the projections 91*b* and 91*c* to define the off position of the switch slide 91. It will be apparent that when the switch slide 91 is moved to the upper end of the recess 97 the switch rocker arm 94 is moved as indicated by the arrow in FIG. 8 of the drawings and the motor 33 is energized to cause reciprocating motion of the output shaft along the longitudinal axis thereof. On the other hand, when the switch slide 91 is moved downwardly toward the bottom of the recess 97, the switch rocker arm 94 is moved in the direction of the arrow shown in FIG. 9 of the drawings causing the motor 33 to be energized to cause oscillating motion of the output or drive shaft 22. In FIG. 1 of the drawings, a set of dashed arrows indicates that when slide 91 is moved upwardly the output shaft 22 reciprocates. A set of solid line arrows indicates that when slide 91 is moved downwardly the output shaft 22 oscillates.

In view of the detailed description included above, the operation of the power unit of the present invention will readily be understood by those skilled in the art. It will be apparent that there has been provided a very simple power unit, and the operator may merely actuate the switch slide 91 selectively to obtain oscillating or reciprocating motion of the toothbrush attachment 21 associated with the output shaft 22. A very simple mechanism is provided so that mere reversal of the direction of rotation of the electric motor 33 changes the nature of the brushing action provided by the power unit 20. Moreover, the power unit is adapted to be associated with a suitable charging unit, as disclosed in the abovementioned Spohr application Ser. No. 353,327.

While there has been shown and described a particular embodiment of the present invention, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the invention in its broader aspects, and it is, therefore, contemplated in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An electrical power unit comprising motor means having a rotatable motor shaft, an output shaft mounted in said unit for either reciprocal or oscillatory movement, and drive means interconnecting said roatable shaft and said output shaft for reciprocating said output shaft in response to rotation of said motor shaft in one direction and for oscillating said output shaft in response to rotation of said motor shaft in the opposite direction.

2. The power unit of claim 1 including selector means for selectively controlling the direction of rotation of said motor shaft.

3. The power unit of claim 2 wherein said selector means includes stop means for restraining a portion of said drive means against movement when said selector means is operated to select one direction of rotation of said motor shaft.

4. An electrical appliance comprising a casing, an electric motor in said casing having a rotatable armature shaft selectively rotatable in either direction, an output shaft projecting from said casing, drive means interconnecting said shafts, said drive means causing oscillation of said output shaft upon rotation of said armature shaft in one direction and reciprocation of said output shaft upon rotation of said armature shaft in the opposite direction, control means movable between first and second positions for selectively controlling the direction of rotation of said armature shaft, locking means included in said control means and movable to a locking position for restraining a portion of said drive means when said control means is in one of said two positions.

5. The appliance of claim 4 wherein when said locking means is in its locking position only reciprocal movement of said output shaft can occur, said locking means being movable to its unlocked position when said control means is in the other of said positions.

6. In a power unit the combination of a casing, a prime mover in said casing having a rotatable first shaft selectively rotatable in either direction, a second shaft projecting from said casing and mounted for both reciprocating motion along its longitudinal axis and oscillating motion about said axis, drive means in said casing interconnecting said shafts and causing oscillating motion of said second shaft in response to rotation in one direction of said first shaft and reciprocating motion of said second shaft in response to rotation in the opposite direction of said first shaft, and control means movable between a plurality of positions for selectively controlling the direction of rotation of said first shaft.

7. A power unit for a cordless electric toothbrush comprising a casing, a battery operated electric motor disposed within said casing and having a rotatable armature shaft selectively rotatable in either direction, a battery for supplying electric energy to said motor disposed in said casing, an output shaft projecting from said casing and mounted for both reciprocating motion along its longitudinal axis and oscillating motion about said axis, drive means interconnecting said shafts and causing oscillating motion of said output shaft in response to rotation of said armature shaft in one direction and reciprocating motion of said output shaft in response to rotation of said armature shaft in the opposite direction, and control means movable between a plurality of positions for selectively controlling the direction of rotation of said armature shaft.

8. In a power unit for a cordless electric toothbrush the combination of a casing, a battery operated electric motor mounted within said casing and having a rotatable armature shaft selectively rotatable in either direction, a rechargeable battery for supplying electric energy to said motor mounted within said casing, an output shaft projecting from said casing and mounted for both reciprocating motion along its longitudinal axis and oscillating motion about said axis, drive means interconnecting said shafts and causing oscillating motion of said output shaft in response to rotation of said armature shaft in one direction and reciprocating motion of said output shaft in response to rotation of said armature shaft in the opposite direction, control means movable between a plurality of positions for selectively controlling the direction of rotation of said armature shaft, and means included in said control means for restraining a portion of said drive means in a predetermined manner when said control means is in one of said plurality of positions.

9. The power unit of claim 8 wherein said control means includes a switch for reversing the connections between said battery and said motor.

10. The power unit of claim 6 wherein said drive means comprises gear means drivingly connected to said first shaft, means defining a recess in said gear means, a cam member disposed in said recess, connecting means drivingly relating said cam member to said gear means, pin and fork means interconnecting said cam member and said second shaft for oscillating said second shaft in response to rotation of said cam member, means included in said control means for holding said cam member against rotation when said control means is in one of said plurality of positions, and means included in said connecting means for causing said cam member to move into and out of said recess when said cam member is held against rotation and said gear means is driven by said first shaft.

11. In a power unit for a cordless electric toothbrush the combination of a casing, a battery operated electric motor in said casing having a rotatable armature shaft selectively rotatable in either direction, a battery for supplying electric energy to said motor disposed in said casing, an output shaft projecting from said casing and mounted for both reciprocating motion along its longitudinal axis and oscillating motion about said axis, drive means interconnecting said shafts and causing oscillating motion of said output shaft in response to rotation of said armature shaft in one direction and reciprocating motion of said output shaft in response to rotation of said armature shaft in the opposite direction, control means movable between a plurality of positions for selectively controlling the direction of rotation of said armature shaft, said drive means comprising a gear driven from said armature shaft, a cam member disposed in said recess, connecting means drivingly relating said cam member and said gear, pin and fork means interconnecting said cam and said output shaft for oscillating said output shaft in response to rotation of said cam member, means included in said control means for holding said cam member against rotation when said control means is in one of said plurality of positions, and means included in said connecting means for causing said cam member to move into and out of said recess when said cam member is held against rotation and said gear is driven by said armature shaft.

12. An electric toothbrush comprising a power unit including a casing, motor means in said casing having a rotary shaft selectively rotatable in opposite directions, a toothbrush supporting output shaft extending outwardly from said casing mounted for both reciprocating and oscillating movement with respect thereto, drive means in said casing interconnecting said rotary shaft and said output shaft, said drive means including first means for reciprocating said output shaft when said rotary shaft is rotated in one direction, and second means for oscillat-

ing said output shaft when said rotary shaft is rotated in the opposite direction, and control means for selectively controlling the direction of rotation of said rotary shaft, said control means including means for disabling one of said first and second means upon actuation of said control means to select a predetermined direction of rotation.

13. The power unit of claim 6 wherein said drive means includes yoke means extending radially from said second shaft and a cam member mounted for reciprocal and rotational movement about a fixed axis with respect to said casing, said drive means further including an eccentric pin secured to said cam member and drivingly connected to said yoke means, said drive means also including a gear driven by said first shaft for rotation about said fixed axis and means for actuating said cam member from said gear to reciprocate said cam member along said fixed axis when said gear is rotated in one direction and to rotate said cam member about said fixed axis when said gear is rotated in the opposite direction.

14. The power unit of claim 13 wherein locking means are proivded for restraining said cam member against rotation when said control means is moved to one of said positions.

15. In a power unit for a cordless electric toothbrush, the combination of a casing, an electric motor in said casing having an armature shaft selectively rotatable in a forward and reverse direction, an output shaft projecting from said casing and mounted for both reciprocating movement along its longitudinal axis and oscillating motion about said axis, shaft means parallel to said output shaft, first cam means mounted for rotation on said shaft means and driven by said armature shaft, second cam means mounted on said shaft means for rotation and reciprocating movement thereon, one of said cam means including drive pin means engageable with groove means in the other cam means for reciprocating said second cam means upon rotation of said first cam means in said forward direction and locking said first and second cam means against relative rotation upon rotation of said first cam means in said reverse direction, yoke means on said output shaft extending radially outward thereof for reciprocating and oscillating said output shaft, said second cam means including a drive pin eccentric of said shaft means for drivingly engaging said yoke means to drive said output shaft, and selector means movable between a first position engaging said second cam means to prevent rotation thereof but permit reciprocation and a second position free of engagement with said second cam member.

16. In a power unit for a cordless electric toothbrush, the combination of a casing, an electric motor in said casing having an armature shaft selectively rotatable in a forward and reverse direction, an output shaft projecting from said casing and mounted for both reciprocating movement along its longitudinal axis and oscillating motion about said axis, drive means for drivingly interconnecting said armature shaft and said output shaft including a frame, shaft means carried by said frame parallel to said output shaft, first cam means mounted for rotation on said shaft means and driven by said armature shaft, second cam means mounted on said shaft means for rotation and reciprocating motion thereon, one of said cam means including drive pin means engageable with groove means on the other cam means for reciprocally moving said second cam means upon rotation of said armature shaft in said forward direction and locking said first and second cam means against relative rotation upon rotation of said armature shaft in a reverse direction, yoke means on said output shaft projecting radially outward of the longitudinal axis thereof, a drive pin on said second cam means engaging said yoke means and eccentric of said shaft means for driving said yoke means in reciprocating and oscillating motion, switch means in said casing movable between selected positions to energize said motor to rotate in said forward and reverse directions, said switch means including a body member slidable on said frame and an operator pivotally mounted on and projecting outwardly of said casing for moving said body member between said selected positions, said body member including lug means engageable with said second cam means to prevent rotation but permit reciprocation thereof when said switch means is moved to energize said motor in said forward direction.

17. In a power unit for a cordless electric toothbrush, the combination of a casing, an electric motor in said casing having an armature shaft selectively rotatable in a forward and a reverse direction, an output shaft projecting from said casing and mounted for both reciprocating movement along its longitudinal axis and oscillating motion about said aixs, said output shaft including yoke means within said casing extending radially outward from said longitudinal axis, and cam means interconnecting said yoke means and said armature shaft, said cam means including a driving cam member rotatably engaging said armature shaft and a driven cam member mounted for rotation about and reciprocation along an axis of said cam means, one of said cam members including a drive pin engageable with groove means on the other cam member for reciprocally driving said driven cam member upon rotation of said armature shaft in a forward direction and locking said cam members against relative rotation upon rotation of said armature shaft in an opposite direction.

18. In a power unit for an electric toothbrush, the combination of a sealed casing, an electric motor in said casing having an armature shaft selectively rotatable in a forward and a reverse direction, an output shaft projecting through said casing and mounted therein for both reciprocating movement along its longitudinal axis and oscillating motion about said axis, said output shaft including drive yoke means extending radially outward of said longitudinal axis, drive means interconnecting said armature shaft and said drive yoke means including a frame, said drive means including cam means comprising a driving member rotated by said armature shaft and a driven member connected to said yoke means, means interconnecting said driving and driven members whereby said yoke means is moved in oscillating motion around said longitudinal axis in response to forward rotation of said armature shaft and said yoke means is driven to reciprocate said output member longitudinally of its axis in response to reverse rotation of said armature shaft, switch means in said casing slidably mounted on said frame for movement between selected positions for energizing said motor in said forward and reverse direction, said switch means including lug means engageable with said driven member to prevent rotation thereof when said switch means is moved to reverse said armature shaft, a toggle actuator pivotally mounted on said casing and having an inward projection engaging said switch means and an actuating arm projecting outwardly of said casing, and means for sealing said casing against the entrance of moisture adjacent said toggle actuator.

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