March 4, 1941. J. D. MINER, JR., ET AL 2,233,623

SHAVER MOTOR

Filed Oct. 18, 1938

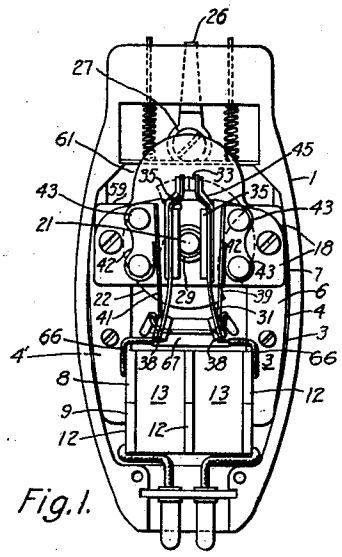


Fig. 1.

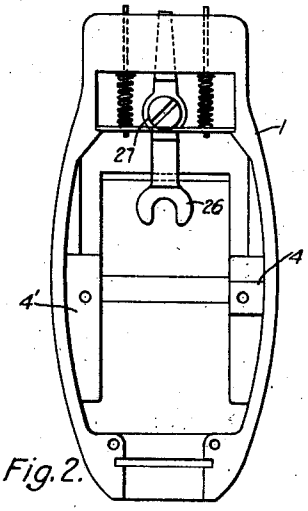


Fig. 2.

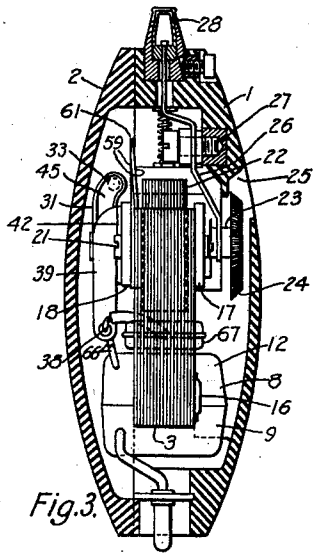


Fig. 3.

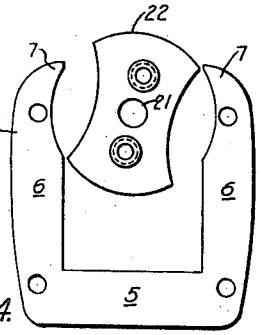


Fig. 4.

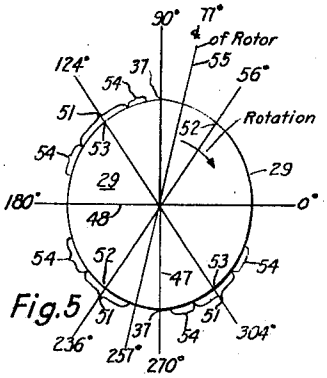


Fig. 5.

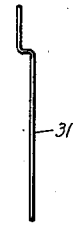


Fig. 6.

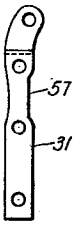


Fig. 7.

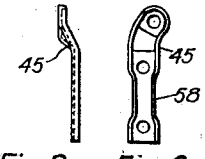


Fig. 8.

Fig. 9.

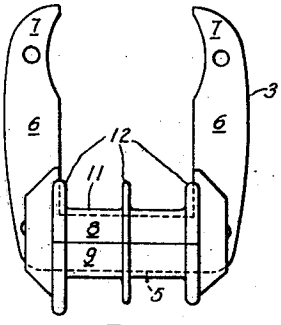


Fig. 10.

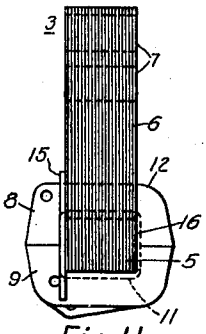


Fig. 11.



Fig. 12.

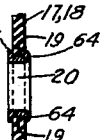


Fig. 13.

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UNITED STATES PATENT OFFICE

2,233,623

SHAVER MOTOR

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Application October 18, 1938, Serial No. 235,599

16 Claims. (Cl. 172—36)

Our invention relates to motors for electric shavers or other small portable tools, and it has particular relation to the type of motor having an unwound bipolar rotor member and a bipolar field member which is energized by a magnetizing coil which is connected in series with a make-and-break contact mechanism actuated by the rotor-shaft.

An object of our invention is to provide improvements in the electrical contact mechanism for such motors; including improvements in the contact-spring supporting-members designed to provide precise adjustment of both the timing and the contact pressure; a contact mechanism in which all pivots have been eliminated, thus avoiding frictional wear and eventual misalignment of the contact points; an improved shape of cam-contour for actuating the resilient contact-arms of the contact mechanism; the utilization of a contact-assembly the major portions of which are all made of the same metal, thereby avoiding bimetallic effects which might otherwise be caused by heating and cooling; the utilization of an improved cam-engaging follower of grease-impregnated insulating material of substantially uniform thickness; the utilization of light-weight, relatively non-flexible channel stiffening portions or braces for preventing flexure of the resilient contact-arms between the intermediate cam-engaging portions and the contact-carrying tips, thus producing the desirable sharp make and break of the contact-points, while utilizing extremely light moving parts, admitting of the use of relatively low spring-pressures; and the utilization of a metal contact-arm construction in which the intermediate portion, which comes closest to the shaft, is of reduced width, to increase the electrical creepage-distance to the shaft, preventing danger of shock to the user.

A further object of our invention is to provide an improved two-part insulating-spool construction, mounted on a cross-arm of the magnetizable core member, for providing a form on which the stator coil is wound, said spool-assembly preferably having a wedge-means for tightening the same on the core, in a novel manner.

A further object of our invention is to provide a thin flexible insulating guard which is caused to assume a bowed shape, thus extending its rigidity.

A further object of our invention is to provide a small portable electrical tool comprising a thin casing adapted to be held in the hand of the operator, and of such thin construction that it is susceptible of slight warping under normal conditions of use, in combination with a small flat electric motor which is disposed within the casing and made of such thin magnetizable laminations that it is susceptible of a damaging amount of warping if subjected to any material warping forces, and novel mounting-means, for this type of instrument, comprising, in effect, a three-point motor-mounting, so as to avoid the transmission of warping forces to the motor-frame.

A further object of our invention is to provide a novel bearing and bearing-finishing means consisting of two bearing members supported in perforations in two stator-frame cross-pieces, with restraining means for holding each bearing member to its associated cross-piece with restraint against both rotary and axial movement, said restraining means including a knurled outside surface and a tight fit of each bearing member in its perforation, the two bearings being finished by a line-reaming operation, so as to make it possible to maintain a very small bearing-clearance between the bearing members and the rotor-shaft. This construction is desirable because the motor is utilized with an eccentric drive which tends to make the shaft rattle excessively, making the motor very noisy if there is any possibility of translational shaft-movement. This construction is further desirable because any movement of the shaft reduces the effectiveness of the motor, both by reducing the amount of travel of the eccentric and also, in general, by interfering with the proper movement of the contact mechanism.

With the foregoing and other objects in view, our invention consists in the structures, combinations and methods hereinafter described and claimed, and illustrated in the accompanying drawing, wherein

Figure 1 is a full-scale plan view of an electric shaver embodying our invention, with the top of the casing removed to show the interior construction.

Fig. 2 is a similar view of the bottom portion of the casing, with the motor removed so as to show the motor-mounting ledges.

Fig. 3 is a side view of the motor, with the shaver-casing indicated in cross section.

Fig. 4 is an enlarged diagrammatic detailed view of the stator- and rotor-laminations.

Fig. 5 is a very much enlarged view showing the surface of the special cam member for actuating the contact mechanism.

Figs. 6 and 7 are enlarged side and front views of a spring contact-arm utilized in the contact mechanism.

Figs. 8 and 9 are enlarged side and front views

of a channeled brace member utilized with the contact-arms.

Figs. 10 and 11 are enlarged side and front views of the stator frame in the condition it assumes when it is ready for the winding operation.

Fig. 12 is an enlarged detail view of one of the bearing members, partly in elevation and partly in section; and

Fig. 13 is an enlarged sectional view through one of the stator-frame cross-pieces, showing the bearing member assembled therewith.

Our invention is particularly designed for, and is illustrated as being embodied in, an electric shaver comprising a light-weight main casing-portion 1 and a light-weight casing-top 2 (Fig. 3). The casing member is of such elongated shape and small size as to be readily held in the hand of the operator, and it is made of insulating material which is susceptible of warping from internal stresses, or when any material external warping-pressures are applied thereto, as when the operator grips the casing very hard.

Disposed within the casing is an electric motor made in accordance with our invention. The motor has a stator member comprising a flat laminated magnetizable core member 3 made up of a plurality of thin iron laminations.

As shown in Fig. 2, the casing-portion 1 is provided with motor-supporting ledges or seats 4 and 4' comprising, in effect, a three-point support for the stator-core 3 of the motor. Thus, in the particular form illustrated, the right-hand seat or bedding-surface 4 for the motor is of a restricted area which may be as small as desired, in order to approximate the effect of a single-point support, whereas the left-hand seat or bedding-surface 4' is of an area having a considerable longitudinal extent in the direction of the long axis of the motor, or the left-hand seat 4' may have any other configuration which approximates, as closely as may be desired a two-point support or two longitudinally separated supporting-points for the motor-core 3.

As shown more in detail in Fig. 4, the magnetizable core member 3 comprises a cross-arm 5, and two end-portions 6 at approximately right angles thereto, each end-portion terminating in a pole-face member 7, thus providing a bipolar field-construction.

As shown in Figs. 10 and 11, the cross-arm 5 of the magnetizable core member is embraced by a two-part insulating spool made up of the two parts 8 and 9 for ready assembly. The spool 8—9, when assembled, comprises a hollow insulating core 11 surrounding the cross-arm 5, and a plurality of insulating flanges 12 extending out from the core 11.

The magnetizable core member 3 of the motor is energized by a coil 13 (Fig. 1) which is wound upon the insulating spool 8—9. In the particular form of embodiment shown in the drawing, the spool 8—9, has three flanges 12, so that the coil 13 is wound in two halves or parts, the two parts operating together to constitute, in effect, a single coil, so far as the magnetization of the magnetizable core member is concerned.

In accordance with our invention, the assembled insulating spool 8—9 is preferably tightened on the cross-arm 5 by two wedges 15 and 16, one on each side of the magnetizable core member 4, as shown in Fig. 11, one of the wedges 16 being also visible in Fig. 3. Preferably, these wedges extend across and break between the two parts 8 and 9 of the insulating spool.

As shown in Fig. 3, the stator member of our motor is completed by means of two cross-pieces 17 and 18 joining the two pole-face members 7 across the opposite sides thereof. At least one of these cross-pieces 17 and 18, and preferably both of them, are made of insulating material. As shown in Fig. 13, each cross-piece 17 or 18 is provided with a perforation 19 in which is located a bearing member 20, the two bearing members, on opposite sides of the stator member, being accurately aligned to journal a shaft 21 which carries a bipolar rotor member 22 made of laminated material similar to the magnetizable stator core 4, but preferably comprising thinner laminations than the stator core, in order to obtain minimum losses due to eddy currents.

Preferably, also, all laminations, both stator and rotor, are annealed in order to reduce magnetic retentivity and hysteresis effects, thereby reducing a tendency for the motor to lock-in at synchronous speed.

Both ends of the shaft 21 project out beyond the stator member of the motor. As shown in Fig. 3, one shaft-end is provided with an eccentric 23, and beyond that, a knurled knob 24, which is accessible through a slit 25 in the bottom of the casing 1, so that the motor may be started by a flip of the forefinger. The eccentric 23 is engaged by a forked reciprocating member 26 which is pivoted at 27 in the casing 1 for actuating a shaver cutter 28 or other tool.

The other shaft-end, as shown in Fig. 1, is provided with a cam 29, which is embraced by a pair of resilient contact-arms 31 of our improved electrical contact mechanism. The two contact-arms extend longitudinally of the motor and casing, and terminate, at their ends which are furthest removed from the coil 13, in two contact-tips 33 which are normally in contact with each other. The intermediate portions of the two contact-arms 31 are faced with cam-engaging stiffening-members or cam-followers 35 which are substantially parallel to each other, and which are periodically pushed apart by the raised portions 37 of the cam 29, during the rotation of the shaft.

It is essential that the two cam-engaging members 35 shall maintain accurately aligned cam-engaging surfaces which do not warp due to variations in humidity and which will insulate the contact-arms 31 from the cam 29. They must maintain a low value of friction and a low rate of wear during a reasonable life of the device. After considerable experimentation we have found that a suitable material for these cam-engaging members 35 is a grease-impregnated molded phenolic insulating plate incorporating powdered mica and having a high resin-content. The plates are ground on both sides to hold the thickness within close limits. These insulating members 35 for engaging the cam 29 are secured to the intermediate portions of the resilient contact-arms 31 and aid in preventing flexure of the arms at these intermediate portions.

The other ends of the resilient contact-arms 31 are secured, in permanent alignment, at supporting-points 38, to supporting members 39 disposed outside of the pair of resilient contact-arms 31, as shown in Fig. 1. Each supporting member 39 comprises a main arm-portion 41, one end of which terminates in a fixed supporting-portion 42 which may be a bent end of the arm-portion 41, the same being secured to the insulating cross-piece 18, as by means of headed fastening means, such as rivets 43 (Fig. 1) ex-

tending through the fixed supporting-portion 42 and also through said insulating cross-piece 18. The arm-portion 41 of each supporting member 39 terminates in a free end-portion which is connected, at the supporting points 38, to the end of its associated contact-arm 31.

The supporting members 39 are made of relatively heavy-gauge material, preferably having a slightly bent surface or even a pronounced channel section, which is stiffly bendable for adjustment-purposes. It is quite desirable to be able to make two different adjustments of the contact mechanism. One adjustment is for the purpose of securing a substantial parallelism between the two cam-engaging portions 35, or to adjust the relative angle between these cam-engaging portions, so as to adjust the timing of the points on the cam 29, where the contact-tips 33 are pushed apart or brought together again. This adjustment is accomplished by adjusting the supporting points 38 toward and away from each other, or toward and away from the plane of the shaft 21, by bending the supporting members 39 at a point at, or close to, the supporting-portions 42 thereof.

A second adjustment which is needed, on the contact mechanism, is an adjustment of the spring-pressure with which the cam-engaging portions 35 are pressed toward each other. This adjustment is made by bending the free ends 38 of the supporting-members 39, so that these ends extend at an angle to the main arm-portions 41 thereof. This bend puts the spring material of the contact-arms 31 under deformation and causes the main arm-portions 41 of the supporting members to be disposed at a slight angle with respect to the main portions of the resilient contact-arms 31, respectively.

It will thus be seen that the resilient contact-arms 31 are flexible at points close to their supporting-points 38, or between said supporting points and the intermediate cam-engaging portions 35. The resilient portions of the contact-arms 31, besides performing the necessary function of pressing the contact arms toward the cam 29, also effectively reduce the transmission of the vibration and noise produced by the engagement of the contacts 33.

It is desirable that the resilient contact-arms 31 be braced against flexure at their other ends, that is, between the intermediate cam-engaging portions 35 and the contact-tips 33. Without some sort of bracing, the spring would flex between the cam and the contact-point, and would produce a gradual change of contact-pressure between the contact-points 33, instead of the sharp make and break required for high-speed operation. In accordance with our invention, we brace the resilient contact-arms 31 by means of light-weight channeled braces 45, as shown in Figs. 1, 8 and 9. The channeled cross-section of these braces stiffens them without requiring an excessive mass, thus keeping the moving parts extremely light, which is an advantage in permitting the use of relatively low spring-pressures.

The exact contour of the cam 29 is important, and on this account, we have shown an enlarged view of the cam-surface in Fig. 5 of the drawing. By careful design of the cam-contour, it is possible to provide a controlled acceleration of the contact-tips 33, and to reduce the impact-noise of the contacts to a minimum, while, at the same time, minimizing the amount of shift in timing which is caused by wear of the cam-followers 35.

The cam 29 is of a modified elliptical shape comprising two substantially diametrically opposite raised portions 37 corresponding to the major axis 47 of the cam. The cam has a minor axis 48 at right angles to the major axis 47. In the regions of the major and minor axes of the modified elliptical surface of the cam 29, the cam-surfaces are substantially cylindrical surface-portions. Intermediate surface-portions 51 of the cam have an approximately constant rate of increment or decrement of the radial height or lift of the cam, per circumferential degree, said constant rate being the maximum rate of increment or decrement obtained anywhere on the cam-surface. These constant-rate intermediate portions 51 extend over a material part of the cam-surface, including portions both before and after each make-point or break-point where contact is made or broken between the cam and the contact-arms 31. At the make-points 52, where the cam first makes contact with the cam-followers 35, the electrical contacts 33 are broken, and at the break-points 53, where the cam-surface breaks away from the cam-followers 35, the electrical contacts 33 come together so that the electrical contact is made. In addition to the foregoing portions, the cam 29 also has transitional surface-portions 54 making a smooth-curve juncture between said cylindrical and intermediate surface-portions.

The result of the above-described cam-structure is that the cam 29 has predetermined rates of increment and decrement of the radial height or lift thereof, per circumferential degree, in the vicinity 51 where the cam makes and breaks contact with the contact-arms 31 at 52 and 53, respectively. These predetermined rates of increment and decrement in the lift of the cam are sufficiently low to avoid excessive impact-noise when the electrical contact-tips 33 come together and when the cam 29 strikes against the cam-followers 35. Said predetermined rates of increment or decrement in the lift of the cam are also sufficiently low to avoid excessive jumping or chattering, and yet these rates are sufficiently high so that a reasonable wear of the contact-surfaces of the cam-followers 35 does not produce a material shift in the circumferential phase or angle of the make-point or break-point.

In the particular design illustrated on the drawing, the electrical contacts 33 are made 47° after the rotor-poles have moved past their position of alignment with the stator poles, and the electrical contacts are broken 21° before said alignment, as indicated by the position of the rotor center-line 55 in Fig. 5, although it will be understood that we are not limited to these precise relationships. Also, in the particular design illustrated, the eccentric 23 of the reciprocating mechanism is in its intermediate position when the minor axis 48 of the cam is presented to the cam-followers 35, although here again we are not limited to this precise construction.

Our entire contact assembly, including the contact-arms 31 and their respective supporting members 39, are made altogether of the same metal, with the exception of the contact-tips 33 and the cam-followers 35. The differences in resiliency and stiffness are obtained by utilizing lighter-gauge material for the resilient contact-arms 31 and heavier-gauge material for the supporting members 39, either with or without some channeling. In this way, we avoid bimetallic effects which might otherwise be caused by heating and cooling. We prefer to use cadmium-plated steel for these parts.

The spring contact-arms 31 and the spring-braces 45, as illustrated in detail in Figs. 7 and 9, are provided with reduced-width portions 57 and 58 where these parts come closest to the shaft, referring to a reduction in width as measured in a direction parallel to the direction of the shaft. This reduction in width greatly increases the electrical creepage-distance to ground or to the metal frame-portions including the shaft 21 and the cam 29.

It will be observed that our electrical contact mechanism maintains, at all times, an accurate alignment of the contact-tips 33, precluding all possibility of these tips getting out of accurate alignment with each other, while providing for very accurate adjustment of both the timing (or parallelism of the cam-followers 39), and the spring contact-pressure (or bending of the supporting points 38 of the spring contact-arms 31). The contact mechanism, furthermore, requires no pivots which will cause friction-wear and eventually misalignment of the points or contact-tips 33.

According to one form of embodiment of our invention, as shown in Figs. 1 and 3, the danger of electrical leakage or a short-circuit between the contact mechanism and the ground or frame of the motor is further reduced by the provision of a thin flexible insulating guard or barrier 59, disposed between the insulating cross-piece 18 and the pole-face members 7. In the illustrated form of our invention, this insulating guard 59 has an extending portion 61, as shown in Figs. 1 and 3, disposed between the rotor member 22 and the contact-ends of the contact-arms 31. This insulating guard or barrier 59 is made of thin flexible sheet-insulating material, and, in the embodiment shown in the drawing, the heads of the rivets 43 (Fig. 1) cause said guard to assume a bowed or concave shape, thereby increasing the rigidity of the extending portions 61.

A detail of the bearing-construction is illustrated in Figs. 12 and 13, from which it will be seen that the outside cylindrical surface 63 of each bearing member 20 is knurled, as indicated in Fig. 12. As shown in Fig. 13, this knurled surface is pressed tightly into the perforation 19 in the bearing-supporting cross-piece 17 or 18, as the case may be, thus restraining the bearing member against rotary movement in said perforation. In order to restrain the bearing member against axial movement or displacement, the end of the bearing member is spun over, as indicated at 64, so that the bearing member is accurately held in place by a shoulder 65, at one end, and the spun portion 64, at the other end.

The particular type of bearing-construction just described was developed to make it possible to utilize a line-reaming operation for accurately adjusting and aligning the bores of the two bearing members 20 on the opposite sides of the frame-member of the motor, as this operation requires that the bearing members shall be very accurately held and restrained against both rotary and axial movement, during the process. This accurate reaming-operation is very desirable, in order to keep the bearing-clearance, between the bearing members 20 and the shaft 21, as low as possible without setting up appreciable bearing friction. If the bearing-clearance were large, the eccentric drive 23—26 would make the shaft rattle excessively, and the motor would be quite noisy. If the bearing clearance were large, the resulting shaft-movement would also reduce the travel of the eccentric 23 and might also interfere with the proper relation between the cam 29 and the spring contact-arms 31.

The electrical connections for our motor are such that the spring contact-mechanism, including the contact-tips 33 and the spring contact-arms 31, are connected in series-circuit relation to the coil 13. In the particular embodiment of our invention shown in the drawing, the contact mechanism is connected between the two halves of the coil 13, the connection being completed by means of leads or electrical connectors 66 connected to the supporting points 38 of the contact-arms 31. While this intermediate connection of the contact mechanism is not essential, it has advantages in reducing the voltage existing between the contact mechanism and the ground or frame of the motor. Sparking at the contact-tips 33 is reduced by the use of a capacitor 67 (Fig. 3) which is connected between the two supporting points 38 of the contact-arms 31.

Our motor is particularly designed for electric shavers. It operates on either alternating or direct current, and when operating on alternating current, its speed of operation has nothing to do with the frequency of the alternations, or what is commonly understood as the synchronous speed of a two-pole motor. Thus, on a 60-cycle system, the maximum synchronous two-pole motor speed is 3600 revolutions per minute, the speed being determined by the timings of the magnetic impulses as determined by the alternations in the current. In our motor, the timings of the magnetic impulses are quite independent of the alternations of the electric current, and are determined solely by the electrical contact-mechanism which, in turn, is automatically adjusted by the speed of the shaft itself. An essential feature of our motor is that it shall operate at a speed much higher than the synchronous 60-cycle speed, as the higher speed not only increases the output obtainable from a motor of such small and definitely limited size, but it also materially reduces the time required for shaving. We obtain speeds as high as 6,500 and 8,000 revolutions per minute, and we set a lower limit of 6,500 revolutions per minute as the lowest speed which will be regarded as acceptable for the motor. It will be obvious that, at such speeds, the precautions which we have taken with the electrical contact-mechanism and with the bearings are very important.

While we have described our invention in a single preferred form of embodiment, it will be obvious that we are not limited to all of the illustrative details of design, and that various modifications and adaptations may be made without departing from the essential spirit of our invention. We desire, therefore, that the appended claims shall be accorded the broadest construction consistent with their language and the prior art.

We claim as our invention:

1. A machine comprising a frame member, a shaft rotatably mounted therein, a cam means on the shaft, and an electrical contact mechanism comprising a pair of resilient contact-arms disposed on opposite sides of said cam means, and a pair of supporting members disposed outside of said pair of resilient contact-arms for respectively supporting the latter, said contact-arms having normally engaged contacts at a first end thereof and having intermediate portions adapted to be periodically engaged by said cam means to periodically separate said contacts during the ro-

tation of said shaft, said cam means having approximately diametrically opposite raised surfaces, each supporting member comprising a main arm-portion, a fixed supporting portion at one end secured to said frame member, and a free end-portion at the other end secured to a second end of its associated contact-arm, said main arm-portion being disposed at a small angle with respect to its associated contact-arm, each supporting member being stiffly bendable, to adjustable angular positions toward and away from its associated contact-arm, at a point at, or close to, said supporting-portion to adjust the position of said free end-portion relatively to the shaft, said free end-portion of each supporting member being stiffly bendable to adjustable angular positions relative to said main arm-portion to adjust the angular inclination of said second end of said associated contact-arm relatively to said shaft and cam means.

2. A machine comprising a frame member, a shaft rotatably mounted therein, a cam means on the shaft, and an electrical contact mechanism comprising a resilient contact-arm disposed in operative relation to said cam means, and a supporting member disposed at the side of said contact-arm opposite to said cam means, said supporting member comprising a main arm-portion, a fixed supporting-portion at one end secured to said frame member, and a free end-portion at the other end secured to one end of said contact-arm, said main arm-portion being disposed at a small angle with respect to said contact-arm, said supporting member being stiffly bendable, to adjustable angular positions toward and away from said contact-arm, at a point at, or close to, said supporting-portion to adjust the position of said free end-portion relatively to the shaft, said free end-portion of said supporting member being stiffly bendable to adjustable angular positions relative to said main arm-portion to adjust the angular inclination of said end of said contact-arm relatively to said shaft and cam means, said contact-arm having a contact portion at its other end and having an intermediate cam-engaging portion.

3. A machine comprising a rotatable shaft, a cam on the shaft, and an electrical contact-mechanism comprising a pair of resiliently pressed contact-arms disposed on opposite sides of said cam, said contact-arms having normally engaged contacts at one end thereof and having intermediate portions adapted to be periodically engaged by said cam to periodically separate said contacts during the rotation of said shaft, said cam having approximately diametrically opposite raised surfaces, the cam-contour being smooth curves having predetermined rates of increment and decrement of the radial height or lift of the cam, per circumferential degree, in the vicinities where the cam makes and breaks contact with the contact-arms, said predetermined rates being sufficiently low to avoid excessive impact-noise and to avoid excessive jumping or chattering, and being sufficiently high so that a reasonable wear of the contacting surfaces does not produce a material shift in the circumferential phase or angle of the make-point or break-point.

4. A machine comprising a rotatable shaft, a cam on the shaft, and an electrical contact-mechanism comprising a pair of resiliently pressed contact-arms disposed on opposite sides of said cam, said contact-arms having normally engaged contacts at one end thereof and having intermediate portions adapted to be periodically engaged by said cam to periodically separate said contacts during the rotation of said shaft, said cam being of a modified elliptical shape characterized by substantially cylindrical surface-portions in the regions of the major and minor axes of the ellipse, intermediate surface-portions having an approximately constant rate of increment or decrement of the radial height or lift of the cam, per circumferential degree, said constant rate being the maximum rate of increment or decrement obtaining anywhere on the cam-surface, said constant-rate intermediate portions extending over a material part of the cam-surface including portions both before and after each make-point or break-point where contact is made or broken between the cam and the contact-arm, and transitional surface-portions making a smooth-curve juncture with said cylindrical and intermediate surface-portions.

5. A machine comprising a frame member, a shaft rotatably mounted therein, a cam means on the shaft, and an electrical contact mechanism comprising a pair of relatively thin-gauge contact-arms disposed on opposite sides of said cam means, and a pair of relatively thick-gauge supporting members disposed outside of said pair of contact-arms for respectively supporting the latter, said contact-arms having normally engaged contacts at a first end thereof and having intermediate portions adapted to be periodically engaged by said cam means to periodically separate said contacts during the rotation of said shaft, said cam means having approximately diametrically opposite raised surfaces, each supporting member comprising a main arm-portion, a fixed supporting-portion at one end secured to said frame member, and a free end-portion at the other end secured to a second end of its associated contact-arm, said main arm-portion being disposed at a small angle with respect to its associated contact-arm, each supporting member being stiffly bendable, to adjustable angular positions toward and away from its associated contact-arm, at a point at, or close to, said supporting-portion to adjust the position of said free end-portion relatively to the shaft, said free end-portion of each supporting member being stiffly bendable to adjustable angular positions relative to said main arm-portion to adjust the angular inclination of said second end of said associated contact-arm relatively to said shaft and cam means, the main portions of each supporting member being of substantially the same metal as the main portions of its associated contact-arm, and the difference in gauges or thickness being sufficient to cause said contact-arm to have resilience at a point between said second end and said intermediate cam-engaging portion.

6. A machine comprising a frame member, a shaft rotatably mounted therein, a cam means on the shaft, and an electrical contact mechanism comprising a relatively thin-gauge contact-arm disposed in operative relation to said cam means, and a relatively thick-gauge supporting member disposed at the side of said contact-arm opposite to said cam means, said supporting member comprising a main arm-portion, a fixed supporting-portion at one end secured to said frame member, and a free end-portion at the other end secured to one end of said contact-arm, said main arm-portion being disposed at a small angle with respect to said contact-arm, said supporting member being stiffly bendable, to adjustable angular positions toward and away from said contact-arm, at a point at, or close to,

said supporting-portion to adjust the position of said free end-portion relatively to the shaft, said free end-portion of said supporting member being stiffly bendable to adjustable angular positions relative to said main arm-portion to adjust the angular inclination of said end of said contact-arm relatively to said shaft and cam means, said contact arm having a contact portion at its other end and having an intermediate cam-engaging portion, the main portions of said supporting member being of substantially the same metal as the main portions of said contact-arm, and the difference in gauges or thickness being sufficient to cause said contact-arm to have resilience at a point between said first-mentioned end and said intermediate cam-engaging portion.

7. A machine comprising a rotatable shaft, a cam on the shaft, and an electrical contact-mechanism comprising a pair of resiliently pressed contact-arms disposed on opposite sides of said cam, said contact-arms having normally engaged contacts at one end thereof and having intermediate portions adapted to be periodically engaged by said cam to periodically separate said contacts during the rotation of said shaft, said intermediate cam-engaging portions being of grease-impregnated insulating material of substantially uniform thickness.

8. The invention as defined in claim 1, characterized by each contact-arm having a lightweight, relatively non-flexible channeled portion between its intermediate cam-engaging portion and its contact end.

9. The invention as defined in claim 2, characterized by said contact-arm having a lightweight, relatively non-flexible channeled portion between its intermediate cam-engaging portion and its contact end.

10. A machine comprising a frame-member, a metal shaft journaled in an insulating-material portion of said frame-member so as to have a shaft-end extending beyond said portion of the frame-member, a cam means on said shaft-end, and an electrical contact mechanism comprising a pair of resilient metal contact-arms disposed on opposite sides of said cam means, and a pair of supporting members disposed outside of said pair of resilient contact-arms for respectively supporting the latter, said contact-arms having normally engaged contacts at a first end thereof and having intermediate portions adapted to be periodically engaged by said cam means to periodically separate said contacts during the rotation of said shaft, said intermediate cam-engaging portion comprising a metal contact-arm portion of reduced width, as measured in a direction parallel to the axis of the shaft, for increasing the electrical creepage-distance to said shaft near its journaled portion, and a reinforcing, substantially non-flexible cam-contacting member of insulating material, said cam means having approximately diametrically opposite raised surfaces, each supporting member comprising a main arm-portion, a fixed supporting-portion at one end secured to said portion of the frame-member, and a free end-portion at the other end secured to a second end of its associated contact-arm, said main arm-portion being disposed at a small angle with respect to its associated contact-arm, each supporting member being stiffly bendable, to adjustable angular positions toward and away from its associated contact-arm, at a point at, or close to, said supporting-portion to adjust the position of said free end-portion relatively to the shaft, said free end-portion of each supporting member being stiffly bendable to adjustable angular positions relative to said main arm-portion to adjust the angular inclination of said second end of said associated contact-arm relatively to said shaft and cam means.

11. A machine comprising a frame-member, a metal shaft journaled in an insulating-material portion of said frame-member so as to have a shaft-end extending beyond said portion of the frame-member, a cam means on said shaft-end, and an electrical contact mechanism comprising a metal contact-arm, means for so mounting said contact-arm, on said portion of the frame-member, that it is resiliently pressed toward said cam means, said contact-arm having a free end carrying an electrical contact portion and having an intermediate portion, near said cam means, of reduced width, as measured in a direction parallel to the axis of the shaft, for increasing the electrical creepage-distance to said shaft near its journaled portion, and a reinforcing substantially non-flexible cam-contacting member of insulating material secured to said intermediate portion.

12. A machine comprising a frame-member, a metal shaft journaled in an insulating-material portion of said frame-member so as to have a shaft-end extending beyond said portion of the frame-member, a cam means on said shaft-end, and an electrical contact mechanism comprising a metal contact-arm, means for so mounting said contact-arm, on said portion of the frame-member, that it is resiliently pressed toward said cam means, said contact-arm having a free end carrying an electrical contact portion and having an intermediate portion near said cam means, and a reinforcing, substantially non-flexible cam-contacting member of substantially uniform-thickness grease-impregnated insulating material secured to said intermediate portion.

13. An electrical apparatus comprising a magnetizable core member comprising a cross arm and two end portions at an angle thereto, a two-part insulating spool mounted on said cross arm and comprising, when assembled, a hollow insulating core surrounding said cross arm, and a plurality of insulating flanges extending out from said hollow core, a winding wound on said spool, and wedge-means for tightening the assembled spool on the cross arm, said wedge-means comprising a member extending across the break in said two-part spool between the hollow core of the spool and a side of the cross-arm.

14. An electric motor comprising a laminated magnetizable core member comprising a cross arm and two end portions at an angle thereto, said end portions including pole-face members, stator-frame cross-pieces joining said pole-face members across opposite sides thereof, at least one of said cross-pieces being of insulating material, a stator coil disposed on the cross arm of the magnetizable core member, a rotor member disposed between said pole face members and having a shaft journaled in said stator-frame cross-pieces, said shaft having a shaft-end extending beyond said insulating cross-piece, a cam means on said shaft-end, an electrical contact mechanism comprising a pair of resilient metal contact-arms disposed on opposite sides of said cam means, and a pair of metal supporting members disposed outside of said pair of resilient contact-arms for respectively supporting the latter, said contact-arms having normally engaged contacts at a first end thereof and having intermediate portions adapted to be periodically engaged by said cam means to periodically separate

said contacts during the rotation of said shaft, said cam means having approximately diametrically opposite raised surfaces, each supporting member comprising a main arm-portion, a fixed supporting-portion at one end, and a free end-portion at the other end secured to a second end of its associated contact-arm, headed fastening-means extending through each of said fixed supporting portions and also through said insulating cross-piece for securing the supporting members to said insulating cross-piece, the main arm-portion of each of said supporting members being disposed at a small angle with respect to its associated contact-arm, each supporting member being stiffly bendable, to adjustable angular positions toward and away from its associated contact-arm, at a point at, or close to, said supporting-portion to adjust the position of said free end-portion relatively to the shaft, said free end-portion of each supporting member being stiffly bendable to adjustable angular positions relative to said main arm-portion to adjust the angular inclination of said second end of said associated contact-arm relatively to said shaft and cam means, and electrical connections for including said contact-arms and their contacts in series-circuit relation to said stator coil.

15. The invention as defined in claim 14, characterized by a thin flexible insulating guard disposed between said insulating cross-piece and said pole-face members, said guard having an extending portion disposed between the rotor member and the contacts of said contact mechanism, the heads on said fastening-means causing said thin flexible insulating guard to assume a bowed shape increasing the rigidity of said extending portion.

16. A small portable electrical tool comprising a thin, two part elongated casing adapted to be held in the hand of the operator, said casing being susceptible of slight warping in response to internally or externally applied forces, an electric motor disposed within said casing, said motor comprising a flat stator frame member built up of thin magnetizable laminations susceptible of a damaging amount of warping if subjected to any material warping forces, one part of said two-part casing having two internal ledges, one on each side of the casing-part, one of said ledges constituting, in effect, a two-point support providing supporting-points which are separated to a material extent in the longitudinal direction of said elongated casing, and the other of said ledges being of only a slight extent in said longitudinal direction, and means for securing said motor within said casing-part so that the edge-portions of one side of the flat stator frame motor are held in engagement with said ledges.

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