Nov. 30, 1954 A. J. WELCH ET AL 2,695,968

COMMUTATOR WITH CONSTANT TENSION SPRING

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Fig. 1

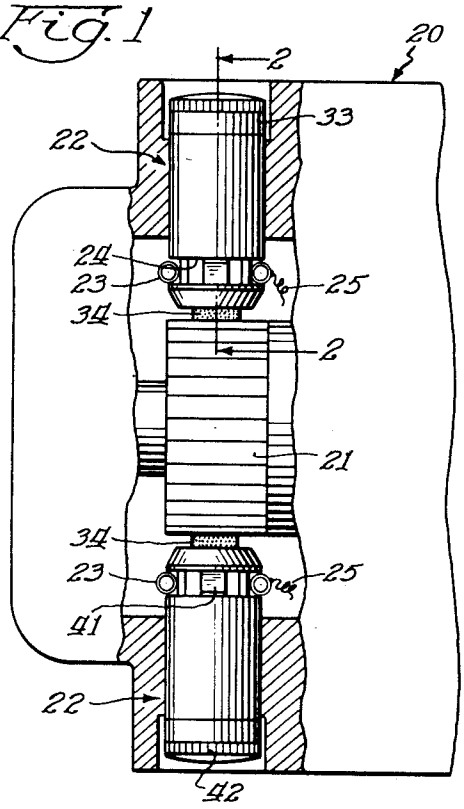


Fig. 2

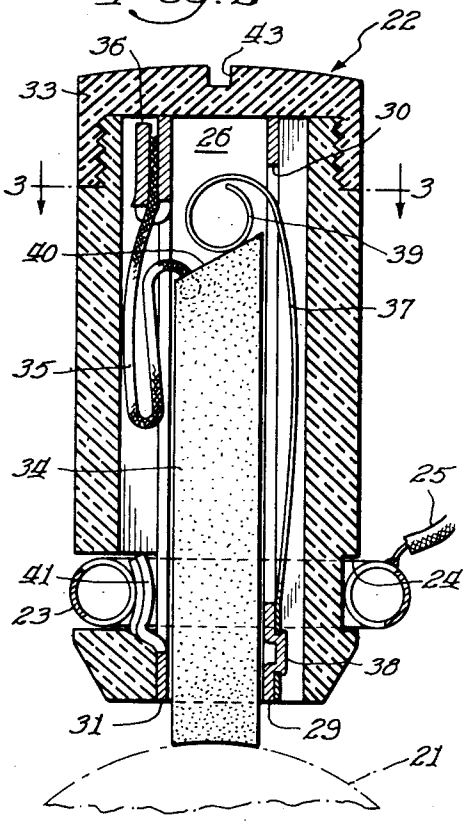


Fig. 4

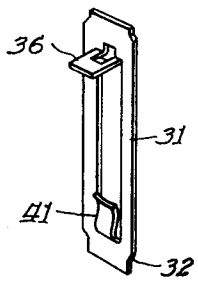


Fig. 5

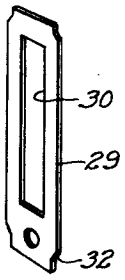
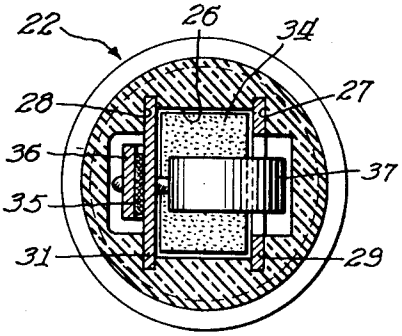


Fig. 3



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Fig. 8

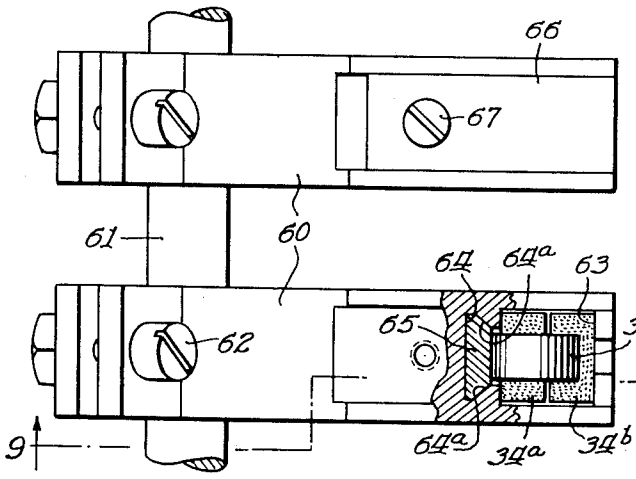


Fig. 11

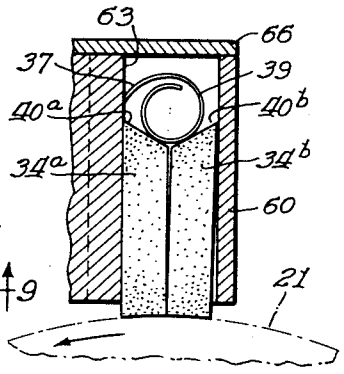


Fig. 9

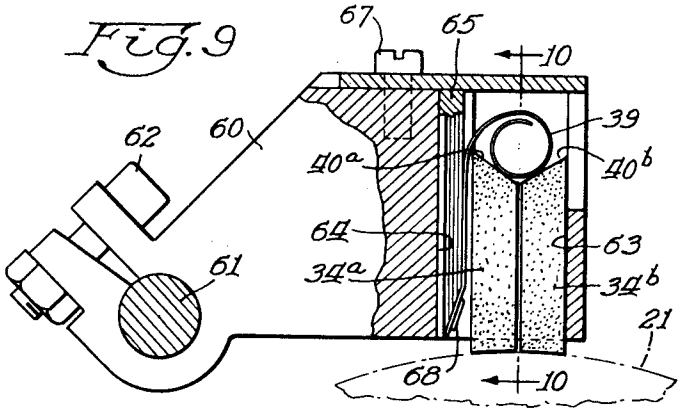


Fig. 10

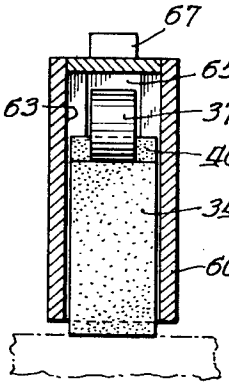


Fig. 6

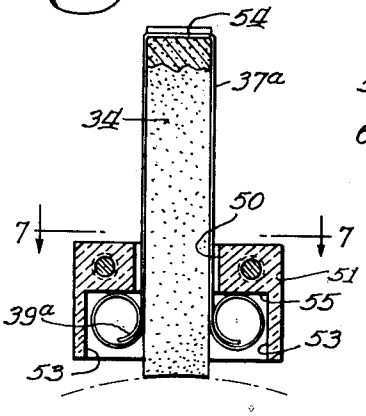
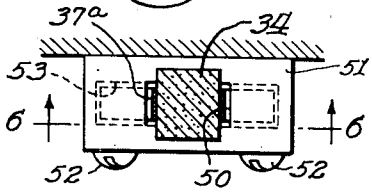


Fig. 7



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COMMUTATOR WITH CONSTANT TENSION SPRING

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Fig. 12

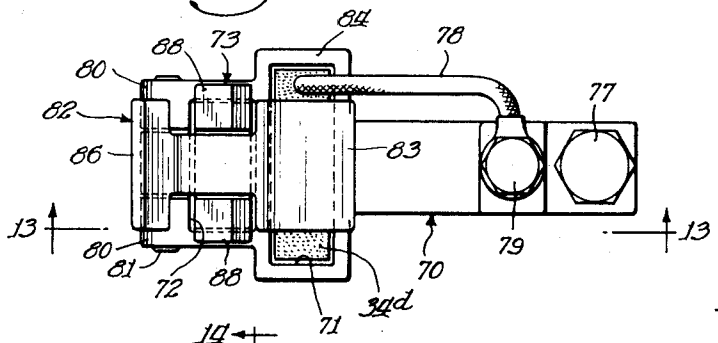


Fig. 13

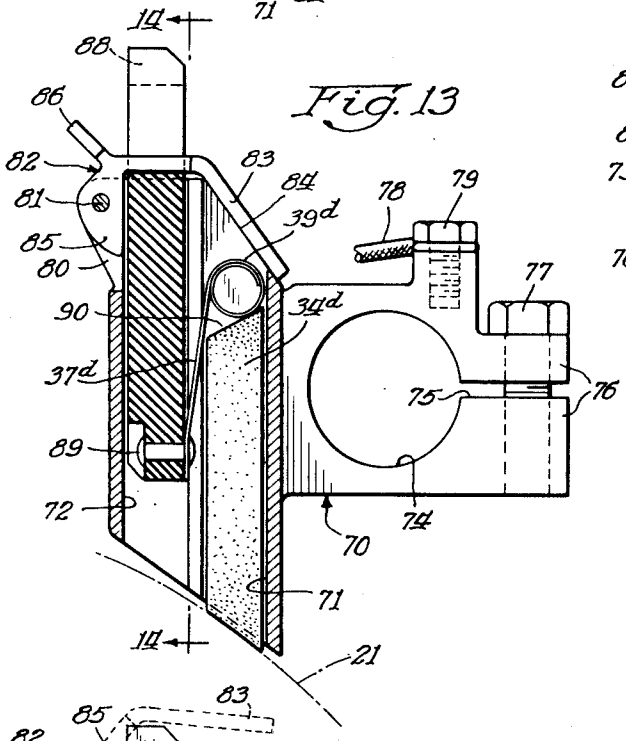


Fig. 14

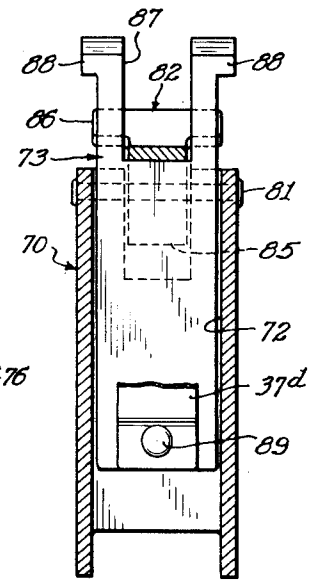
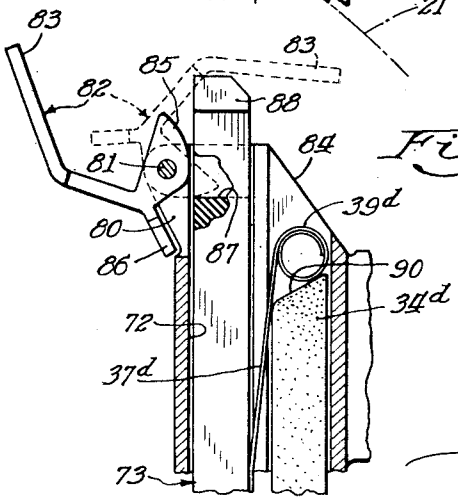


Fig. 15



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COMMUTATOR WITH CONSTANT TENSION SPRING

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Fig. 16

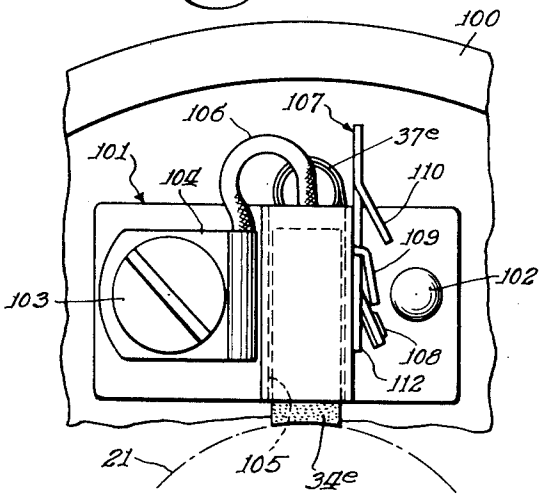


Fig. 17

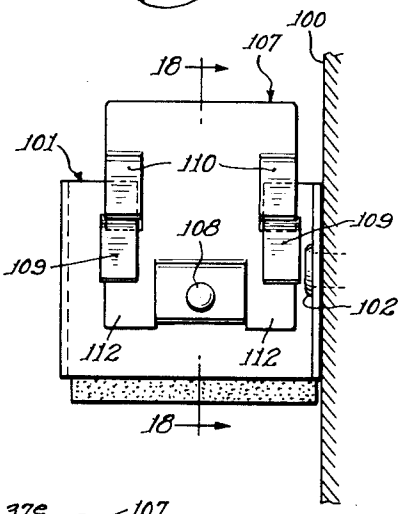


Fig. 18

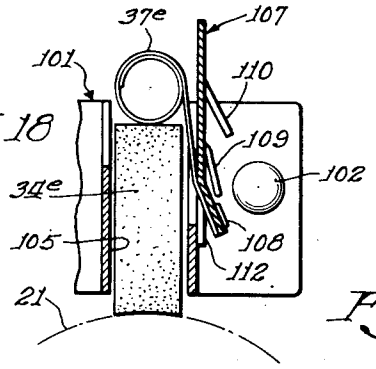


Fig. 19

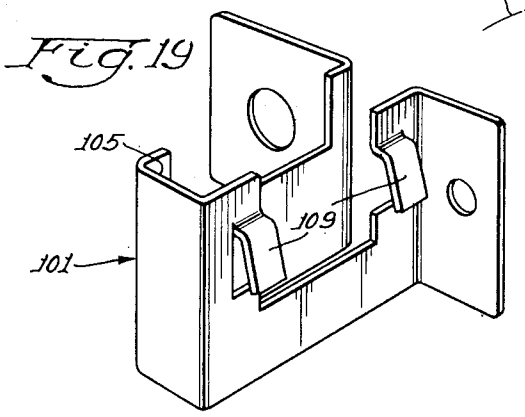
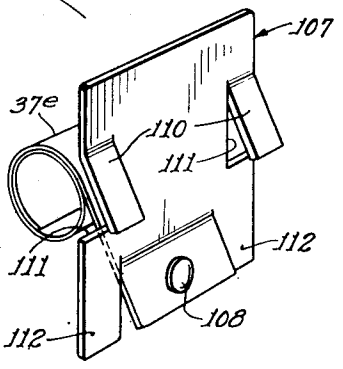


Fig. 20



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United States Patent Office 2,695,968
Patented Nov. 30, 1954

2,695,968

COMMUTATOR WITH CONSTANT TENSION SPRING

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Application November 9, 1950, Serial No. 194,802

3 Claims. (Cl. 310—246)

This invention is directed to commutator brush holders and parts therefor. More specifically, the invention is directed to a commutator brush holder assembly wherein use is made of spring means having substantially constant tension or load characteristics for the actuation of the brush for its full effective length and life.

Heretofore commutator or other electrical brushes have employed various means of mounting wherein there has been exerted on the brush, tension or pressure from an ordinary helical, spiral, leaf or motor type spring. The effectiveness of the brushes, and the wear thereof, is naturally lessened when the brushes are subjected to arcing. This arcing has been inherently present in prior brush constructions due to the tendency of the brush to "bounce" or move away from the commutator upon hitting an irregularity or rough spot thereon. As heretofore mounted and with the springs heretofore used, a rapidly revolving commutator may have a tendency to set up a bouncing action which may be likened to a harmonic, and which may in fact have resulted from the harmonic or periodicity of the brush spring.

The main object of the present invention is to provide a brush holder employing a substantially constant load spring, or which has a substantially zero spring rate. The use of a substantially zero rate spring makes unnecessary the usual practice of adding many coils or a great length of active spring material as is necessary and usually done in the case of existing brush pressure springs of the helical, spiral, leaf or motor spring types.

Another object of the present invention is to provide a brush holder wherein the insulating components may be used to support a brush without the aid of the usual round or rectangular metal formed or drawn tubes employed as the intermediate casing for the brush.

Another object of the present invention is to provide a brush holder in which the insulating material can be used to form the main casing for the brush except that one or more surfaces may be comprised of a metal insert whose function is to provide electrical paths or act as a spring support.

Another object of the invention is to provide a brush holder assembly in which the spring used to urge the brush toward the commutator is in the most intimate possible relationship with the brush and which does not employ the usual intervening levers and devices to convey the spring pressure to the brush. This serves to reduce the masses that must react in order to return the brush to contact with the commutator after it has been disturbed during the usual course of commutation.

By constructing the brush holder in accordance with the principles set forth by the present invention whereby the brush is urged towards the commutator with a substantially constant pressure throughout its effective life, the length of life of the brush is increased considerably.

In brush holders constructed as shown herein, there is a minimum amount of reactive mass which must be moved whenever the brush is depressed away from the commutator or moved towards the commutator. Therefore, it is possible, when the brush is depressed away from the commutator, due to its engaging an irregularity or rough spot thereon, to return the brush into engagement with the commutator in the shortest possible time. A further advantage of a brush holder of the type disclosed herein is that there is a greater sensitivity of reaction when the spring is depressed and this is due to the fact that a minimum amount of reactive mass

is moved when the brush is displaced, as when it hits a rough spot on the commutator.

When a constant tension spring as disclosed herein is used in the brush holder a lower optimum spring pressure is required to achieve satisfactory commutation, and this results from the greater sensitivity of reaction and the shorter reaction time when the constant tension spring is employed.

A feature of the present invention, since the rate of the spring utilized herein is substantially zero, is that the spring lacks the usual vibration characteristics of the conventional brush springs and therefore regular reoccurring disturbances of the brush cannot result in resonance with the vibration period of the spring or its harmonics. This lack of a fundamental vibration frequency in the spring thus eliminates one of the undesirable characteristics of conventional springs which are frequently responsible for undesirable commutation results.

Another feature of the invention is that the spring exerts a snubbing action when the brush is disturbed away from the commutator and this resists such factors which disturb the brush, minimizes the undesirable motion of the brush away from the commutator and aids in restoring it to intimate relationship with the commutator in the shortest possible time. It is a characteristic of the spring employed in the present invention that small increments of movement of the brush change the moment arm of the reactive mass and because of this the maximum or full load of the spring resists movement of the brush away from the commutator, while a somewhat lesser load urges the brush towards the commutator.

Another object of the present invention is to provide a brushholder in which a spring in intimate relationship with the brush can urge the brush toward the commutator and at the same time provide a component of pressure that stabilizes one side of the brush continuously against one side of its casing and thus prevent sidewise chatter of the brush within its containing cavity. This stabilizing effect does not require the use of any auxiliary device and the degree of stability does not change throughout the length and life of the brush.

Due to the fact that intervening levers and devices for conveying spring pressure from the spring to the brush are not necessary, it is possible to provide a very compact arrangement of parts and the reduction in the number of parts required in the brush holders disclosed herein makes a brush arrangement that is more economical to manufacture and cheaper to maintain. The compactness of design of the brush holders also makes it possible to provide greater circumferential spacing between successive brush holders and the possibility of flashovers is minimized considerably. The compactness of design permits smaller motor units and smaller and lighter mountings for the brushes. Because it is not necessary to utilize intervening levers to convey the spring pressure to the brush, a minimum amount of radial space is required for housing the brush and this is particularly important in the construction of hand tools such as drills, the diameters of which are generally determined by the space required to house the brush assembly. In applications where space is not a prime consideration a larger brush may be utilized than would be possible with conventional brush holder constructions. This becomes important in applications wherein the brush itself is required to last throughout the life of the motor.

Another important feature of the present invention is that the spring itself does not contact the commutator when the brush has completely worn out and this eliminates a frequent source of damage to the commutator.

By the present invention the spring can be divorced economically electrically from the electric current.

The intimacy of contact between the spring and the brush, the small mass required to react, the short reaction time, the snubbing action, and the absence of fundamental frequencies in the arrangements disclosed by this invention all act to retain greater intimacy of contact between the brush and commutator with subsequent less brush wear and better commutation.

Other objects, advantages and uses of the invention will become apparent from the following detailed de-

scription when read in conjunction with the accompanying drawings wherein:

Fig. 1 is a fragmentary view showing in cross-section a commutator for a generator, electric motor or the like having the brush assembly mounted thereon;

Fig. 2 is a longitudinal cross-sectional view showing the detailed arrangement of a preferred form of commutator brush assembly, incorporating the present invention;

Fig. 3 is a cross-sectional view taken substantially on the line 3—3 of Fig. 2 looking in the direction of the arrows;

Fig. 4 is a view showing the shunt support or contact plate for the present construction;

Fig. 5 is a view showing the spring support plate;

Fig. 6 is a vertical cross-sectional view through a modified form of a commutator brush assembly, the view being on line 6—6 of Fig. 7 looking in the direction of the arrows;

Fig. 7 is a cross-sectional view taken on the line 7—7 of Fig. 6 looking in the direction of the arrows;

Fig. 8 is a plan view, partly broken away, of a commutator brush holder assembly mounting, incorporating still another modification of applicant's invention wherein a split brush assembly is shown;

Fig. 9 is a vertical view partly in cross-section, taken on the line 9—9 of Fig. 8 looking in the direction of the arrows, the commutator being shown schematically in dotted lines;

Fig. 10 is a cross-sectional view taken on the line 10—10 of the Fig. 9 looking in the direction of the arrows;

Fig. 11 is another cross-sectional view showing the mounting of the type disclosed in Fig. 9;

Fig. 12 is a plan view of another embodiment of the invention;

Fig. 13 is a side elevational view, shown partly in section, of the embodiment of the invention disclosed in Fig. 12;

Fig. 14 is a sectional view taken substantially along the line 14—14 of Fig. 13;

Fig. 15 is a fragmentary side elevational view, showing the spring and insulator retaining latch in open position;

Fig. 16 is a front view of another embodiment of the invention;

Fig. 17 is a side view of the embodiment of the invention disclosed in Fig. 16;

Fig. 18 is a sectional view taken substantially along the line 18—18 of Fig. 17;

Fig. 19 is a detail view of the casing employed in the embodiment of the invention disclosed in Fig. 16; and

Fig. 20 is a detail view of the spring mounting plate employed in the embodiment disclosed in Fig. 16.

Referring now to the drawings, wherein like reference numerals designate like parts in the different figures, and referring first to the embodiment of the invention shown in Fig. 1, an electrical motor or electrical generator 20 having a commutator 21 of standard construction and form is shown. The motor 20 has a pair of carbon brush holder assemblies 22 mounted in its housing and the assemblies 22 comprise one form of the invention disclosed herein. It will be noted that the carbon brush holder assembly 22 is of the "cartridge" type, which may be readily removed for servicing and replacement, and which may be mounted in the motor housing by any convenient means, such as, for example, a set screw (not shown) or the like.

The cartridge 22 may be made of any desired metal or, in its preferred form, it may be made of a plastic having electrical insulation properties. A garter spring 23 is seated in a peripheral groove 24 in each of the cartridges and constitutes the electrical connection to a lead wire 25.

The cartridge 22 is provided with a cavity 26 extending therethrough and has a pair of slots 27 and 28 in communication with the cavity. Mounted within the slot 27 is a spring support 29 which is provided with an elongated aperture 30. Mounted in the slot 28 is a contact plate or shunt support 31. The slots 27 and 28 do not extend completely through the cartridge 22, but rather have a configuration for seating shoulders 32 on the spring support 29 and shunt support 31. A cap 33 having an internal threaded portion for engaging an external threaded portion at the upper end of the cartridge 22 (as shown in Fig. 2) retains the supports 29 and 31 rigid in the slots 27 and 28. A rectangular brush 34 which may be made of any suitable material is slidable longitudinally within the cavity 26 and engages the commutator 21. A shunt 35 is electrically connected to one end of the carbon brush 34 and is also connected to the shunt support 31 by means of a lug 36 on the shunt support which lug may be bent over as shown in Fig. 2 to afford an electrical connection between the shunt 35 and the shunt support 31.

The spring support 29 has a spring 37 secured thereto at 38. The spring 37 may be secured to the spring support 29 by means of a rivet, welding or any other convenient means. The spring 37 comprises any suitable type of resilient material, preferably spring steel, and is deformed such that each increment of its length has substantially the same radius of curvature as every other increment thereof. It is clear that when the spring 37 is allowed to relax it will form a plurality of relaxed convolutions, one of which is shown at 39. Each convolution 39 will be tightly engaged with the next inner and the next outer convolution due to the fact that the entire length of the spring 37 is deformed to a substantially constant radius of curvature. The outer convolution 39 is maintained in constant tangential and sliding engagement with a beveled surface 40 on the brush 34. Because of the beveled surface 40, the spring 37 continuously exerts a component of force urging the brush 34 to the right, thereby stabilizing the brush within the cavity 26.

It will be noted that the spring 37 is secured to the spring support 29 on the side thereof opposite the brush 34 and the elongated aperture 30 permits the spring to protrude through the support 29 whereby it can engage the brush 34. The spring 37, since each increment of its length is deformed with substantially a constant radius of curvature, is what may be termed "a constant load spring" or "a constant tension spring." Because the spring 37 is a constant tension spring, it exerts a substantially constant force on the brush 34 at all times irrespective of the length of the brush 34 extending into the cavity 26. Because of this propensity of the spring 37 it lends itself particularly well to the present application as it is desirable to have the commutator brush 34 engage the commutator 21 with the same force no matter whether the brush is new or nearly worn out. When the brush extends into the cavity 26 to the depth shown in Fig. 2, a substantial portion of the spring 37 is unwound to almost a straightened condition. The portion of the spring 37 which is thus straightened is ineffective to exert any force on the brush 34 in a direction which would move the brush 34 towards the commutator 21. Likewise the convolution 39 which is relaxed also does not exert any force on the brush 34. It is therefore only that length of the spring 37 between the relaxed convolutions 39 and the straightened portion which urges the brush 34 downwardly. It will be seen that this length of spring 37 between the relaxed convolution or convolutions and the straightened portion is substantially the same no matter how much the brush 34 is worn. Since a substantially equal length of the spring 37 urges the brush 34 towards the commutator 21 at any one time, the force of engagement between the brush 34 and the commutator 21 is substantially constant.

As seen in Fig. 2, the brush 34 is engaged with the commutator 21 and is urged towards the commutator by the portion of the spring 37 between the relaxed convolutions and the substantially straight portion of the spring. This portion of the spring 37 acts on the brush 34 through a moment arm that extends from the center of the convolution 39 to this portion of the spring. It is apparent that this moment arm is considerably longer than the radius of the convolution 39. When a rough spot on the commutator 21 strikes the brush 34, the brush is displaced away from the commutator and due to the natural tendency of the spring to resist uncoiling the moment arm between the center of the relaxed convolution 39 and the portion of the spring between the convolution 39 and the straightened portion becomes somewhat shorter, with the straightened portion of the spring more nearly approaching a tangent to the relaxed convolution 39. Because of this shorter moment arm, when the brush 34 is displaced slightly from the commutator 21 a somewhat greater load, constituting substantially the full load of the spring, is applied to the brush 34 to resist displacement thereof. It is thus ap-

parent that the spring **37** exerts a snubbing action such that the shorter moment arm of the spring causes substantially the full load thereof to resist movement of the brush away from the commutator while the slightly longer moment arm causes somewhat less than the full load of the spring to urge the brush towards the commutator when it is engaged therewith.

The peripheral groove **24** within which the garter spring **23** is positioned is deeper on one side of the cartridge **22** and actually communicates with the slot **28**. The shunt support **31** has a bent over portion **41** which extends into the peripheral groove **24** thereby insuring electrical contact between the garter spring **23** and the shunt support **31**.

The cap **33** has a knurled peripheral surface **42** for facilitating the manual placement of the cap on the cartridge **22**. The cap **33** may also be provided with a transverse slot **43** for facilitating the placement of the cap on the cartridge by means of a screw driver.

Figs. 6 and 7 show a second embodiment of the present invention which differs from the Fig. 2 embodiment only slightly. In this embodiment of the invention the carbon brush **34** extends completely through a slot **50** in a casing **51** but still is designed to engage the commutator **21**. The casing **51** may be bolted to the motor housing by means of bolts **52**. The casing **51** is provided with cavities **53** which communicate with the slot **50** and which are located on opposite sides of the slot **50**. The spring **37***a* in this embodiment is made of the same material as the spring **37** disclosed in Fig. 2 but is deformed substantially midway between its ends to form a U-shaped portion **54** for receiving the upper end of the brush **34** (as viewed in Fig. 6). The relaxed convolutions **39***a* of the spring **37***a* are housed within the cavities **53** and tangentially and slidably engage walls **55** in the casing **51**. The spring **37***a* is deformed in the same manner as the spring **37** so that no matter how far the brush **34** extends into the slot **50** a substantially constant force is applied thereto tending to hold it engaged with the commutator **21**.

The spring **37***a* shown in Fig. 6 tends to hold the brush **34** somewhat more rigidly than the spring **37** by reason of the fact that two reaction points for the spring rather than only one are provided. The spring **37***a* exerts a snubbing action just as the spring **37** of the first embodiment.

A third embodiment of the invention is disclosed in Figs. 8, 9, 10 and 11 of the drawings. In this embodiment of the invention a pair of casings **60**, which are substantially identical are provided. Each of the casings **60** is mounted on a shaft **61** and held rigidly thereon by means of bolts **62**. The casings **60** are provided with suitable slots **63** for receiving a split brush having two sections **34***a* and **34***b*. A cavity **64** is also provided in the casing **60** for receiving a spring support **65**. The spring support **65** may be held rigidly in the cavity **64** by any convenient means and, as shown in Fig. 8, is held against lateral displacement by the wedging surfaces **64***a*. A cover plate **66** is provided for each of the casings **60** and is held in place thereon by means of a bolt **67**.

Each of the brush sections **34***a* and **34***b* has a beveled surface **40***a* and **40***b* respectively which enable the spring **37** to stabilize one of the sections against one side of the cavity formed in the casing **60** and the other section against the other side of the cavity. It will be noted from Figs. 9 and 11 that the beveled surfaces **40***a* and **40***b* together form an obtuse angle. The spring **37** is secured to the spring support **65** by any suitable means such as a rivet **68** and its relaxed convolutions **39** are seated within the groove formed by the beveled surfaces **40***a* and **40***b* in order to tangentially and slidably engage each of the brush sections **34***a* and **34***b*. The spring **37** in the embodiment of the invention shown in Figs. 9 and 11 functions in substantially the same manner as the spring **37** shown in the Fig. 2 embodiment and exerts a substantially constant force and a snubbing action on each of the brush sections **34***a* and **34***b*. The forces exerted on each of the brush sections **34***a* and **34***b* are also approximately equal so that each of the sections wears at approximately the same rate.

A fourth embodiment of the invention is disclosed in Figs. 12–15. In this embodiment a casing **70** is provided with a slot **71** for receiving a brush **34***d* and with a slot **72**, which communicates with the slot **71**, for receiving a spring mounting insulator **73**. The casing **70** is formed with a cylindrical aperture **74**, for receiving a mounting shaft (not shown) and is slotted as at **75**. A pair of arms **76** on either side of the slot **75** are slightly resilient and a bolt **77** threaded into suitable internal threaded apertures in the arms **76** may be used for rigidly connecting the brush holder to the mounting shaft seated within the cylindrical aperture **74**.

The casing **70** is formed of any electrical conducting material, preferably brass, and a shunt **78** connected to the brush **34***d*, as shown in Fig. 12, is also electrically connected to the casing **70** by means of a bolt **79**.

The casing **70** is provided with a pair of ears **80** and a shaft **81** extends through the ears **80** to pivotally mount a latch **82**. The latch **82** is provided with an arm **83** that is designed to engage a beveled surface **84** formed on the casing **70**. The latch **82** also has an arm **85** and an operating arm **86**.

The portion of the latch **82** which connects the arm **83** with the remainder of the latch is narrower than a U-shaped notch **87** formed in the insulator **73**. Consequently the insulator **73** is reciprocable with the narrow portion of the latch positioned within the notch **87**. The insulator **73** is provided with a pair of outwardly extending projections **88** which engage the casing **70** to limit its downward movement in the slot **72**. The insulator **73** has a substantially constant tension spring **37***d*, riveted thereto by means of a rivet **89**. The spring **37***d* is the same type of a spring as the spring **37** disclosed in Fig. 2 and a plurality of relaxed convolutions **39***d* tangentially engage a beveled surface **90** on the brush **34***d*.

When the brush **34***d* and insulator **73** are being assembled in the casing **70** the latch **82** is moved to the position shown in Fig. 15. The insulator **73** is pushed into the slot **72** with the convolutions **39***d* tangentially engaging the beveled surface **90** on the brush **34***d* until the base of the latch **87** is deep enough to permit the arm **85** to pass therethrough, as shown in Fig. 15, until the arm **83** engages the beveled surface **84** of the brush holder. The spring **37***d* urges the brush **34***d* against the usual commutator **21** and urges the insulator **73** upwardly, as viewed in Fig. 13. When the latch **82** is in the position shown in Fig. 13 the spring **37** is effective to hold the insulator **73** upwardly against the latch **82** and to hold the brush **34***d* against the commutator **21**. The insulator **73** engages the face of the arm **85** and thereby retains the latch **82** in the position shown in Fig. 13. When the latch **82** is retained in this position it prevents the insulator **73** from being forced upwardly out of the notch **72** due to the force of the spring **37***d*.

By this embodiment of the invention the constant tension spring **37***d* itself is effective to retain the movable parts of the brush holder in assembled relation and therefore a very simple and easily maintainable brush holder is provided. The spring **37***d* exerts a snubbing action on the brush **34***d* and the beveled surface **90** enables the spring **37***d* to stabilize the brush **34***d* in the slot **71**. The brush holder disclosed in this embodiment of the invention is particularly applicable to large machines.

Another embodiment of the present invention is disclosed by Figs. 16–20 and this embodiment is particularly suitable for use with small electrical generators and the like. With particular reference to Fig. 16, a mounting plate **100** for mounting a plurality of brush holder assemblies is provided. A casing **101** is formed as shown in detail in Fig. 19 and is provided with a pair of apertures for receiving rivet **102** that secures the casing to the mounting plate **100** and for receiving a bolt **103** that secures a shunt connector **104** to the casing **101**. The casing **101** is formed so as to provide a cavity **105** for receiving a brush **34***e*. A shunt **106** connects the brush **34***e* with the shunt connector **104**.

A spring mounting plate **107** has a constant tension or constant load spring **37***e* secured thereto by means of a rivet **108** and when the mounting plate is assembled with the casing **101** the spring **37***e* tangentially engages the brush **34***e* to continuously urge it into engagement with the commutator **21**. The casing **101** is cut out to provide a pair of outwardly protruding lugs **109** and the spring mounting plate **107** is provided with a pair of outwardly protruding lugs **110**. The portion of the mounting plate **107** which is cut out to

provide the lugs **110** provides suitable notches **111** for receiving the lugs **109** on the casing **101**.

In assembling the brush holder disclosed in Figs. 16–20 the brush **34***e* is inserted within the cavity **105**. The spring mounting plate, having the spring **37***e* secured thereto is then placed adjacent the casing **101** with the spring **37***e* in engagement with the brush **34***e*. As viewed in Fig. 16 the mounting plate **107** is moved downwardly until the portions **112** thereof slip past the lugs **109**. The mounting plate then snaps into engagement with the casing **101** and the spring **37***e* urges the mounting plate **107** upwardly whereby the lugs **109** are positioned within the notches **111** and grasp the portions **112** of the mounting plate **107** to retain it in latched engagement with the casing **101**. In this embodiment of the invention the spring **37***e* is effective to retain the casing and spring mounting plate engaged and to simultaneously maintain the brush **34***e* in engagement with the commutator **21**, and further the spring exerts a snubbing action on the brush as in all the other embodiments.

By the present invention there is provided a brush holder for electric motors or generators which is very efficient in its operation. Because of the fact that the spring at all times exerts a substantially constant force on the brushes the normal harmonic bouncing of the brushes due to the irregularities in the surface of the commutators is substantially eliminated. Also because of the constant force applied by the spring throughout the life of the brushes, their rate of wear is uniform.

It is contemplated that numerous changes and modifications may be made in the present invention without departing from the spirit or scope thereof.

We claim:

1. In an article of manufacture, a cartridge having an opening therethrough, a contact plate secured within said opening, a support secured within said opening, a commutator brush slidable within said opening, a shunt electrically connecting said brush and said contact plate, a spring fastened at one end to said support and engaged with said brush for biasing said brush towards the other end of said opening, said cartridge having a peripheral groove, a portion of said contact plate protruding into said groove, and a garter spring in said groove engaging the protruding portion of said contact plate.

2. In an article of manufacture, a cartridge having an opening therethrough, a contact plate secured within said opening, a support secured within said opening, a commutator brush slidable within said opening, a shunt electrically connecting said brush and said contact plate, a spring engaged with said brush and fastened to said support for biasing said brush towards one end of said opening, said cartridge having a peripheral groove, a portion of said contact plate protruding into said groove, and a garter spring in said groove electrically engaging the protruding portion of said contact plate.

3. In an article of manufacture, a casing having an opening therethrough, removable means for closing one end of said opening, a contact plate secured within said opening, a commutator brush slidable within said opening, a shunt electrically connecting said brush and said contact plate, a spiral ribbon spring mounted within said opening for continuously urging said brush towards the other end of said opening with a substantially constant force irrespective of the position of said brush within said opening, said casing having a peripheral groove, a portion of said contact plate protruding into said groove, and a garter spring in said groove electrically engaging the protruding portion of said contact plate.

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