March 13, 1962 D. W. SIEVERT 3,025,421

BRUSH MOUNTING FOR SMALL COMMUTATOR TYPE MOTORS

Filed June 27, 1958

FIG. 1.

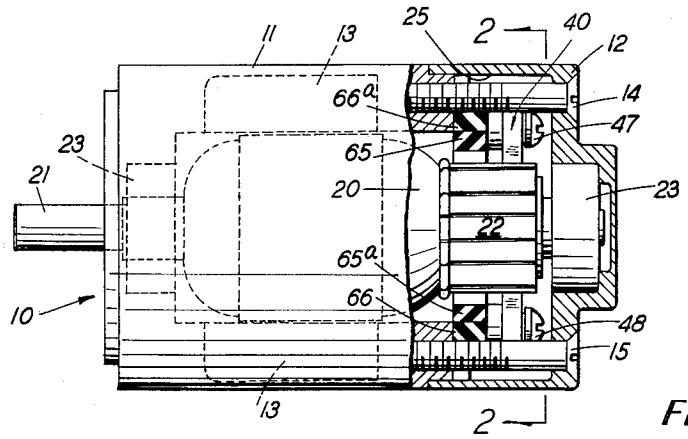


FIG. 3a.

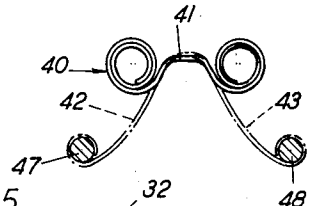


FIG. 2.

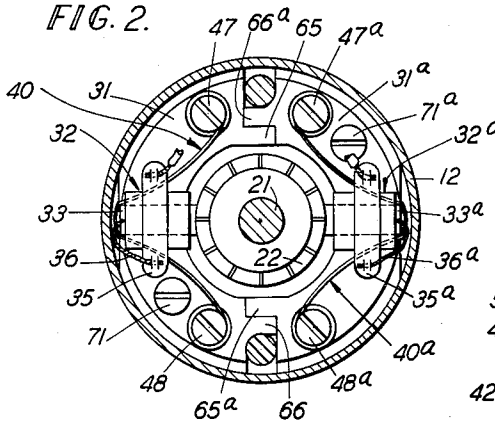


FIG. 5.

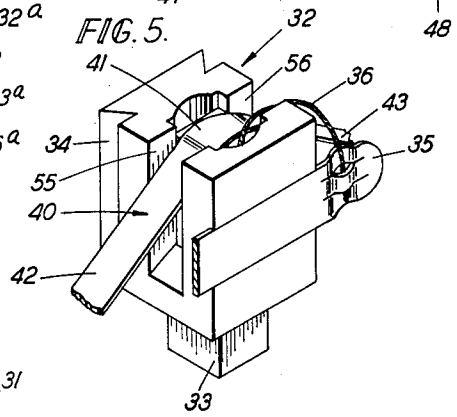


FIG. 3.

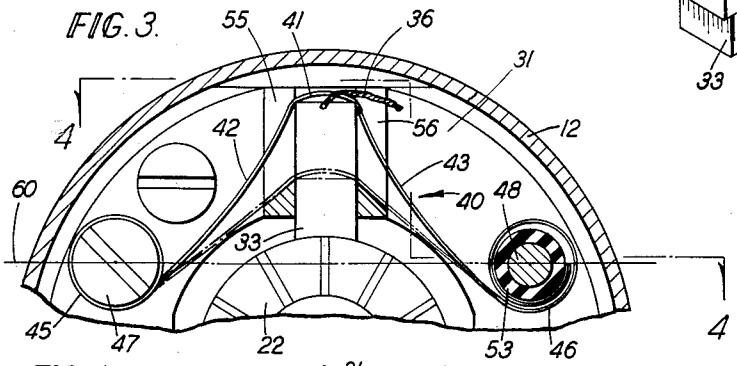
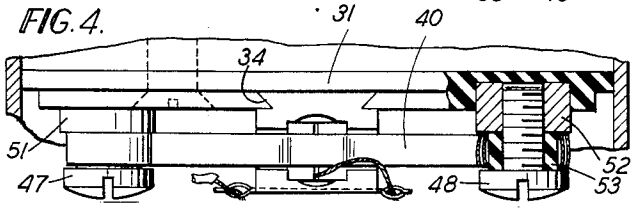


FIG. 4.



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BRUSH MOUNTING FOR SMALL COMMUTATOR TYPE MOTORS

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The present invention relates to the mounting of carbon brushes in a motor assembly and more particularly to a mounting arrangement for a non-cumulative, constant tension spring which is especially suited to small motors of compact design. Where, in this specification and in the subjoined claims, reference is made to a "non-cumulative, constant tension spring" these terms are employed to designate a spring of the well known "Negator" type, i.e. a spring every increment of which requires an equal force to straighten it, such a spring being produced by drawing or passing a strip of metal between two forming elements to bend the strip partially so that every increment of the spring is bent on an equal radius. Inasmuch as every increment of the spring is equally stressed and bent, the force required to straighten any given portion of the spring is exactly the same as the force required to straighten any other portion of the spring. Therefore, in a spring of the "Negator" type, the resistance to straightening or drawing out of the spring is non-cumulative.

In the past, attempts have been made to employ non-cumulative, constant tension springs for applying constant take-up pressure to carbon brushes in commutator type motors. However, the special problems existing in compact miniature motors and the need for reliability have prevented springs of this type from being fully utilized.

It is the primary object of the present invention to provide a brush mounting for small motors which is characterized by a high degree of reliability and long life, a life safely exceeding that of the remainder of the motor. More specifically, it is an object of the present invention to provide a brush mounting arrangement for a non-cumulative, constant tension spring in which there is no danger of breakage of the spring due to concentrated forces being developed in the spring. It is a related object to provide a brush mounting arrangement having a non-cumulative, constant tension spring so arranged as to permit long brush travel, and therefore maximum take-up for brush wear, without subjecting the spring to sharp bending or other concentrated stress, especially at the limits of travel.

It is another object to provide a non-cumulative, constant tension spring brush mounting which fully and efficiently utilizes the annular space in the motor casing surrounding the commutator, space which is largely wasted in conventional designs. Specifically, it is an object to provide a symmetrical double non-cumulative, constant tension spring arrangement in which the spring anchoring posts are on opposite sides of and straddle the commutator recess.

It is a further object related to the foregoing to provide a non-cumulative, constant tension spring brush mounting which is especially suited to motors in which the radial brush space is severely limited.

In one of its aspects, it is an object of the present invention to provide a novel commutator assembly which may be paired with a similar assembly to provide a brush supporting ring arrangement for nesting in the motor housing in the annular space surrounding the commutator and forming a rigid structural part of the motor frame. It is a related object to provide a structure of the above type which requires a minimum of structural hardware for securing the component pieces together.

It is another object to provide a commutator brush assembly which may be readily removed for service or

replacement and which enables production of a small motor at minimum cost.

Other objects and advantages will become apparent upon reference to the attached detailed description and upon a review of the drawing in which:

FIGURE 1 is a side view of a motor employing the present invention with the end portion in vertical section.

FIG. 2 is a transverse section of the motor of FIG. 1 taken along the line 2—2 therein.

FIG. 3 is an enlarged fragmentary view similar to FIG. 2 to bring out some of the details of the brush rigging.

FIG. 3*a* shows the non-cumulative, constant tension spring in extended and relaxed positions respectively.

FIG. 4 is a top view in partial section looking along the line 4—4 in FIG. 3.

FIG. 5 is an enlarged perspective of the brush guide shown in the preceding figures.

While the illustrative form of the present invention has been shown in the drawing and described herein in detail, it will be understood that I do not intend to limit myself to this embodiment but intend to cover all modifications and equivalent constructions falling within the spirit and scope of the appended claims.

Turning now to FIG. 1 there is shown a motor **10** having a housing **11** including an end cap **12**. Telescoping within the housing **11** is an annular field structure **13**, the parts being secured together by longitudinal screws **14**, **15** to form a stator assembly.

Centered within the field structure **13** is an armature **20** having a shaft **21** and a commutator **22**, with the shaft journaled in bearings **23**. The commutator and housing define an annular space **25** of small cross section hereinafter referred to as the "commutator recess."

Arranged within the annular space **25** is a brush assembly generally indicated at **30** having a mounting plate of annular shape comprised of two semi-annular portions **31**, **31***a*. Taking the mounting plate **31** and its associated brush assembly by way of example (FIG. 3), it will be seen that the mounting plate carries a hollow brush guide **32** enclosing a brush **33** which is movable radially therein. The brush guide **32** preferably has a dovetailed mounting portion **34** which is integrally molded in the mounting plate **31**, which latter may be made of thermosetting plastic material. To provide convenient electrical connection, a terminal plate **35** is secured to the front surface of the brush guide and connected to the brush by a pigtail **36**.

In accordance with the present invention, an inverted V-shaped non-cumulative, constant tension spring is provided which is looped over the brush **33** at its central portion and anchored in supporting posts which lie on opposite sides of the commutator. More specifically, I provide a V-shaped non-cumulative, constant tension spring **40** which, as shown in FIG. 3, has a rounded crotch portion **41** and side portions **42**, **43** terminating in end curls **45**, **46** respectively. The latter are wound about posts **47**, **48**. These posts are preferably in the form of headed screws threaded into bushings **51**, **52** which are molded integrally in the mounting plate, each screw being surrounded by a sleeve or spacer **53** to provide clearance for the curled ends of the spring as well as to provide an antifriction surface about which the spring may rotate as it curls or uncurls.

For the purpose of providing exit clearance for the side portions **42**, **43** of the spring, the brush guide is slotted as indicated at **55**, **56**, with the slots extending almost to the lower end of the guide.

It is one of the features of the present invention that the posts **47**, **48** which mount the curled ends of the non-cumulative, constant tension spring are spaced wide apart within the motor housing at points lying on opposite sides of the commutator or commutator recess. Pref-

erably, the posts are positioned in the end portions of the respective semi-annular mounting plates. As brought out in FIG. 3, the location of the posts in the present instance is such that a line 60 which interconnects them intersects the commutator.

Viewed in a slightly different light, the post spacing is sufficiently wide so that the two side portions 42, 43 of the spring are at approximate right angles with respect to one another. In the present embodiment this angle varies from a minimum of approximately 70° when the spring is fully extended, as with a new brush, to approximately 120° when the spring is in its lowered position and with the brush near the end of its useful life.

It is found that this arrangement, in practice, is accompanied by a number of important advantages. In the first place, my observations show that reliability is greatly improved and that spring breakage is substantially eliminated. Thus the spring is required to undergo only a limited bending or flexure in covering the entire range of movement, a change of only approximately 50° in included angle. Materials conventionally employed in the making of small non-cumulative, constant tension springs can accommodate such change in angle without subjecting the material to any undue stress, i.e., stress which is localized and which runs the risk of breakage. Moreover, it is found that the arrangement is such as to give a long stroke of brush take-up movement, with the force being at all times radially centered on the brush and of substantially non-cumulative, constant tension over the range of movement. This permits longer brushes to be used than would otherwise be possible thereby enabling a longer period of use before replacement. Since balanced forces are maintained over the entire stroke of the brush, there is no risk that the brush will become skewed or "hung up" within the brush guide.

It will be understood by one skilled in this art that the arrangement described enables maximum and most efficient utilization of the commutator recess, i.e. the annular space available between the commutator and the housing. Thus it will be noted in FIG. 2 that the sides of the springs form chords of maximum length. It can be shown that this arrangement not only permits longer springs to be employed but more effective utilization of the non-cumulative, constant tension action or phenomenon.

With regard to the non-cumulative, constant tension spring itself, the making of springs of this type is within the skill of the art (see for example, such patents as Lermont Pat. No. 2,609,192 of September 2, 1952, Lermont Pat. No. 2,801,669 of August 6, 1957, and Cook Pat. No. 2,647,743 of August 4, 1953), the spring in the relaxed state occupying the position shown in full lines in FIG. 3*a*.

If desired, the crotch portion 41 of the spring may be curved as shown at 41 in FIG. 3, with a sharper bend on each side of the curve for engaging the shoulders of the upper end of the brush and to insure that the spring remains centered on the brush. Over the useful range or stroke, the change in the included angle tends to be accommodated by a change in the curvature of the curved portion 41 rather than by bending at the shoulder-accommodating portions of the spring. The setting up of localized stress at the "corners" is avoided.

While the invention has been described thus far in connection with only one of the brush assemblies, it is one of the features of the present invention that the companion assembly, mounted on plate 31*a*, is identical in every way, with corresponding parts having corresponding reference numerals with subscript *a*. In accordance with one of the detailed features of my device, the

mounting plates 31, 31*a*, although identical, have ends which are interfitting or interlocked. The latter is brought about by making the ends of each of the mounting plates respectively non-symmetrical, the mounting plate 31 having an inwardly offset tongue 65 at one end and an outwardly offset tongue 66 at the other. These mate respectively with corresponding tongues 66*a*, 65*a* on the other piece as shown. The result is to produce a continuous annular plate, which is substantially self-supporting and which forms an integral part of the motor structure. Because of the interfitting, it is possible to secure both brush assemblies in place within the housing with only two screws 71, 71*a* (FIG. 2).

Experience through the years with miniature commutator-type motors has indicated that the brushes and brush rigging constitute the weakest link in the conventional design, the portion of the motor which is most likely to fail and which requires most frequent maintenance. By contrast, the present arrangement requires substantially no maintenance, giving long brush life and reliable operation over long periods of time and enabling motors of the present design to be employed in the most exacting commercial and military applications.

I claim as my invention:

1. In a motor, the combination comprising a rotor having a commutator, a stator surrounding said commutator and spaced therefrom to provide a commutator recess between said commutator and stator; a brush within said recess and having its inner end engaging said commutator; a brush guide mounted within said recess for guiding said brush for radial take up with respect to said commutator; a non-cumulative, constant tension spring of the inverted V shape type within said recess and having a crotch portion looped over the outer end of said brush and having substantially straight side portions disposed on opposite sides of said brush guide, said side portions terminating in curled end portions; and a pair of supporting posts within said recess each surrounded by a curled end portion of said spring with said curled end portions free to curl and uncurl about said supporting posts, said posts being spaced substantially away from said brush guide at opposite sides thereof so that the substantially straight side portions of said spring extend generally chordwise within said recess, and said posts being symmetrically spaced within said recess so that a line joining the substantially center portions of said supporting posts passes through said commutator.

2. In a motor, the combination set forth in claim 1, wherein the side portions of said spring extend at approximate right angles to one another.

3. In a motor, the combination set forth in claim 1, and including a semi-annular mounting plate within said recess, with said brush guide mounted on said plate near the center thereof, and with the said supporting posts mounted on said plate near the opposite ends thereof.

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