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MOUNTING ASSEMBLY FOR ROTARY SWITCH WITH MOUNTING PLATE
HAVING RADIALY DISPOSED SLOTS TO SLIDABLY RECEIVE
WAFER SUPPORTING RODS
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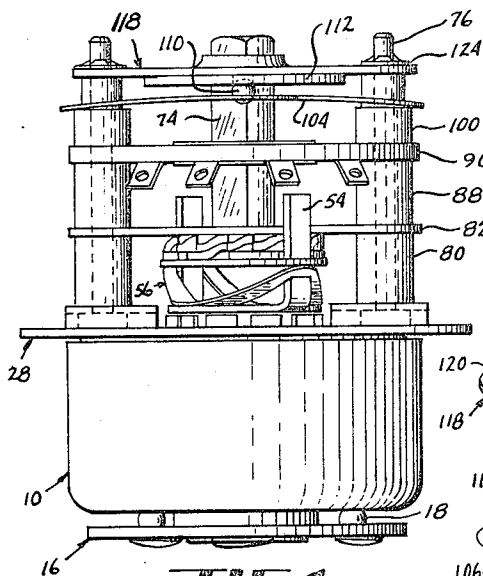


FIG. 1

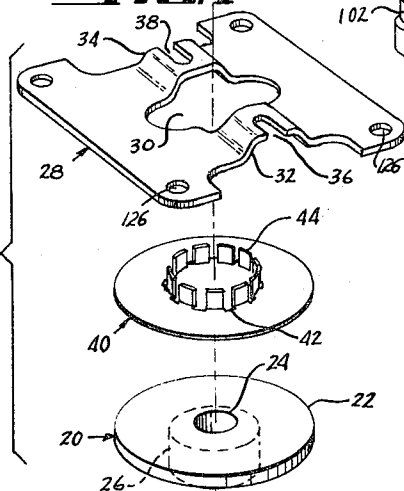


FIG. 3

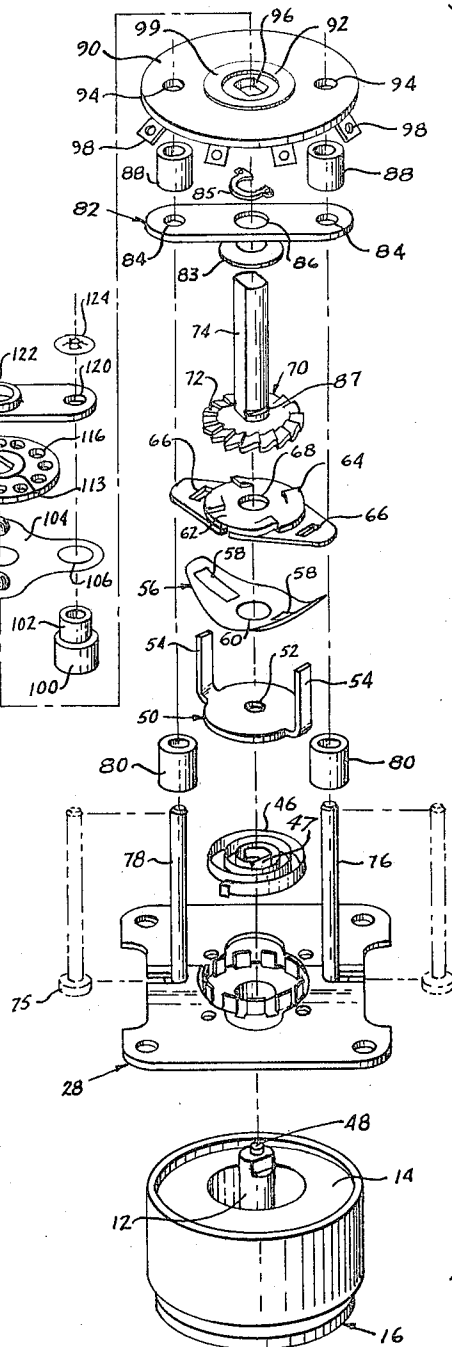


FIG. 2

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**MOUNTING ASSEMBLY FOR ROTARY SWITCH
WITH MOUNTING PLATE HAVING RADIALLY
DISPOSED SLOTS TO SLIDABLY RECEIVE
WAFER SUPPORTING RODS**

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ABSTRACT OF THE DISCLOSURE

A rotary switch mounting assembly has a mounting plate provided with radial slots to receive support rods disposed diametrically with respect to the rotary axis of the switch mounting. The assembly is effected by sliding the support rods radially into said slots, sliding a rotary switch mechanism including one or more switch wafers axially onto said rods, and locking the assembly by suitable collar devices affixed to the ends of said rods. The assembled switch mechanism retains the support rods in said radial slots.

This invention relates to a switch mounting assembly and a method of assembling and, more particularly, to an improved mounting arrangement for a rotary switch device utilized with a rotary stepping motor.

Rotary stepping motors in which axial movement of an armature is translated into rotary movement are well-known. One example of a rotary stepping motor is shown in U.S. Patent No. 2,496,880.

One previous arrangement for mounting a rotary switch for use with a rotary stepping motor employed a mounting bracket in which holes were provided. Threaded rods were then passed through the holes. The various elements of the switch assembly were then mounted on the threaded rods and held thereon by threaded nuts.

While the arrangement produces a satisfactory switch assembly, it is relatively expensive and time consuming to employ threaded rods for supporting the switch assembly. The present invention satisfactorily overcomes this problem by utilizing slots formed in a mounting plate on opposite sides thereof in a self-aligning assembly which eliminates the need for threaded rods. The present invention not only reduces the cost of material but also reduces the labor time for assembling.

An object of this invention is to provide a relatively low cost switch mounting assembly and a method of assembling.

Other objects and advantages reside in the construction of parts, the combination thereof, the method of manufacture and the mode of operation, as will become more apparent from the following description.

In the drawing, FIGURE 1 is an elevational view of a rotary stepping motor including the switch mounting assembly of the present invention.

FIGURE 2 is an exploded perspective view of one portion of the switch mounting assembly of the present invention.

FIGURE 3 is an exploded perspective view of another portion of the switch mounting assembly of the present invention.

Referring to the drawing, there is shown a casing or housing 10 of a rotary stepping motor. As shown in FIGURE 2, a shaft 12 is disposed centrally within the casing

or housing 10 and is surrounded by a coil 14, which is supported within the casing 10.

One end of the shaft 12 is fixed to an armature 16, which has cam surfaces thereon confronting complementary cam surfaces on the housing 10. These confronting cam surfaces cooperate with balls 18 disposed therebetween. When the armature 16 is moved axially toward the housing 10, the balls 18 cooperate with the cam surfaces on the armature 16 and the housing 10 to cause rotation of the shaft 12 in the well-known manner.

A core piece 20, which is ferromagnetic, is adapted to have its cylindrical base 22 press fitted within the housing 10. The core piece 20 has a passage 24 extending therethrough to receive the shaft 12 for both axial and rotational movement relative thereto. The core piece 20 also includes a cylindrical shoulder or projection 26, which fits between the coil 14 and the shaft 12 when the base 22 is press fitted within the housing 10.

When the coil 14 is energized, a flux path is completed through the shoulder 26, the base 22, and the wall of the housing 10 to the armature 16 whereby the armature 16 and shaft 12 are moved axially toward the core piece 20. This results in rotation of the shaft 12 due to the cooperation between the balls 18 and the confronting cam surfaces on the armature 16 and housing 10.

A primary use of a rotary stepping motor is to position a rotary contact with respect to various stator contacts of a switch deck whereby various operations may occur depending upon the position of the rotary contact. For such uses, a switch assembly is mounted for actuation by the rotational movement of the shaft 12.

In mounting the switch assembly of the present invention, a mounting plate 28 is produced by stamping the same with a central opening 30 and raised portions 32 and 34 on opposite sides of the central opening 30. The portions 32 and 34 are both raised from the same face of the plate 28 and corresponding depressions appear in the opposite face of the plate 28. A slot 36 is formed in the raised portion 32, and a slot 38 is formed in the raised portion 34.

A thin metallic sheet or shim 40 is fixedly attached to the side of the mounting plate 28 opposite from the raised portions 32 and 34 by suitable means such as spot welding. The shim 40 has an enlarged opening 42 therein with lugs 44 extending from one side of the shim 40 and disposed around the periphery of the opening 42.

In assembling the present invention, the shim 40 and the core piece 20 are simultaneously attached to the mounting plate 28 after the mounting plate 28 has been stamped in the form shown in FIGURE 3. Thus, both the core piece 20 and the shim 40 are spot welded simultaneously to the mounting plate 28 to form a unitary portion of the switch mounting assembly of the present invention. Prior to spot welding the shim 40 to the core piece 20, the passage 24 in the core piece, the opening 42 in the shim 40, and the central opening 30 in the mounting plate 28 are aligned.

After the shim 40 and the core piece 20 have been spot welded to the mounting plate 28, the core piece 20 has its base 22 press fitted within the casing 10, the passage 24 in the core piece 20 being passed over the shaft 12. Of course, the opening 42 in the shim 40 and the central opening 30 in the mounting plate 28 also are centered about the shaft 12 at the same time.

As shown in FIGURE 2, the shaft 12 has a flattened portion in its periphery. A spiral spring 46 has a flattened

interior convolution 47 designed to slidably and non-rotatably engage with the periphery of the shaft 12. The outer end of the spiral spring 46 has a hook thereon for engagement with one of the lugs 44 of the shim 40. The particular lug 44 to which the spring 46 is connected determines the amount of torque delivered by the spiral spring 46 to return the shaft 12 to its non-rotated position after the coil 14 is de-energized.

A drive plate 50 has a central opening 52 designed to receive a cylindrical boss 48 at the end of the shaft 12. After the boss 48 enters the opening 52, the end of the boss 48 is upset to anchor or rivet the drive plate to the shaft 12.

The drive plate 50 is thus fastened to the shaft 12 after the spiral spring 46 has been connected to the shaft 12 and to the selected lug 44. The drive plate 50 loosely cages the spiral spring 46 between one side thereof and the core piece 20.

The drive plate 50 has a pair of diametrically disposed arms 54 extending from the side opposite to that under which the spiral spring 46 is caged. A flat spring 56 has radial slots 58 therein to receive the arms 54 of the drive plate 50. The flat spring 56 has a central, circular opening 60, which has a diameter greater than the diameter of the boss 48 so that the presence of the boss 48 in the opening 52 will not affect the bias supplied by the spring 56.

A driving ratchet 62, which has four equally angularly spaced teeth 64 thereon, has slots 66 on opposite sides thereof to receive the arms 54 of the drive plate 50. The driving ratchet 62 has a central, circular opening 68 the purpose of which will be more fully described hereinafter.

After the drive plate 50 has been fastened to the shaft 12, the flat spring 56 and the driving ratchet 62 are mounted on the arms 54 of the drive plate 50. This arrangement permits the drive plate 50 and the shaft 12 to move axially with respect to the driving ratchet 62 but to cause rotation of both the flat spring 56 and the driving ratchet 62 whenever the shaft 12 rotates.

A driven ratchet 70 is adapted to have its teeth 72 engaged by the teeth 64 of the driving ratchet 62 whereby the driven ratchet 70 rotates whenever the shaft 12 rotates counterclockwise (as viewed in FIGURE 2). Depending upon the design of the aforementioned cam surfaces, this can occur either upon energization of the coil 14 or, alternatively, upon return of the shaft 12 by the spring 46. The driven ratchet 70 has a non-circular shaft 74, which preferably has a double D shape, extending from one side thereof. The shaft 74 has a cylindrical boss, not shown, entering a central aperture, also not shown, in the driven ratchet 70 and upset against the lower face of the driven ratchet 70. This produces a crown below the driven ratchet 70 which the previously described opening 68 receives without interference.

The flat spring 56 yields to permit the shaft 12 to axially approach the drive ratchet 62 and at all times biases the driving ratchet 62 upwardly against the driven ratchet 70. The slots 58 in the flat spring 56 have sufficient radial length to permit the yielding movement of the flat spring 56.

After the flat spring 56 and the driving ratchet 62 have been disposed on the arms 54 of the drive plate 50, a support rod 76 is placed within the slot 36 in the mounting plate 28 and a support rod 78 is positioned within the slot 38 in the mounting plate 28. The support rods 76 and 78 are moved from the phantom positions of FIGURE 2 into the solid line positions of FIGURE 2 by disposing the heads 75 of the rods 76 and 78 between the raised portions 32 and 34, respectively, of the mounting plate 28 and the shim 40. By having positioned the shim 40 and the core piece 20 against the face of the mounting plate 28 into which the portions 32 and 34 are depressed, a receiving pocket is provided for the heads of the rods 76 and 78, such heads being smaller in axial thickness

than the extent of depression of the portions 32 and 34 in the mounting plate 28.

After the rods 76 and 78 have been properly positioned, cylindrical spacers 80 are slid down the rods 76 and 78. Thereafter, a thin washer 83 is passed onto the shaft 74 in overlying relation to the driven ratchet 70 and a rigid retaining strap 82 has its apertures 84 passed over the rods 76 and 78. The washer 83, which is smaller in diameter than the diametric separation between the teeth 72, prevents any interference or undue friction between the ratchet teeth 72 and the strap 82.

The retaining strap 82 has a central, circular opening 86 therein to receive the double D shaft 74 fixed to the driven ratchet 70. When the strap 82 is positioned on the rods 76 and 78, the driven ratchet 70 is supported with its teeth 72 adjacent the teeth 64 of the driving ratchet 62. The diameter of the circular opening 86 is sufficient to provide support by the strap 82 to the shaft 74 while still permitting the shaft 74 to turn with respect to the strap 82.

The shaft 74 is secured against axial movement relative to the strap 82 by means of a snap ring 85 seated in grooves 87 cut into the periphery of the shaft 74 at its radially largest sides. The grooves 87 are axially spaced from the adjacent face of the ratchet 70 a distance substantially equal to the combined axial thickness of the washer 83 and the strap 82 with the result that the shaft 74 has substantially no axial play relative to the strap 82.

It should be understood that the arms 54 of the drive plate 50 are positioned with respect to the rods 76 and 78 so that there will be no interference between the arms 54 of the drive plate 50 and the strap 82. This relation is shown in FIGURE 1.

After the strap 82 has been positioned on the rods 76 and 78 with the strap 82 abutting against the spacers 80 so that the strap 82 is in spaced relation to the mounting plate 28, a second set of cylindrical spacers 88 is placed on the rods 76 and 78. A wafer switch deck, which comprises a stator wafer 90 and a rotor wafer 92, is then moved downwardly on the rods 76 and 78 until it engages the spacers 88. The stator wafer 90 has openings 94 therein to permit mounting of the wafer switch on the rods 76 and 78.

The rotor wafer 92 is supported by the stator wafer 90 so that it may rotate with respect to the stator wafer 90. The rotor wafer 92 may have only a single contact integral with conductive ring 99 while the stator wafer 90 has a plurality of equally angularly spaced contacts 98 whereby the single contact on the rotor wafer 92 engages a different contact on the stator wafer 90 after each rotation of the shaft 74. The single contact on the rotor wafer 92 does not appear in the drawing since it is located in the face of rotor wafer 92 opposite to that illustrated in the drawing.

The rotor wafer 92 has an opening 96 therein of the same shape as the shaft 74. With the shaft 74 having a double D shape, the shape of the opening 96 is double D to provide a snug but axially sliding fit between the shaft 74 and the rotor wafer 92 whereby the rotor wafer 92 rotates when the shaft 74 rotates.

After the wafer switch deck has been mounted on the rods 76 and 78 and abuts against the tops of the spacers 88, a third set of spacers 100 is mounted on the rods 76 and 78. The spacers 100 are different in shape from the spacers 80 and 88 in that the spacers 100 are formed of two cylindrical portions of different outer diameters to form a shoulder 102 therebetween.

With the spacers 100 mounted on the rods 76 and 78, a metallic, flexible plate 104 is placed on the spacers 100 by means of its apertures 106. The diameter of the apertures 106 is less than the diameter of the larger cylindrical portions of the spacers 100 so that the flexible plate 104 rests on the shoulders 102 of the spacers 100 as shown in FIGURE 1. The diameter of the apertures 106 is suffi-

cient to pass over the smaller cylindrical portions of the spacers 100.

The plate 104 has a central, circular opening 108 therein to permit the double D shaft 74 to pass therethrough. The flexible plate 104 has a pair of diametrically disposed perforations, not shown, cradling diametrically disposed balls 110 of larger diameter than the perforations.

After the flexible plate 104 is properly mounted, a metallic detent plate 112 is disposed slidably on the double D shape shaft 74. The detent plate 112 has a central opening 114, which is the same shape as the shaft 74, so that there is a driving fit between the detent plate 112 and the double D shaft 74 whereby the detent plate 112 rotates with the shaft 74.

The detent plate 112 has a plurality of apertures 116 formed therein along its periphery. The apertures 116 are equally angularly spaced from each other and are disposed for cooperation with the pair of balls 110 in the flexible plate 104. It should be understood that the flexible plate 104 is somewhat bowed so that an upward bias urges the two balls 110 into two diametrically opposed apertures 116 in the detent plate 112.

As shown in FIGURE 2, the detent plate 112 has twelve apertures 116 therein. Thus, these are disposed 30° apart, and this is the amount of rotation of the shaft 74 resulting from each axial-rotary movement of the shaft 12 due to energization of the coil 14.

After the detent plate 112 has been engaged to the shaft 74 fixed to the driven ratchet 70, a second metallic retaining strap 118 is mounted on the rods 76 and 78 through its apertures 120. The second strap 118 has a circular opening 122 therein which receives the double D shaft 74 to provide further support to the shaft 74 and the driven ratchet 70. As shown in FIGURE 1, the strap 118 rests on top of the spacers 100. Friction between the detent plate 112 and the strap 118 is minimized by providing on the detent plate 112 a raised annular rib 113 which encircles the opening 114 therein.

With the strap 118 properly positioned, drive nuts or collars 124, which have serrated inner surfaces, are driven onto the ends of the non-threaded rods 76 and 78. This takes up any axial play in the entire assembly. During each step of the assembly, the radial play was taken up as each of the retainer straps 82 and 118 was properly positioned on the rods 76 and 78. Thus, the assembly aligned itself as the assembly progressed.

After the drive nuts 124 have been driven on the rods 76 and 78, a suitable binder such as epoxy cement, for example, is applied to the rods 76 and 78 adjacent the drive nuts 124 and adjacent the slots 36 and 38. This protects the assembly against loosening due to exposure to vibratory forces.

The mounting plate 28 has apertures 126 formed in each of its corners. The apertures 126 extend beyond the casing 10 to permit mounting of the rotary stepping motor to other suitable structure.

From the foregoing, it will be observed that the switch mounting assembly of the present invention may be easily and quickly assembled. The amount of labor required is reduced, and the cost of the materials is decreased since threaded rods are replaced by non-threaded rods which slide easily into position and are aligned accurately by the various components assembled thereon.

During the operation of a rotary stepping motor utilizing the switch mounting assembly of the present invention, the shaft 12 moves axially to cause the armature 16 to be rotated due to the cooperation between the balls 18 and the cam surfaces on the armature 16 and housing 10. When this occurs, the shaft 12 rotates through a power stroke.

Upon subsequent deenergization of the coil 14, the spring 46, which was tightened during the power stroke of the shaft 12, imparts a return stroke, restoring the shaft 12 to its starting position. The net result of one cycle of operation of the stepping motor is thus an advance and return of the shaft 12 through a rotary angle determined

by the confronting cam surfaces on the armature 16 and the housing 10. The driving ratchet 62 rotates in unison with the shaft 12 and thus advances and returns through the same rotary strokes executed by the shaft 12.

Depending upon the tooth shapes of the driving and driven ratchets 62 and 70, respectively, the shaft 74 will be driven either on the power stroke or on the return stroke of the driving ratchet 62. The shaft 74 will not move during the immediately succeeding return or power strokes due to the holding action of the balls 110 seated in the detent plate 112. As a result, the shaft 74 rotates only unidirectionally in a stepwise manner and the rotor wafer 92 keyed to the shaft 74 also rotates only in a unidirectional stepwise manner. The unidirectional stepwise movements of the rotor wafer 92 result in successive opening and closing of electrical circuits associated with the stator contacts 98 in the well-known manner.

While for purposes of illustration, only a single wafer switch has been shown, it should be understood that a plurality of wafer switches might also be employed. This only requires an increase in the lengths of the shaft 74 and the rods 76 and 78 and use of more of the spacers 88 to space the additional wafer switches from each other.

Although a preferred embodiment of the invention has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consists in a device capable of carrying out the objects set forth, as disclosed and defined in the attached claims.

Having thus described my invention, I claim:

1. A switch mounting assembly comprising: a mounting plate having slots entering the body thereof from opposite side margins thereof, said slots having inner ends spaced one from the other, a pair of headed rods, there being one said rod disposed in each said slot at the inner end thereof, the head of each rod abutting one face of said mounting plate and said rods projecting outwardly from the opposite face of said mounting plate, collar means engaging said rods in spaced relation to said mounting plate, and means including a switch wafer received on said rods between said mounting plate and said collar means to retain said rods at the inner ends of said slots.

2. A switch mounting assembly comprising: a mounting plate having slots entering the body thereof from opposite side margins thereof, said slots having inner ends spaced a predetermined distance one from the other, a pair of headed rods, there being one said rod disposed in each said slot, the head of each rod abutting one face of said mounting plate and said rods projecting outwardly from the opposite face of said mounting plate, collar means engaging the end portions of said rods in spaced relation to said mounting plate, assembled means received on said rods between said mounting plate and said collar means and cooperating with said mounting plate to occupy the lengths of said rods between the heads thereon and said collar means, said assembled means including first and second retaining straps spaced apart along the lengths of said rods and a switch wafer disposed between said straps, each said strap having spaced apertures therein receiving said rods, the spacing between said apertures of each strap being substantially equal to said predetermined distance, said switch wafer having apertures therein spaced said predetermined distance and receiving said rods, said straps cooperating one with the other to support said rods in parallel relation and to retain the ends of said rods adjacent the heads thereon in the inner ends of said slots.

3. The assembly of claim 2, in which said mounting plate is a generally planar member having portions on opposite sides thereof which are depressed into one face thereof and correspondingly raised from the opposite face thereof, said slots being disposed in said portions and said heads of said rods being received in said depressed sides of said portions, the axial thickness of said

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heads being not greater than the axial extent of the depression of said portions out of the plane of said one face.

References Cited

UNITED STATES PATENTS

2,740,056	3/1956	Parker et al.	200—14
3,230,321	1/1966	McCann	200—14

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3,248,490	4/1966	Allison et al.	200—14
3,254,165	5/1966	Volkmann	200—14
3,286,048	11/1966	Golbeck	200—14

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