

March 19, 1968

D. V. TINDER ET AL

3,373,528

ACTUATOR WITH MULTIPLE REVERSELY OPERABLE OUTPUT MEANS

Filed Aug. 2, 1965

5 Sheets-Sheet 1

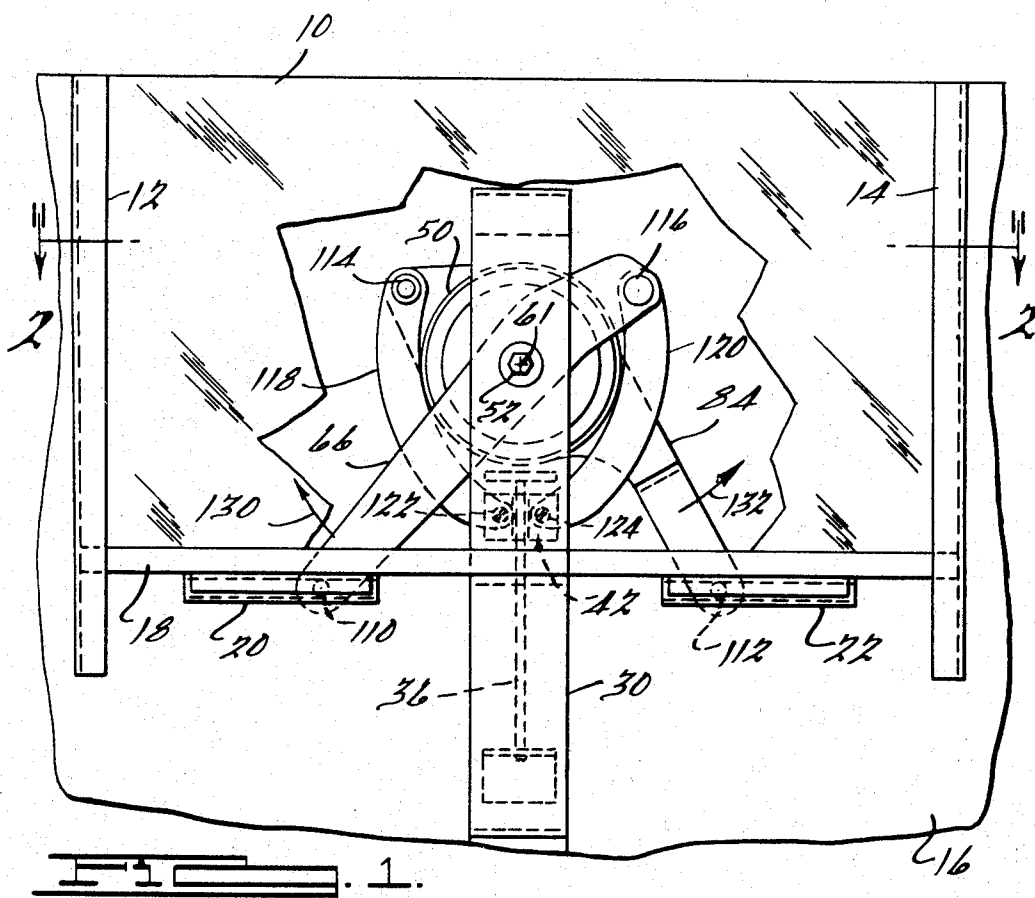


FIG. 1.

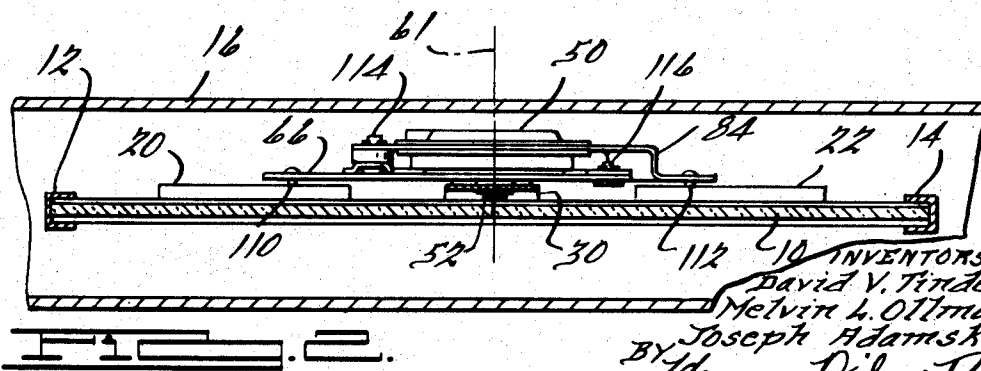


FIG. 2.

INVENTORS
David V. Tinder
Melvin L. Ottman
BY Joseph Adamski
HARRIS, DICKY & PERE
ATTORNEYS

March 19, 1968

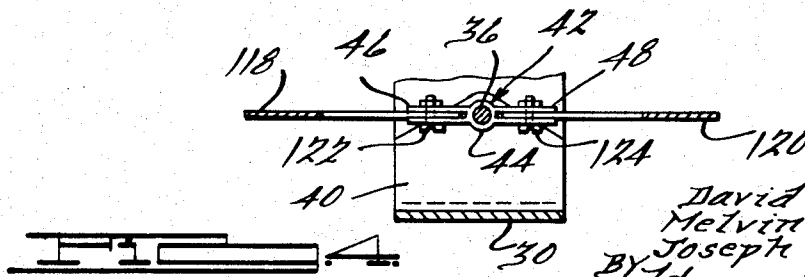
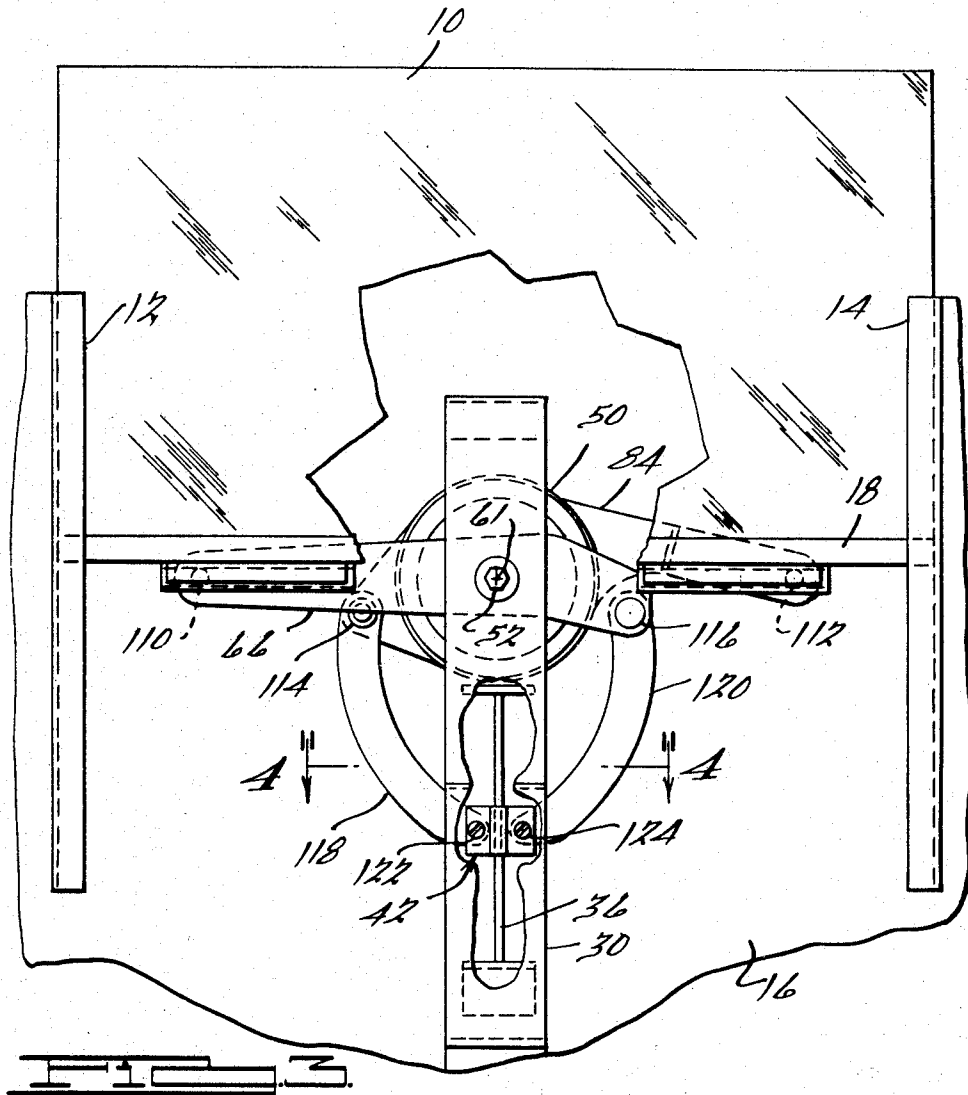
D. V. TINDER ET AL

3,373,528

ACTUATOR WITH MULTIPLE REVERSELY OPERABLE OUTPUT MEANS

Filed Aug. 2, 1965

5 Sheets-Sheet 2



INVENTORS.
David V. Tindler.
Melvin L. Ottman
Joseph Adams Jr.
BY Harness, Dickey & Pusey
ATTORNEYS.

March 19, 1968

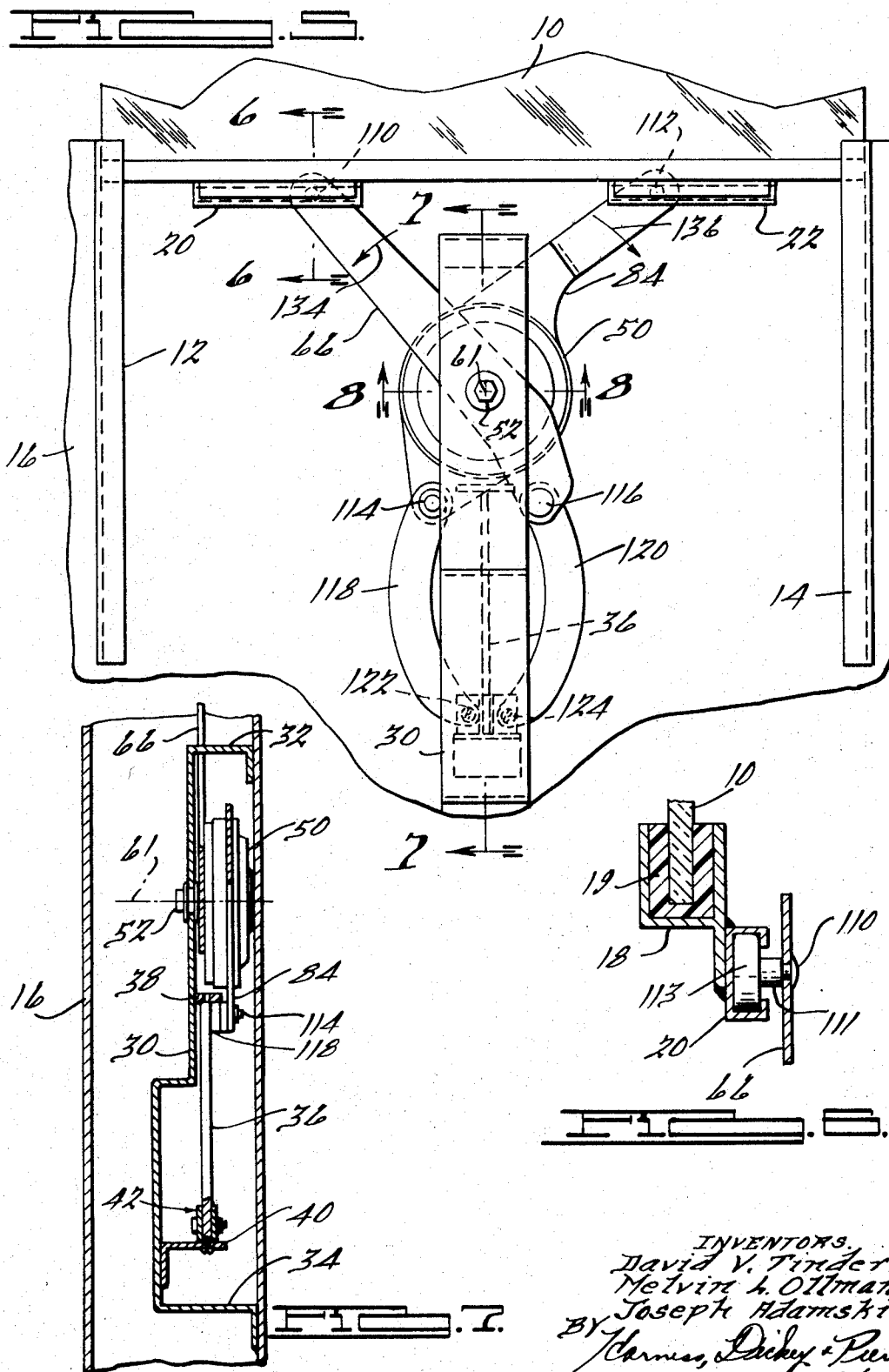
D. V. TINDER ET AL

3,373,528

ACTUATOR WITH MULTIPLE REVERSELY OPERABLE OUTPUT MEANS

Filed Aug. 2, 1965

5 Sheets-Sheet 3



INVENTORS,
David V. Tinder
Melvin A. Oltman
Joseph Adamski
BY *Kerns, Dickey & Paris*
ATTORNEYS.

March 19, 1968

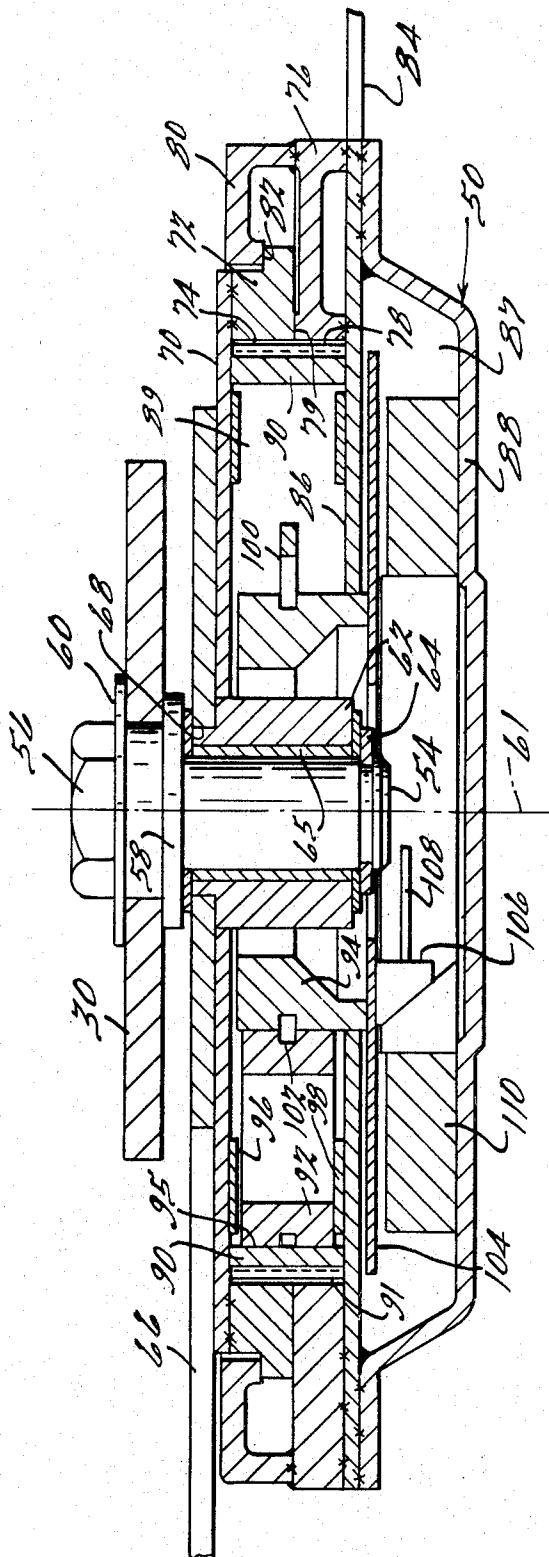
D. V. TINDER ET AL

3,373,528

ACTUATOR WITH MULTIPLE REVERSELY OPERABLE OUTPUT MEANS

Filed Aug. 2, 1965

5 Sheets-Sheet 4



INVENTORS.
David V. Tinder
Melvin L. Ollman
Joseph Adamski.
BY *Carmes, Dicky & Price*
ATTORNEYS.

March 19, 1968

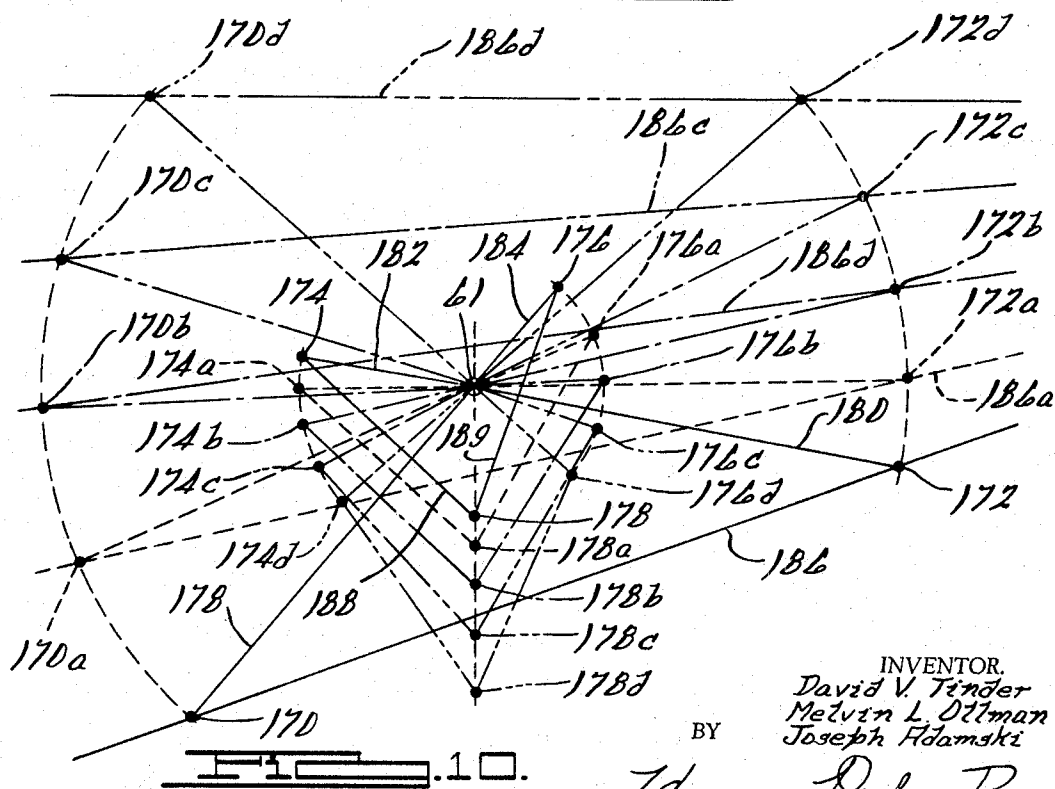
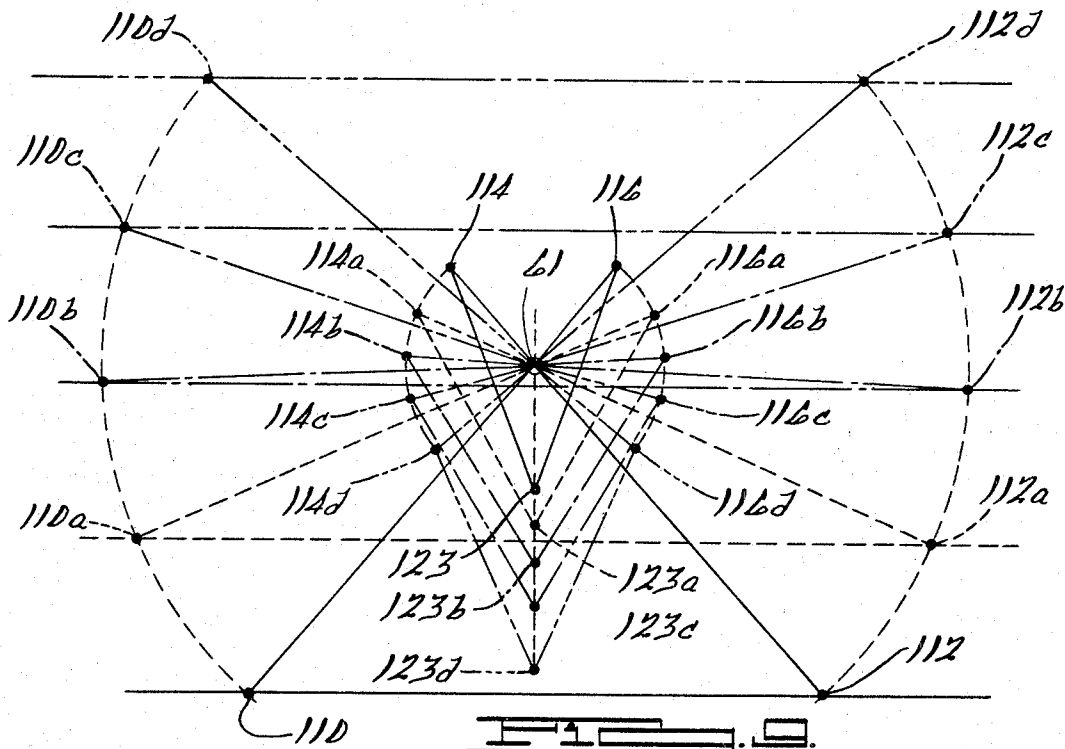
D. V. TINDER ET AL

3,373,528

ACTUATOR WITH MULTIPLE REVERSELY OPERABLE OUTPUT MEANS

Filed Aug. 2, 1965

5 Sheets-Sheet 5



INVENTOR.
David V. Tinder
Melvin L. Ottman
Joseph Adamski
BY

Carness, Dickey & Pierce
ATTORNEYS.

1

3,373,528

ACTUATOR WITH MULTIPLE REVERSELY OPERABLE OUTPUT MEANS

David V. Tinder and Melvin L. Ollman, Detroit, and Joseph Adamski, Brooklyn, Mich., assignors to Dura Corporation, a wholly owned subsidiary of Walter Kiddie & Company, Inc., a corporation of New York
Filed Aug. 2, 1965, Ser. No. 476,525
32 Claims. (Cl. 49—349)

ABSTRACT OF THE DISCLOSURE

There is herein disclosed a power actuator arrangement for a vehicle window comprising a pair of rotatable actuator arms driven by a reversible axial air gap type electrical motor having a disc armature through harmonic motion transmission means.

This invention relates to actuator apparatus and, more particularly, to window actuator apparatus adapted to open and close vehicle windows and the like.

One of the main objects of this invention is to provide a new and improved actuator device having multiple reversely operable output means. The reversely operable output means of such an actuator device may be variously connected to an actuable device.

In the illustrative embodiments of the invention disclosed in detail hereinafter, the inventive principles are incorporated in window actuating mechanism for use with windows mounted in vehicle doors, tail gates, and the like. While particularly advantageous results are attainable in vehicular usage as a window actuator, it will be understood that the principles may be otherwise variously embodied and employed. In vehicular usage as a window actuator, the actuator device may be variously employed with various types of window structure requiring varying types of movement due to limitations in available space and in overall vehicular design.

For example, some types of window structure are adapted to be moved uniformly between open and closed positions while other types are adapted to be moved by a "monkey" motion which is not uniform. Thus some windows, such as in sedans, are adapted to be moved substantially vertically between open and closed positions while other windows, such as rear quarter windows in hard tops, are adapted to be moved by both vertical and horizontal components of motion.

Furthermore, the mounting of windows in vehicular usage varies substantially depending upon styling considerations. In some installations, for example, guide channels are provided to guide the window during the entire movement between open and closed positions while in other installations the window is only partially supported by guide channels and in still other installations guide channel support may be dispensed with entirely.

Therefore, it is intended that the following detailed description of the invention be illustrative of the various ways of utilizing the inventive principles and illustrative of the various vehicular window arrangements with which the invention principles may be employed.

Another main object of this invention is to provide a new and improved actuator arrangement comprising a relatively thin cylindrical motor-transmission unit and connecting and supporting means for operatively mounting the motor-transmission unit between the actuated device and support means therefor.

In general, the invention resides in an actuator arrangement comprising an actuable device movable between spaced positions relative to a support means, an actuator device reversely rotatable to effect movement between the spaced positions and having a first reversely rotatable out-

2

put means and a second reversely rotatably output means with the output means being rotatable in opposite directions, and pivotal means pivotally supporting and connecting the actuator device between the actuable device and the support means and permitting movement of the actuator device relative to the support means as the actuable device is moved between the spaced positions.

The inventive concepts have been incorporated in an illustrative embodiment as shown on the accompanying drawings wherein:

FIGURE 1 is a partial side elevational view, with portions broken away, of an actuator arrangement for a vehicle window mounted in a vehicle door and showing the window in a lowered position;

FIGURE 2 is a cross-sectional view taken along the line 2—2 in FIG. 1;

FIGURE 3 is a side elevational view of the apparatus shown in FIG. 1 in an intermediate operational position;

FIGURE 4 is a cross-sectional view taken along the line 4—4 in FIG. 3;

FIGURE 5 is a side elevational view of the apparatus shown in FIG. 1 in a raised window position;

FIGURE 6 is a cross-sectional view taken along the line 6—6 in FIG. 5;

FIGURE 7 is a cross-sectional view taken along the line 7—7 in FIG. 5;

FIGURE 8 is an enlarged cross-sectional view taken along the line 8—8 in FIG. 7;

FIGURE 9 is a diagrammatic illustration of the actuator mechanism and connecting linkage of FIG. 1; and

FIGURE 10 is a diagrammatic illustration of the actuator mechanism of FIG. 1 and alternative non-symmetrical connecting linkage capable of producing a "monkey" motion.

Referring now to FIG. 1, an illustrative embodiment of the invention is shown to comprise an actuable device in the form of a vehicle window unit 10 suitably mounted for movement between spaced positions relative to support means in the form of spaced vertically extending channel-shaped guides 12, 14 located within a compartment formed by a vehicle door or the like 16. A channel-shaped sash 18 and gasket 19, FIG. 6, may be utilized to support the glass window and a pair of spaced horizontally extending guideways 20, 22 are attached thereto. It will be understood that the window construction may be varied as necessary or desirable and that the window unit may be otherwise mounted in any conventional or suitable manner. Furthermore, it will be apparent that the broad aspects of the invention are not limited to window actuators or to vehicular usage.

The actuator mounting means comprises support means 30, FIG. 7, in the form of an elongated vertically extending bracket which is suitably mounted within the vehicle door as by, for example, transverse flanges 32, 34. A guide means 36 in the form of a vertically extending rod is mounted in spaced relation to the bracket 30 by means of suitable support flanges 38, 40. A slide means 42, FIGS. 3 and 4, is slidably mounted on the rod 36 and comprises a tubular portion 44, slidably receiving the rod, and transversely extending bifurcated wing portions 46, 48.

The actuator means comprises a combined transmission-motor means unit 50 movably mounted relative to the support means by connecting means shown generally at 52. In the presently preferred embodiment, the unit 50 is rotatably supported, as shown in FIG. 8, by a supporting shaft means 54 provided with a head portion 56 extending through an aperture in the bracket 30 and fixedly mounted therein by a flange portion 58 and a suitable fastener 60. The central axis 61 of the shaft means provides a common central axis of rotation for the actuator means as hereinafter described in detail.

The transmission-motor means unit 50 has a substantially cylindrical overall peripheral configuration with a diameter of substantially greater length than the thickness or width. The transmission-motor means unit is thus relatively thin and particularly well suited for use in confined areas such as vehicle doors. In general, the motor means comprises a reversible electrical motor of the axial air gap type having a disk armature. The transmission means comprises a harmonic drive output arrangement associated with a speed reduction unit. It will be apparent that the speed reduction unit components, the harmonic drive components, and the motor components are inter-related and mutually interdependent as hereinafter described.

Referring now to FIG. 8, the transmission-motor means comprises a hub member 62 rotatably mounted on the shaft 54 and held thereon between the flange portion 58 and suitable fastener means 64. A bearing sleeve 65 may be provided between the hub 62 and the shaft 54, and suitable bearing washers may be provided between the hub and the flange portion and between the hub and the fastener means 64.

A rotatable output arm means 66 is fixedly secured to the hub 62 about a reduced diameter shoulder portion 68 and to an end plate 70 of the unit 50. The output arm means 66 is rotatably driven by a rotatable annular splined output member 72 having internal spline teeth 74 and being fixedly secured to the end plate 70. Thus, the splined member 72 is rotatable about the central axis 61 with the hub 62, the output arm means 66, and the end plate 70. A second rotatable annular splined output member 76 having internal spline teeth 78 is mounted coaxially in abutting engagement with the splined output member 72 at 79. A locating ring 80 may be attached to the splined output member 76 and provided with an internal face 82 in abutting engagement with the output member 72. Another radially extending output arm means 84 is fixed to the annular splined output member 76. A portion of the radially extending output arm means 84 is radially enlarged to form a central motor partitioning plate portion 86 of substantially annular peripheral configuration. Plate portion 86 effectively divides the actuator into a motor compartment 87 in connection with a dished cover plate 83 which is securely fastened thereto, and into a transmission compartment 89 in connection with the end plate 70.

The internally splined output members 72, 76 form part of a harmonic drive arrangement and are adapted to be simultaneously rotatably driven in opposite directions by means of an annular flex spline member 90. External teeth 91 on the flex spline member are adapted to be flexed into and out of driving engagement with the internal teeth on the output members at circumferentially spaced peripheral locations. The flex spline and output splines have different numbers of teeth, i.e., at least one output spline has a different number of teeth than the other output spline and the flex spline. The number of teeth on the flex spline and output members and the number of areas of engagement therebetween may be varied as is presently known in the harmonic drive art and discussed in detail in United States Patent No. 2,906,143 issued to Musser. The harmonic drive is actuated by the motor means through transmission means including planet roller means 92 mounted circumferentially about sun roller means 94. Each planet roller means is maintained in driving engagement with the flex spline at spaced peripheral locations as shown at 95. In the illustrative embodiment, three such planet roller means may be advantageously employed. Suitable bearing rings 96, 98 may be provided between the planet roller means 92 and the plates 70, 86. Suitable separator means 100 may be utilized to maintain the desired circumferential spacing of the planet roller means and a portion 102 may be utilized to axially locate the sun roller means relative to the planet roller means. Thus, it may be observed that the

power transmission means, comprising the sun roller means 94, the planet roller means 92, the flexible spline member 90, and the output members 72, 76, are axially and radially confined relative to the shaft means 54 while being radially spaced therefrom.

The motor means is integrally associated with the transmission means and comprises a disk armature member 104 fixedly mounted on and supported and located radially and axially by the sun roller means 94. Radially extending winding means are provided on the disk armature in a conventional manner and commutation means in the form of brush elements 106 engage the surface of the winding means. The brush elements are connected by electrical leads 108 to a suitable energy source through suitable control circuitry of the type now utilized in conventional power operated vehicle window systems. An annular multiple pole permanent magnet 110 is mounted on the cover plate 83. Armature 104 is rotatably supported by the sun roller means 94 in axially spaced relationship between the permanent magnet 110 and the plate 86 for rotation within the flux path therebetween, plate 86 providing a return flux path in conjunction with the cover plate 83. The details of construction and operation of motors of this type are now known in the art and shown, for example, in copending United States patent application Ser. No. 288,152 filed June 17, 1963. The details of construction and connection of the motor means and the transmission means are shown in copending application Ser. No. 396,978 filed Sept. 14, 1964. It is to be noted that the transmission-motor means unit is rotatably supported by the shaft means 54 and that annular spline members 72, 76 are rotatable about the shaft means 54 and are rotatable relative to one another whereby the actuating arms 66, 84 are oppositely rotatable about the central axis 61.

The actuator output arms are suitably connected to the window to enable the window to be raised and lowered as the arms rotate.

Motion controlling means are utilized to obtain the desired movement of the window when the actuator is operated. The motion controlling means may take any of a variety of forms whereby a desired output motion is attained. For example, guide means such as window guide channels may be utilized to control the motion of the actuable device, such as a window, or guide means in the form of linkage means connected to the actuator may be utilized, or both guide channels and linkage means may be used. Furthermore, the linkage means may be symmetrical, as shown in FIG. 9, to produce generally uniform motion, such as vertical non-uniform motion, such as a partial vertical, partial horizontal, motion which may include both reciprocating and swinging movement. While the illustrative embodiment employs motion controlling means comprising both window guide channels and linkage means, either means can be used without the other.

In the illustrative embodiment, as shown in FIG. 1, the actuator output arms 66, 84 are pivotally and slidably connected at one end at 110, 112, respectively, to the window 10 by means 111 and roller means 113, FIG. 6, mounted in the channel-shaped guides 23, 22. It may be noted that the pivotal axis of the arms 66, 84 at 110, 112 are spaced equidistant from the central axis 61 of the actuator means 50. The other ends of the actuator output arms extend radially outwardly beyond the periphery of the actuator casing a distance sufficient to enable pivotal connections to be made at 114, 116 to one end of link members 118, 120. The opposite ends of the link members are pivotally connected at 122, 124 to the slide 42 as shown in detail in FIG. 4. The link members are bowed sufficiently to accommodate the actuator casing therebetween in the lowermost position shown in FIG. 2. It may be noted that the pivots 122, 124 are equidistant from the pivots 114, 116.

In the lowered position of the window shown in FIG. 1, the pivots 114, 116 are located above the central axis

5

61, the pivots 122, 124 and the slide 42 are located at the top of the guide rod 36, and the pivots 110, 112 are located toward the innermost ends of their respective slides 20, 22. When it is desired to raise the window, the motor means may be selectively operated in a direction causing upward rotation of the output arm means 66 in the direction of the arrow 130 and upward rotation of the output arm means 84 in the direction of arrow 132 as shown in FIG. 1. As the window is raised, pivots 110, 112 move upwardly around the central axis 61 and outwardly in the slides 20, 22, the pivots 114, 116 move downwardly around the central axis 61, and the pivots 122, 124 are moved downwardly with the slide 42 along the rod 36 to the intermediate position shown in FIG. 3. Further opposite upward rotative movement of the output arms causes inward displacement of the pivots 110, 112 along the slides 20, 22, further downward movement of the pivots 114, 116 about the axis 61, and further downward displacement of the pivots 122, 124 with the slide 42 to the raised position shown in FIG. 5. Thus, in the fully extended position, the pivots 110, 112 and 114, 116 have changed positions above and below the central axis 61. The pivots 114, 116 and 124, 122 are vertically stacked and closely positioned horizontally relative to a vertical plane including the central axis 61 and extending parallel to the direction of movement of the window. The pivots 110, 112 are located further outwardly to provide optimum support for the window. When it is desired to lower the window, the motor means are reversely actuated to cause downward rotation of the output arm means 66, 84 in the direction of the arrows 134, 136 as will be obvious.

Referring now to FIG. 9, a schematic representation is shown of the synchronized window movement provided in the illustrative embodiment due to the use of the symmetrical motion controlling linkage. The spaced pivotal connections 122, 124 are shown as a single pivot 123. The distances between the pivotal center 61 and the pivots 110, 112, and the distances between the pivotal center 61 and the pivots 114, 116 are equal. Thus the pivot points move symmetrically as shown in the diagrammatic representation of the movement in FIG. 9. In the lowered position of the window, FIGS. 1 and 9, the pivot points are designated 110, 112, 114, 116, 122, 123, 124 and the corresponding links are shown by solid lines in FIG. 9. Successively higher positions are shown in FIG. 9 by the dotted lines, the dash-dot-dash lines, the dash-dot-dot-dash lines, and the dash-dot-dot-dot-dash lines. The pivot positions are designated, respectively, *a*, *b*, *c*, and *d*.

In FIG. 10, a non-symmetrical monkey linkage arrangement is schematically illustrated in a similar manner. The length of link 178 measured from the central axis 61 to the pivot 170 is the same as the length of link 180 measured from the central axis 61 to the pivot 172 but, in the lowered position, the links are inclined at different angles. The length of link 182 measured from the central axis 61 to the pivot 174 is longer than the length of link 184 measured from the central axis 61 to the pivot 176.

Thus, in the lowered window position shown by the solid lines, the window bottom line 136 is inclined with pivot 172 being located a substantial distance above pivot 170. As the actuator rotates the links about the central axis 61, the angle of inclination of the window bottom line 186 decreases as indicated at the positions 186*a*, 186*b*, 186*c* until, at the position 186*d*, the window bottom line is horizontal. At the same time, the vertical spacing of the pivots 170, 172 changes, as indicated at 170*a*, 172*a* and 170*b*, 172*b*, and 170*c*, 172*c*, until at 170*d*, 172*d* they are vertically aligned. A corresponding change in position of links 182, 184 and pivots 174, 176 results. If control linkage 188, 189 is used, the control linkage and pivots 178 will move as shown.

The aforescribed linkage is but one example of a non-symmetrical arrangement by which a particular movement may be effected. It is to be understood that the control linkage 188, 189 may be deleted or modified and

6

that the movement control means may be otherwise provided by, for example, guide channels as previously discussed.

It is contemplated that the inventive concepts hereinbefore illustratively shown and described may be variously otherwise embodied without departing from the intended scope of the following claims as limited by the prior art.

The invention claimed is:

1. An actuator arrangement comprising an actuable device reversely movable between spaced positions, an actuator device comprising an axial air gap type electrical motor having a disc armature reversely rotatable to effect reverse movement of said actuable device, said actuator device further comprising transmission means integrally associated with said motor and including a first reversely rotatable output means forming part of said transmission means and a second reversely rotatable output means forming part of said transmission means, said first reversely rotatable output means and said second reversely rotatable output means being simultaneously rotatable relative to one another in opposite directions, motion controlling means controlling movement of said actuable device between said spaced positions and of said first and second reversely rotatable output means relative to each other, and support means movably supporting said actuator device relative to said actuable device.

2. An actuator arrangement comprising actuable means reversely movable between spaced positions, guide means confining movement of said actuable means to a predetermined path between said spaced positions, reversely operable motor means for effecting movement of said actuable means, output means integral with said motor means and forming a housing therefor having a pair of housing portions simultaneously operable in opposite directions and being operably connected to said motor means and reversely operable thereby, and linkage means connecting said output means to said actuable means to cause movement of said actuable means in one direction upon selective operation of said motor means in one direction and to cause reverse movement of said actuable means in the opposite direction upon selective operation of said motor means in the opposite direction.

3. An actuator arrangement for causing substantially rectilinear movement of a window in a vehicle door or the like between an open position and a closed position comprising: guide means fixed to said door and guidably receiving said window for movement relative to said door, slide means fixed to said window and including a first track portion adjacent one side of the window and a second track portion adjacent the opposite side of the window, selectively operable reversible electric motor means for moving the window toward the closed position when operated in one direction and toward the open position when operated in the opposite direction, said motor means being of the axial air gap type and having a disk type armature reversibly rotatable about a central axis of the motor, speed reduction means drivably connected to said armature of said motor means and having a first reversely rotatable output means and a second reversely rotatable output means, said first and second rotatable output means being relatively rotatable about the central axis and being arranged for simultaneous rotation in opposite directions, said motor means and said reduction means being integrally connected as a unit and having a common axis of rotation, rotatable operating arm means connected to each of said first and second reversely rotatable output means and being rotatable thereby in opposite directions about said central axis, each of said operating arm means having a pair of spaced pivotal connections located on opposite sides of said central axis of rotation, a first set of corresponding ones of said pivotal connections on said operating arm means on the same side of said central axis of rotation being slidably received by said slide means on said window for movement along said slide means

7 toward and away from one another as said window is closed and opened, a second set of corresponding ones of said pivotal connections on said operating arm means on the same side of said central axis of rotation and opposite said first set of corresponding ones of said pivotal connections forming pivotal connections between said actuator and said door, and movable support means for at least one of said second set of corresponding ones of said pivotal connections movably connecting said rotatable output means to said door.

4. The invention as defined in claim 3 and wherein said movable support means comprises a second slide means mounted on said door between said slide means on said window, slide follower means mounted on said second slide means for movement therealong, connecting link means pivotally connected at one end to said slide follower means and extending outwardly therefrom on opposite sides thereof, and said second set of corresponding pivotal connections being pivotally connected to the other end of said connecting link means.

5. An actuator unit comprising an axial air gap type motor having a disk armature rotatable about a central axis, a housing enclosing said motor and said armature, said housing having a pair of oppositely relatively rotatable output means integrally rotatably mounted on said unit and being reversely rotatable about said central axis, pivotal connecting means mounted on each of said output means and being radially spaced from said central axis to impart movement to an actuable device connected thereto, and unit support means extending parallel to said central axis and movably supporting the entire unit including the motor and the armature and the housing and the output means.

6. An actuator arrangement comprising an axial air gap type motor, rotatable output means operably connected to said motor, a cylindrical housing formed for and by said motor and said output means, a pair of oppositely rotatable operating arm means connected to said output means, each of said operating arm means having a common centrally located axis of rotation and pivotal connecting means located on opposite sides of said centrally located axis of rotation, one of said pivotal connecting means of each arm means having a pivotal axis located radially outwardly from said centrally located axis of rotation adjacent the periphery of said cylindrical housing, the other of said pivotal connecting means of each arm means having a pivotal axis located further radially outwardly from said centrally located axis of rotation than the pivotal axis of said one of said pivotal connecting means, support means mounting said cylindrical housing and said arm means, and bowed movement controlling linkage means connected between said arm means and arranged so as to control movement of said arm means and arranged so that in one extreme position of said arm means said bowed linkage means envelopes a portion of said cylindrical housing and is positioned closely adjacent the outer cylindrical periphery thereof.

7. An actuator for a reversibly displaceable device such as a vehicle window or the like adapted to be mounted within a compartment such as a vehicle door or the like and comprising: reversibly operable rotatable electric motor means mounted within said compartment; rotatable transmission means connected to said motor means in said compartment; a pair of simultaneously oppositely rotatable output means having a common central axis of rotation and being drivably connected to said transmission means and adapted to be simultaneously rotatably driven in opposite directions by said motor means about said common central axis of rotation; said motor means and said transmission means and said output means being connected together to form a unit having relatively rotatable sections, supporting means movably supporting said unit and permitting relative rotation of said sections and said output means and said transmission means and said

motor means; and means for connecting said output means and said device to cause reversible displacement of said device when said motor means is reversibly operated.

8. The invention as defined in claim 7 and wherein said motor means comprises a disk armature motor adapted to be rotatably driven about the central axis of rotation of said output means.

9. The invention as defined in claim 8 and wherein said transmission means comprises harmonic drive means operable by a rotatable input means having an axis of rotation coincident with the central axis of rotation of said output means.

10. The invention as defined in claim 7 and having a common support for rotatably supporting said motor means, said transmission means, and said output means.

11. The invention as defined in claim 10 and wherein said common support comprises shaft means fixedly mounted in said compartment, hub means rotatably mounted and axially confined on said shaft means, and said motor means, said transmission means, and said output means being rotatably supported by said hub means.

12. The invention as defined in claim 7 and wherein said last mentioned means comprises elongated radially extending arm means fixedly connected to said rotatable output means, pivot means at corresponding ends of said arm means pivotally connected to said device, first slide means providing a linear track fixedly mounted on said device and slidably supporting said pivot means to permit variable displacement of the pivot means toward and away from one another along said linear track as said arm means are rotatably driven by said output means, and movable support means supporting the opposite ends of said arm means.

13. The invention as defined in claim 12 and wherein said support means comprises a second slide means providing a linear track extending transversely to said linear track provided by said first slide means, and support linkage means pivotally connected to the opposite ends of said arm means and to said second slide means.

14. An actuator for a displaceable window or the like mounted in a vehicle door or the like comprising: guide means for guidably supporting the window for opening and closing movement between a closed position and an open position, spaced guideway means mounted on said window and providing track means extending generally transversely to the path of movement of said window, pivotal connecting means slidably mounted in said guideway means for reciprocable movement toward and away from one another during opening and closing movement of said window, a pair of oppositely rotatable output arms, one of said output arms being connected at one end to one of said pivotal connecting means, and another of said output arms being connected at a corresponding end to the other of said pivotal connecting means, said output arms being rotatably supported about a common axis of rotation, slide means adapted to be mounted on said door, linkage means pivotally connected at one end to said slide means and pivotally connected at the other end to each of said output arms on portions of said output arm means located radially outwardly of said common axis of rotation opposite said pivotal connecting means, and actuating means mounted on said door and being operatively connected to said output arm means to cause reverse rotation of said output arm means about said common axis of rotation, said output arm means being rotated in opposite directions to cause closing movement of said window when said actuating means is operated in one direction and to cause opening movement of said window when said actuating means is operated in the reverse direction.

15. The invention as defined in claim 14 and wherein said actuating means comprises a pair of relatively rotatable splined output members, flex spline drive means drivingly engageable with said splined output members, one of said splined output members being rotatably supported

about said common axis of rotation and fixedly connected to one of said output arms, and another of said splined output members being rotatably supported about said common axis of rotation and fixedly connected to the other of said output arm means.

16. The invention as defined in claim 15 and having common support shaft means rotatably supporting said splined output members, and said common axis of rotation coinciding with the central axis of said support shaft means.

17. The invention as defined in claim 16 and having speed reduction means drivably engaged with said flex spline means, reversible electric motor means drivably connected to said speed reduction means, said speed reduction means and said motor means being rotatably supported by said common support shaft means for rotation about said common axis of rotation.

18. An actuator arrangement comprising an axial air gap type motor having a disk armature rotatable about an axially extending central axis of rotation, speed reduction means integrally associated with said motor and being rotatable about the central axis of said disk armature, a first output means forming part of said reduction means and being reversely rotatable about the central axis by reverse operation of said motor, a second output means forming part of said reduction means and being reversely rotatable about the central axis by reverse operation of said motor, said first output means and said second output means being adapted and arranged to rotate simultaneously in opposite directions, a first actuating arm means connected to one of said output means and being rotatable therewith about the central axis, a second actuating arm means connected to the other of said output means and being rotatable therewith about the central axis, said first actuating arm means and said second actuating arm means being reversely rotatable simultaneously in opposite directions, a first set of pivot connections for connecting said actuating arm means to an actuable device, one of said first set of pivotal connections being located adjacent one end of one of said actuating arm means, the other of said first set of pivotal connections being located adjacent the same end of the other of said actuating arm means, each of said first set of pivotal connections being located radially outwardly from the central axis on opposite sides of a plane including the central axis and extending parallel to the direction of movement of the actuable device, connecting means for connecting said first set of pivotal connections to the actuable device and enabling movement of said first set of pivot means having transverse components of motion, means providing a second set of pivotal connections for supporting said actuating arm means, one of said second set of pivotal connections being located adjacent an opposite end of one of said actuating arm means, the other of said second set of pivotal connections being located adjacent an opposite end of the other of said actuating arm means, said second set of pivotal connections being located radially outwardly from the central axis opposite to said first set of pivotal connections, and support means movably supporting said second set of pivotal connections and permitting relative movement of said motor and said reduction unit and said output means and said actuating arm means about the central axis.

19. An actuator arrangement comprising an actuable device reversely movable between spaced positions, support means for said actuable device including as a component part a reversibly operable rotatable electric motor, an actuator device reversely rotatable to effect reverse movement of said actuable device and further including as component parts a first reversely rotatable output means and a second reversely rotatable output means, said first reversely rotatable output means and said second reversely rotatable output means being simultaneously rotatable in opposite directions, and support means rotatably supporting and connecting said actuator device and the component parts thereof between said actuable device

and said support means and permitting relative rotative movement of said actuator device and the component parts thereof between said support means and said actuable device as said actuable device is moved between said spaced positions.

20. A power actuator arrangement for an actuable device such as a vehicle window or the like which is reversibly movable back and forth between spaced positions, comprising:

a pair of rotatable actuator arms rotatable simultaneously oppositely about a common axis of rotation, connecting means on each arm radially spaced from said common axis and adapted to be connected to the actuable device in a manner causing reversible back and forth movement of the actuable device, reversible electrical motor means having a rotatable annular armature mounted for reversible rotation about said axis of rotation,

flexible annular drive spline transmission means mounted circumjacent said motor means for reversible rotation about said axis of rotation and connected to said motor means for driving actuation thereby,

first annular driven output spline transmission means mounted circumjacent said flexible drive spline transmission means and connected thereto for driving actuation thereby,

second annular driven output spline transmission means mounted circumjacent said flexible drive spline transmission means and connected thereto for driving actuation thereby,

one of said rotatable actuator arms being operatively connected to the first driven output spline means and rotatably driven thereby,

the other of said rotatable actuator arms being operatively connected to the second driven output spline means and rotatably driven thereby,

and mounting means mounting said actuator arms and said motor means and said transmission means relative to said actuable device so that operation of said electrical motor and rotation of said armature and said flexible drive spline transmission means causes simultaneous opposite rotation of said first and second driven output spline transmission means and said rotatable actuator arms.

21. The invention as defined in claim 20 and there being common support means rotatably supporting each of said armature, said flexible drive spline transmission means, said first and second driven output spline transmission means, and said actuator arms.

22. The invention as defined in claim 20 and said electrical motor means being of the axial air gap type and said armature being a disc type armature.

23. The invention as defined in claim 20 and said armature being axially spaced from said flexible drive spline transmission means and from said first and second driven output spline transmission means and from said actuator arms.

24. The invention as defined in claim 20 and the actuator components being associated so as to form an integral self-contained narrow width unit comprising:

a motor-transmission housing having opposite relatively rotatable portions,

said first and second driven output spline transmission means being drivably connected to said relatively rotatable portions of said housing,

and said actuator arms being mounted on said relatively rotatable portions of said housing and rotatable therewith.

25. The invention as defined in claim 24 and having common support means rotatably supporting said armature and said housing portions and said actuator arms, a portion of said support means being mounted within said housing and a portion of said support means extending without said housing for mounting of said unit.

26. The invention as defined in claim 25 and said

support means radially supporting and locating said housing portions, axial locating means associated with said support means axially locating said housing portions, and axial and radial locating and supporting means within said housing radially and axially locating and supporting said armature in spaced relationship to said support means.

27. The invention as defined in claim 25 and having support bracket means fixed relative to said actuable device, and said support means being attached to said support bracket means and supporting said housing portions and said actuator arms for rotation relative to one another and to the actuable device.

28. The invention as defined in claim 27 and having motion control means connected to said actuator arms to control movement of said arms and said actuable device.

29. The invention as defined in claim 28 and wherein said motion control means comprises a control means connecting each actuator arm to said support bracket means.

30. The invention as defined in claim 29 and having slide means movable relative to said housing, at least one of said control means being mounted on and carried by said slide means.

31. The invention as defined in claim 30 and said con-

trol means providing for non-uniform motion of said actuable device.

32. The invention as defined in claim 31 and said control means restricting movement of one of said arms relative to the other of said arms to cause the non-uniform movement of the actuable device.

References Cited

UNITED STATES PATENTS

10	3,039,324	6/1962	Waterfield	74—640
	3,101,009	8/1963	Musser	74—640
	3,166,949	1/1965	Lapp	74—640 X
	3,182,525	5/1965	Tinder et al.	74—640
	3,209,182	9/1965	Spring	74—640 X
15	3,211,262	10/1965	Hoffstrom	74—640 X
	3,239,699	3/1966	Ferrary	310—83
	1,720,063	7/1929	Serste	49—351
	2,304,245	12/1942	Dorries	49—349 X
20	2,793,907	5/1957	Hess et al.	49—349 X

FOREIGN PATENTS

581,480 10/1946 Great Britain.

DAVID J. WILLIAMOWSKY, *Primary Examiner.*

25 J. K. BELL, *Assistant Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,373,528

March 19, 1968

David V. Tinder et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 61, "invention" should read -- inventive --.
Column 4, line 50, after "vertical" insert -- reciprocation, or non-symmetrical, as shown in Fig. 10, to produce --; line 61, "pivatal" should read -- pivotal --. Column 5, line 3, "inermost" should read -- innermost --; line 5, "selctively" should read -- selectively --. Column 9, line 65, after "device" insert -- an actuator device --; line 67, cancel "an actuator device"; line 73, "rotatably" should read -- movably --.

Signed and sealed this 5th day of August 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents