March 21, 1967 E. J. HUNTER ET AL 3,310,099

ELECTRIC VENETIAN BLIND

Filed July 19, 1965 3 Sheets-Sheet 1

FIG. 1.

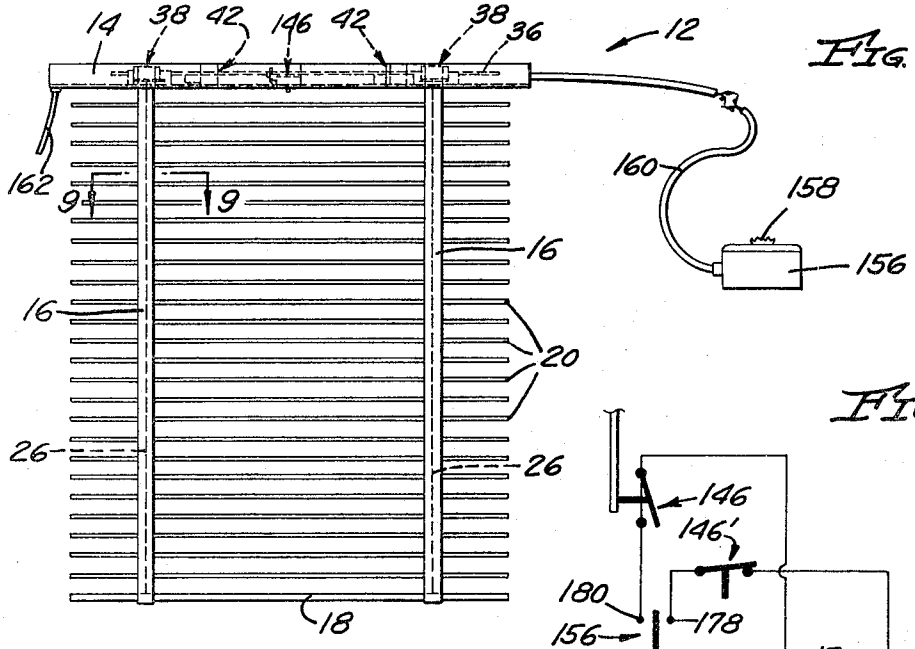

FIG. 10.

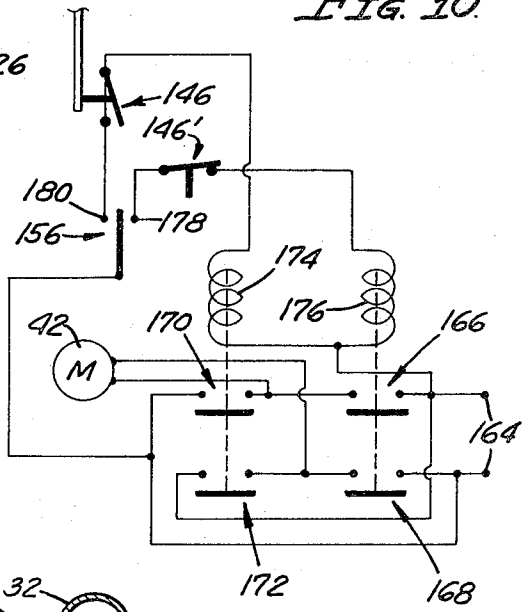

FIG. 9.

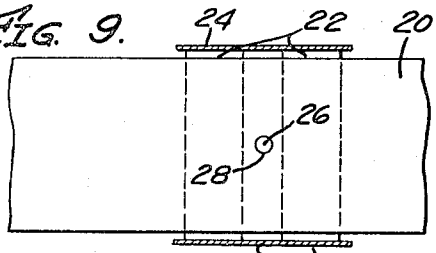

FIG. 8.

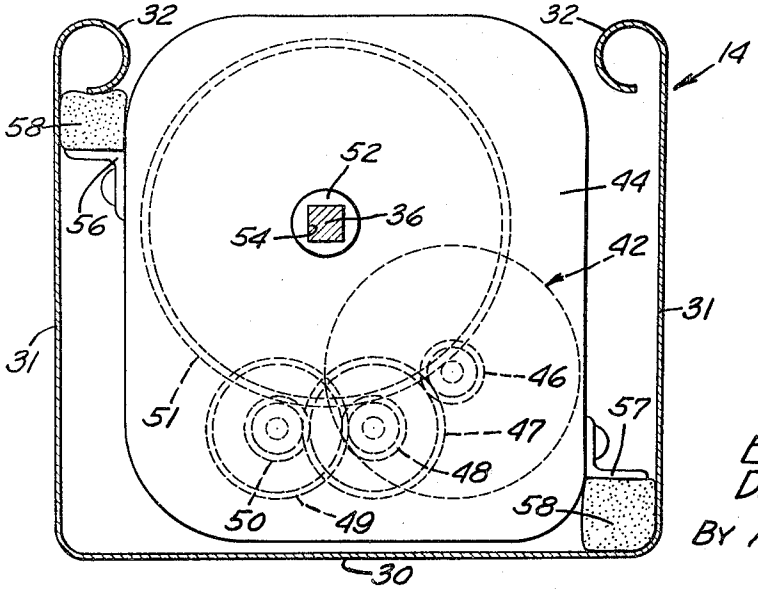

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FIG. 3.

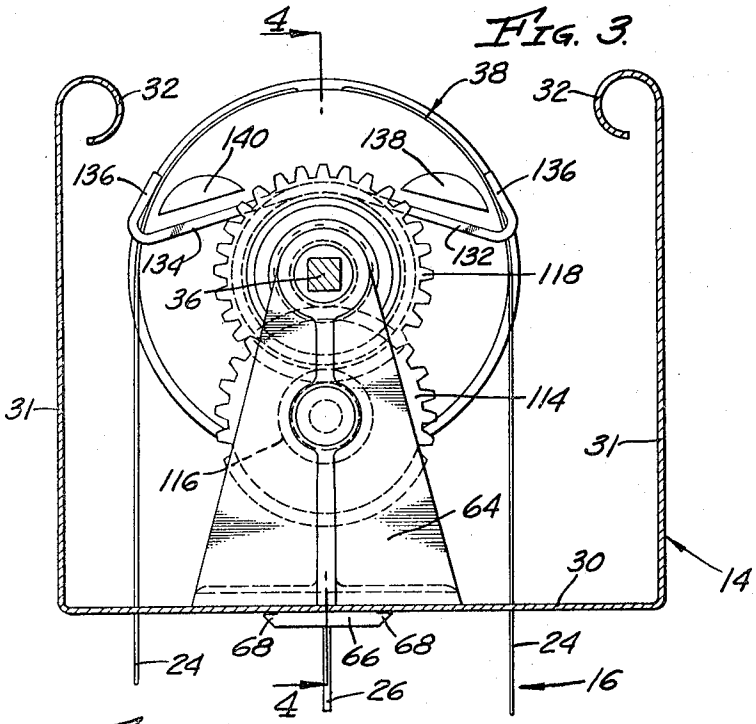


FIG. 5.

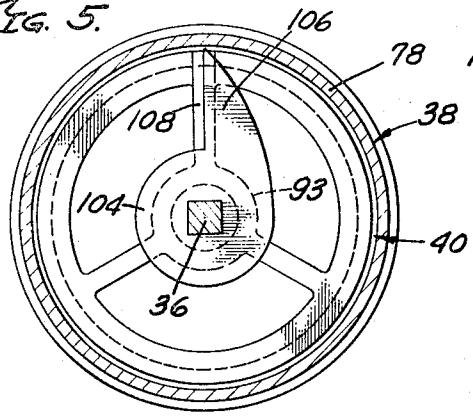


FIG. 6.

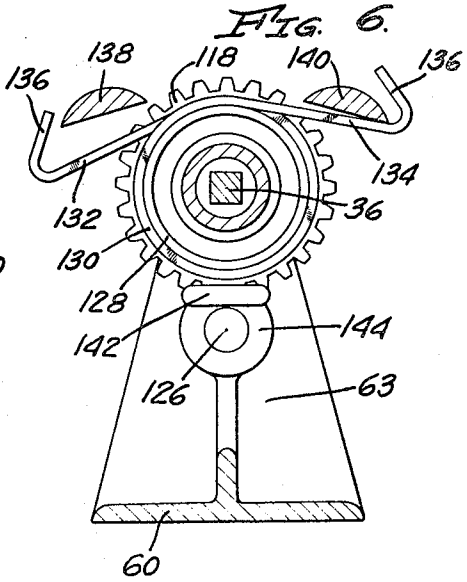
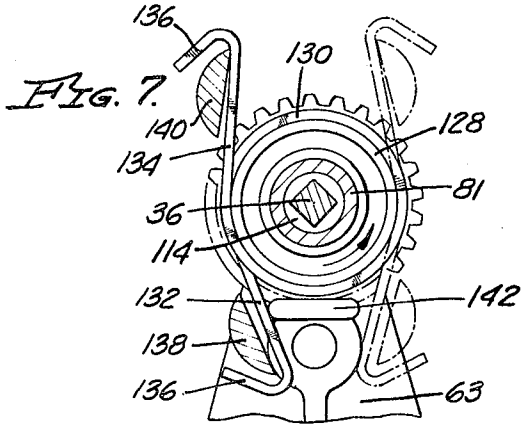


FIG. 7.



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ELECTRIC VENETIAN BLIND

Filed July 19, 1965 3 Sheets-Sheet 3

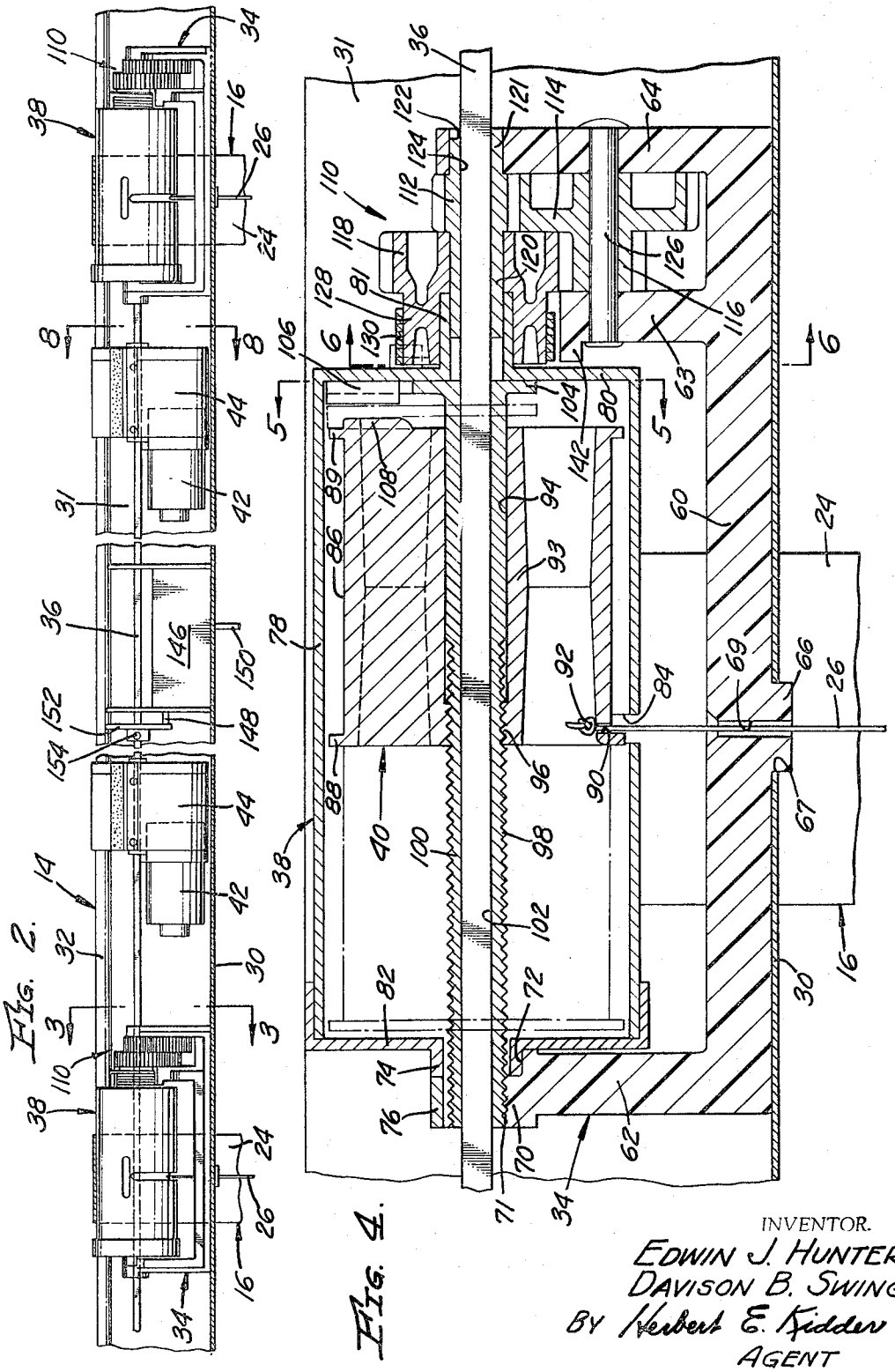

Fig. 2.

Fig. 4.

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3,310,099

ELECTRIC VENETIAN BLIND

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Filed July 19, 1965, Ser. No. 472,780
14 Claims. (Cl. 160—171)

The present invention relates generally to Venetian blinds, and more particularly, to blinds wherein the slats are tilted and raised or lowered by electric motors actuated by a remote-control switch.

Electric Venetian blinds have found relatively little acceptance in the United States up to this time, but are used to some extent in Europe, particularly for commercial installations or where the blind is located in a relatively inaccessible spot, as for example, between panes of glass, or where the blinds are mounted on the outside of a window. One reason for the limited use of electric blinds is their extra cost, which makes the electric blind considerably more expensive than ordinary Venetian blinds.

Electric Venetian blinds have many advantages over conventional, manually operated Venetian blinds, which make them attractive for home use. One of these advantages is that there are no unsightly cords dangling from the headrail. In the case of a large blind, there may be as many as six cords hanging downwardly from the headrail, four of which are for raising and lowering the blinds, and the other two for tilting. With the electric blind, there is a remote-control switch that is connected to the headrail by a small, inconspicuous wire, which may be concealed if desired. Another advantage of the electric blind is that a number of blinds on windows along one wall, as in the case of a business office, can be operated simultaneously without going from one blind to the next. Still another advantage is that the electric blind is adapted to automatic control, using a photoelectric cell to obtain maximum light transmission without direct sunlight. With these advantages, it is believed that the electric Venetian blind would find widespread use in this country as well as in other parts of the world, if the cost were brought down to a level more competitive with the ordinary, manually operated Venetian blinds.

The primary object of the present invention, therefore, is to produce a low-cost electric Venetian blind that can be produced to sell at a price only slightly higher than the cost of a conventional, manually operated blind of the same size and quality.

Another object of the invention is to provide an electric blind using low-voltage components that do not require installation by a licensed electrician in order to comply with municipal building ordinances.

Another object of the invention is to provide an electric blind in which the tilting operation is done at a relatively slow speed for precise control, so that the slats can be tilted to the exact angle desired, without overshooting.

A further object is to provide an electric blind which shuts off automatically as the blind reaches the fully-raised or fully-lowered positions.

Still a further object is to provide an electric blind in which the mechanism for lowering the lift cords is responsive to any interference with the free descent of one end or the other of the blind by a piece of furniture or the like, to stop the lift cord from being paid out further until the obstruction has been removed, at which time the mechanism lowers that end of the blind gently to the same level as the other end. This prevents the lift cords from being paid out while the slack is not being taken up, with resultant tangling and disarrangement of the lift cords.

These objects are achieved in the present invention by the use of a new and unique approach to the concept of the motor-driven electric Venetian blind. Prior electric blinds known to applicants use one large motor to drive a shaft that turns both the lift cord drums and the ladder tape drums at the same speed, with a friction clutch between the drive shaft and the tape drums that allows slippage between them when the tape drums have reached the fully tilted position, in one direction or the other. In order to ensure that the same motor will satisfactorily operate any size blind in which it is installed, the motor used is large enough to handle the largest blind that may be encountered. This means that on a small blind, the motor is considerably more powerful than necessary, hence its cost is disproportionately high for small blinds. Another reason for using the large, relatively powerful electric motor, is that the motor must overcome the friction of the clutches connecting the drive shaft to the tape drums. This may consume as much as half of the power output of the motor.

In the present invention, a drive shaft is driven by one or more electric motors, depending upon the size of the blind. The motors used are small, low-voltage, reversible D.C. motors of the permanent magnet type, having only a few watts of output. Motors of this type are very inexpensive and are already available on the market. One motor is sufficient to operate the smaller blinds, and in the larger size blinds, two or more motors may be used, with the motors located adjacent the components which accomplish the tilting and raising or lowering of the blind. Since the torque that is applied to the drive shaft by each of the motors is relatively small, and in the case of the larger blinds the driving torque is applied to the shaft at several points closely adjacent the loads, a relatively small shaft can be used. This small-sized shaft not only offers cost advantages, but also permits use of smaller size bearings, and this proportionally reduces the friction that is developed at this point.

One important feature of the invention is that the tape drum is driven from the drive shaft through a train of speed-reduction gears, so that it turns at a fraction of the speed of the drive shaft. This is in contrast with previous electric blinds, wherein the tape drum is driven at the same speed as the drive shaft, with the result that the tilting action is much too fast for accurate control, and it is virtually impossible to stop the tilt at a precise position. In the present invention, a novel clutch is interposed between the speed-reduction gears and the tape drum, and since the clutch is located beyond the gears, the torque at the drive shaft required to overcome the friction of the clutch is only a fraction of that required with a clutch that is driven at the same speed as the drive shaft, as in prior electric blinds. Another advantageous feature of this gear-reduction drive to the tape drum is that it permits more accurate control over the tilt of the blind, and the slats can readily be adjusted to any precise angle of tilt, so that there is maximum transmission of light without any direct sunlight.

Another advantageous feature of the invention is that the lift cord is wound up onto a drum in a single layer of closely spaced turns, so that the mechanical advantage remains the same at all times when raising or lowering the blind. This is in contrast with prior electric blinds, where the blind is raised or lowered by means of steel tapes that wind up on top of themselves, with the result that the effective diameter of the drum increases as the blind is raised, thereby reducing the mechanical advantage as the load becomes greater.

The foregoing and other objects and advantages of the present invention will become apparent to those skilled in the art upon consideration of the following detailed de-

scription of the preferred embodiment thereof, reference being had to the accompanying drawings, wherein:

FIGURE 1 is a side elevation of an electric Venetian blind embodying the principles of the invention;

FIGURE 2 is an enlarged longitudinal vertical section through the headrail, showing the several operating components in the side elevation;

FIGURE 3 is a still further enlarged transverse sectional view, taken at 3—3 in FIGURE 2;

FIGURE 4 is a sectional view, taken at 4—4 in FIGURE 3;

FIGURE 5 is a sectional view through the tape drum, taken at 5—5 in FIGURE 4;

FIGURE 6 is a sectional view, taken at 6—6 in FIGURE 4, and showing the clutch spring driving the tape drum in the counter-clockwise direction;

FIGURE 7 is a fragmentary view, similar to FIGURE 6, showing the manner in which the clutch spring releases the tape drum when the latter reaches either of two limiting positions;

FIGURE 8 is an enlarged sectional view of the motor and integral gearbox, taken at 8—8 in FIGURE 2;

FIGURE 9 is an enlarged sectional view through one of the ladder tapes, taken at 9—9 in FIGURE 1; and

FIGURE 10 is a circuit diagram, showing the electrical system.

In the drawings, the electric Venetian blind of the present invention is designated in its entirety by the reference numeral 12, and comprises a channel-shaped headrail 14 from which the ladder tapes 16 depend. In the case of a small-to medium-size blind, there are normally two ladder tapes 16, which are disposed near the ends of the headrail, as shown in FIGURE 1. However, there may be three, four, or more ladder tapes on larger blinds, in which case they are spaced at intervals along the length of the headrail, as is well-known in the art. The bottom ends of the ladder tapes 16 are attached to a bottomrail 18, and supported on the ladder tapes is a plurality of vertically spaced, horizontally extending slats 20. The slats 20 rest upon staggered cross-pieces 22 (FIG. 9), which are connected to and extend between side tapes 24 of the ladder tapes. Lift cords 26 are attached to the bottomrail 18 and extend upwardly therefrom to the headrail, passing through aligned cord holes 28 in the slats. The lift cord 26 is preferably a small-diameter steel cable, about $\frac{1}{32}$" in diameter, and the cord holes are preferably small-diameter circular holes bout $\frac{3}{16}$" in diameter.

The headrail 14 is preferably made of sheet metal formed into a square channel and having a bottom 30 and sides 31. Along their top edges, the sides 31 have inwardly rolled edges 32. Extending longitudinally of the headrail and rotatably supported therein on brackets 34 is a drive shaft 36. The drive shaft 36 may be relativley small in size, and is preferably square in cross-section, with dimensions of the order of $\frac{1}{8}$" on a side. Rotatably mounted on each of the brackets 34 is a tape drum 38 and a lift cord drum 40.

The drive shaft 36 is driven by one or more, small, reversible, D.C. electric motors of the permanent magnet type, having an output in the neighborhood of 3 watts. The number of motors 42 is dependent upon the size of the blind, and therefore for the very smallest blinds, there would be only one motor. In a somewhat larger blind, there would be two electric motors, as shown in FIGS. 1 and 2, and for very large blinds, there could be as many as four or five motors. Each motor has an integral gearbox 44 containing a train of speed-reduction gears 46, 47, 48, 49 and 50 (see FIG. 8). The final gear 51 has a hub 52 which is journaled in the gearbox housing 44, and formed in the center of this hub is a square hole 54, through which the shaft 36 extends. Mounted on opposite sides of the gearbox 44 near its top and bottom corners, respectively, are angle brackets 56 and 57, having rubber cushioning blocks 58 bonded thereto, which bear against the bottom of the headrail and against one rolled edge 32, as shown in FIG. 8. These cushioning blocks 58 transmit the torque of the motor to the headrail while the mechanism is raising the blind, and at the same time prevent transmission of vibration to the headrail, which tends to amplify the sound.

Each of the brackets 36 is preferably molded of plastic, and is formed with a base 60, having three upstanding posts 62, 63 and 64. Formed on the underside of the base 60 is a boss 66, which projects downwardly through an aperture 67 in the headrail bottom 30, as shown in FIGURE 4. The boss 66 has laterally projecting lips 68 on opposite sides thereof (see FIG. 3), which hook under the headrail bottom 30 along the margins of the aperture 67, and these prevent the boss 66 from being pulled out of the aperture. A vertical hole 69 is formed in the bracket bottom 60 and extends through the boss 66, and the lift cord 26 passes up through this hole to its attachment with the lift drum 40.

The left-hand end post 62 (as viewed in FIG. 4) of the bracket 34 has a semi-cylindrical saddle 70 formed in its top end, and this is provided with internal screw threads 71, the purpose of which will be explained presently. Also formed in the top end of the post 62 on the inner side thereof is a semi-cylindrical bearing support 72, which receives a bearing hub 74 projecting axially from the left-hand end of the tape roll 37. A retainer 76 extends over the top of the threaded saddle portion 70 to hold the tape roll in the bracket during shipment.

The tape drum 38 has a hollow cylindrical body 78 with an integral end 80 at the right-hand end thereof, from which a hub portion 81 projects axially to the right. The left-hand end of the body portion 78 is closed by an end cap 82, and the bearing hub 74 projects axially to the left from the center of the end cap 82. Midway between the ends of the cylindrical body portion 78, in the lower half thereof, is a circumferential slot 84, through which the lift cord 26 passes upwardly to its attachment with the drum 40. Means (not shown) is provided on the top half of the body portion 78 for attaching the ends of the tapes 24 thereto, such means being more-or-less conventional and comprising axially projecting fingers which are inserted through loops formed in the top ends of the tapes 24 by bending the tape over and stapling it onto itself.

The lift cord drum 40 is disposed concentrically within the hollow tape drum 38 and is only about one-half the length of the latter, as seen in FIGURE 4. The drum 40 consists of a cylindrical body portion 86 on which lift cord 26 is wound, and at opposite ends of the cylindrical portion 86 are radial end flanges 88 and 89, which confine the lift cord and prevent it from slipping off the ends of the drum. A hole 90 is formed in the cylindrical body portion 86 closely adjacent the left-hand flange 88, through which the lift cord 26 passes and is knotted at 92. At the center of the lift cord drum 40 is a hub 93 having a central bore 94. At one end of the bore 94 is an internal thread 96 which engages an external thread 98 on a rotatable member 100.

The member 100 is an elongated, tubular member having a square hole 102 through its center, into which the shaft 36 is inserted. The threaded left-hand end of the rotatable member 100 is seated in the saddle 70, and threads 98 are engaged by the threads 71 of the saddle. The purpose of this threaded engagement between the rotatable member 100 and the stationary saddle 70 is to advance the lift cord drum 40 as the latter turns, so that the cord 26 is wound onto the drum in a single layer, with the individual turns of the cord spaced closely together along the length of the cylindrical surface 86.

At the right-hand end of the rotatable member 100 is a radial flange 104, and extending outwardly from this flange is a driving arm 106 (see FIG. 5) which engages a lug 108 projecting axially from the adjacent end of the lift cord drum 40. Counterclockwise rotation of the arm 106 (as viewed in FIG. 5) causes the arm to push lug 108 ahead of it, and this causes the drum 40 to move in that

direction. The engagement of arm **106** by lug **108** also prevents the drum **40** from rotating in the clockwise direction responsive to the torsional effect due to load on the cords **26** when the blind is raised.

The internal threads **96** at the left-hand end of the bore **94** in lift cord drum **40** engage the external threads **98** on the rotatable member **100** for the purpose of enabling the drive shaft **36** to make three full turns after the blind is completely lowered and before the motors **42** are shut off automatically. This enables the lowered blind to be opened and closed without the raising and lowering action. As the blind reaches the fully lowered position and the lift cord **20** hangs straight down from its attachment to the drum **40**, the drum stops turning and is held stationary by the cord **26**, while the member **100** continues to turn with the drive shaft **30**. As the member **100** rotates, it continues to move axially toward the right (as viewed in FIG. 4), owing to the engagement of threads **98** and **71**, and the driving arm **106** moves clear of the lug **108**. When the flange **104** abuts against the end **80** of the tape drum **38**, the motors are shut off by a limit switch, which will be described presently. During the last three turns of the drive shaft **36**, the tape drum **38** is turned approximately one-half turn, which tilts the slats to the fully closed position. From this position, the slats of the lowered blind can be opened to any angle without raising the bottomrail **18**, as the drive shaft **36** is allowed three full turns to rotate the tape drum **38** through approximately a half-turn to tilt the slats from fully-closed to partially-closed in the other direction before the lug **108** is picked up by the arm **106**. When the lug **108** is engaged by the arm **106**, the lift cord drum is then caused to rotate with the drive shaft **36**, thereby winding the cord onto the drum and raising the blind.

The tape drum **38** is driven by the shaft **36** through a train of speed-reduction gears **110**, consisting of a first pinion **112** meshing with a cluster gear **114** having a second pinion **116** which meshes with a final gear **118**. The first pinion **112** has oppositely extending hub portions **120** and **121**, the latter of which is journaled in a bearing **122** in the top end of bracket post **64**. Extending all the way through the pinion **112** and hub portions **120** and **121**, is a square hole **124**, through which the shaft **36** is inserted. It will be noted in FIG. 4 that hub sleeve **81** at the right-hand end of drum **38** is telescoped over and journaled on the outer end of hub **120**, while final gear **118** is journaled on hub **120** between the end of hub sleeve **81** and first pinion **112**. Cluster gear **114**, with its pinion **116**, rotates on a shaft **126**, the ends of which are seated in aligned holes in posts **63** and **64**.

Final gear **118** has a cylindrical portion **128** projecting toward the tape drum **38**, and wrapped around this hub portion in firm frictional engagement therewith is a clutch spring **130**. The hub portion **128** also extends over and is journaled on the hub sleeve **81**.

The two ends of the spring, designated **132** and **134** respectively, project outwardly from the hub **128** in parallel planes perpendicular to the axis of the hub, and their outer extremities are bent over at an acute angle, as shown at **136**, to form hooks. Each of the spring ends **132**, **134**, is engageable with one of two driving lugs **138** and **140** projecting axially from the end **80** of the tape drum **38**, as illustrated in FIGS. 3, 6 and 7. Each of the lugs **138**, **140**, has a flat underside that is engageable by its associated spring end **132**, **134**, and an arcuately curved top side.

End **134** of the clutch spring **130** engages lug **140** to drive the tape drum **38** in the clockwise direction, as viewed in FIG. 3, or in the counterclockwise direction as viewed in FIGS. 6 and 7. This apparent reversal in direction is due to the fact that FIGS. 6 and 7 are sectional views taken at **6—6** in FIGURE 4, looking away from the tape drum, whereas FIG. 3 is a sectional view taken at 3—3 in FIG. 2, looking toward the tape drum. Spring end **132** engages lug **138** to drive the tape drum **38** in the counterclockwise direction in FIG. 3, or in the clockwise direction in FIGS. 6 and 7. When either of said spring ends **132**, **134** is driving its associated lug **138**, **140**, the clutch spring **130** is wrapped tighter around the hub **128**, thereby increasing the frictional grip of the clutch spring on the hub.

It will be noted in FIG. 6 that when spring end **134** is driving lug **140**, spring end **132** is spaced a considerable distance from its lug **138**. However, as the tape drum **38** reaches its point of maximum tilt in the counterclockwise direction, as shown in FIG. 7, spring end **132** engages a lug **142** on the post **63**, and this prevents the spring end from moving any further in the counterclockwise direction. Additional counterclockwise movement of spring end **134** and lug **140** causes spring end **132** to move relatively toward lug **138**, as shown in FIG. 7, and this has the effect of unwinding the clutch spring **130** slightly, so that the coils of the spring are caused to expand in diameter and thereby release their grip on hub **128**. With the grip of the clutch spring **130** thus relaxed on the hub **128**, the latter is allowed to slip, and the gears **112**, **114**, **116** and **118** continue to turn as they are driven by the shaft **36**, although the tape drum **38** remains stationary. The same condition is obtained in the opposite direction, when spring end **132** is driving lug **138**, except that spring end **134** engages a boss **144** on post **63**, in which one end of shaft **126** is held.

One of the important features of the present invention is the speed-reduction gear and clutch arrangement just described, wherein the clutch is disposed between the final gear and the tape drum. The speed-reduction gears **110**, as shown in this embodiment, gives a 6-to-1 reduction in speed, with a corresponding 6-to-1 increase in torque. Thus, the torque required to slip the clutch spring **130** on the hub **128** is amplified by the speed-reduction gears **110**, and the torque required at the drive shaft is only one-sixth the torque that would be required if the tape drum were driven at the same speed as the shaft **36**.

The motors **42** are shut off automatically when the blind is fully raised or lowered, by means of a limit switch **146** mounted in the headrail **14**. Limit switch **146** comprises a housing having two actuating plungers **148** and **150** projecting therefrom. Plunger **148** projects from one end of the switch housing and is engageable by a limit stop member **152** mounted on the drive shaft **36**. Limit stop member **152** moves axially with the drive shaft **36**, and is secured to the drive shaft by a set screw **154**, in position to engage and depress the plunger **148** just as the blind reaches the fully lowered position and is tilted closed. When the plunger **148** is depressed by the limit stop **152**, the motors **42** are shut off.

The other plunger **150** projects downwardly through a hole in the bottom of the headrail, and is engageable by the accumulated bundle of slats as the blind reaches the fully raised position. Depression of plunger **150** by the bundle of slats causes the motors **42** to be shut off automatically. Alternatively, the motors might be shut off when the blind is fully raised, using a separate limit switch with a plunger corresponding to **150**, which is engageable by a limit stop on the drive shaft **36** when the latter has moved axially to the position representing the fully raised position of the blind.

Operation of the blind is controlled by means of a control switch **156** (FIG. 1) having an actuating member **158**, which is pushed in one direction to raise the blind or tilt the slats in one direction, and in the other direction to lower the blinds or tilt the slats in the opposite direction. The control switch **156** is connected to the headrail by means of wire **160**. Another wire **162** is connected to the headrail **14**, and this latter wire is connected to a source of low voltage D.C. or rectified A.C. current. Alternatively, the wire **160** might be connected to the control switch **156**.

The circuit diagram shown in FIG. 10 illustrates one form of electrical circuit that might be used with the invention. In FIG. 10, the source of low voltage D.C. (or

rectified A.C.) current is designated at 164. Current is supplied to relay switches 166, 168, 170 and 172, which are actuated by electromagnets 174 and 176. Control switch 156, and limit switches 146 and 146' are shown. Limit switches 146 and 146' are normally closed, and are opened when their respective actuating plungers are depressed. Thus, assuming the switch 146 is opened when the blind is fully lowered, it will be seen that the circuit to motor 42 can only be completed in the direction to raise the blind, which is done by closing switch 156 to contact 178. If limit switch 146' were open and switch 146 closed, the circuit to the motor 42 could be completed only in the direction to lower the blind, which would be done by closing switch 156 to contact 180.

When the circuit is completed through limit switch 146', relay electromagnet 176 is energized, closing switches 166 and 168. When the circuit is completed through limit switch 146, relay electromagnet 174 is energized, closing switches 170 and 172. The direction of rotation of motor 42 depends upon which pair of switches 166, 168 and 170, 172 is closed. The two relays may be mounted in the headrail 14, in which case there would be three conductors in wire 160. Alternatively, the relays might be omitted, and power for the motors 42 brought to the headrail from the control switch 156. In that case, there would be five conductors in the wire 160. In still another alternative arrangement, the electricity for the motors might be brought into the control switch 156 from the source 164, and this would be transmitted directly to the motors through three conductors in wire 160. Where there are several motors 42, they would preferably be connected in parallel.

One aspect of the invention that should be pointed out is that the small size of the drive shaft 36 causes a considerable amount of binding between the shaft and the final gears 51 of the gear boxes 44, as well as between the shaft 36 and rotatable member 100. As brought out earlier in this description, member 100 is caused to move axially as it rotates, due to the coactivity of threads 98 and 71. The binding of shaft 36 to member 100 causes the shaft to move axially with member 100. Likewise, the binding of shaft 36 to hub 52 of final gear 51 causes the motor 42 and speed-reduction gear box 44 to move axially with the shaft. The torque of the motor and gear box is transmitted to the headrail at points where the rubber cushion blocks 58 touch the headrail, and the relatively long moment arm from the shaft to these points of contact of blocks 58 with the headrail, results in very little pressure between them. Hence, the motors 42 and gear boxes 44 are freely slidable with respect to the headrail.

With the construction described herein, the number of motors 42 may be varied to suit the size of the blind, and where there are several motors, each is mounted closely adjacent one of the brackets 34 with its drums 38 and 40. This eliminates transmission of torque loads along the full length of the drive shaft, which makes it possible to use a small size shaft.

While we have shown and described in considerable detail what we belive to be the preferred embodiment of our invention, it will be understood by those skilled in the art that various changes may be made in the shape and arrangement of the several parts without departing from the broad scope of the following claims.

We claim:

1. In an electrically operated Venetian blind having a headrail, at least two ladder tapes depending from said headrail near opposite ends thereof, a plurality of vertically spaced, horizontally extending slats supported by said ladder tapes, a bottomrail attached to the bottom ends of said ladder tapes, and at least two lift cords extending downwardly from said headrail through aligned cord holes in said slats to points of attachment with said bottomrail, the improvement comprising:

a drive shaft extending lengthwise of said headrail and supported thereon for rotation;

a pair of tape drums rotatably supported on said headrail in line with said ladder tapes, the upper ends of said ladder tapes passing on opposite sides of said tape drums and being attached thereto;

a pair of lift cord drums rotatably supported on said headrail in line with said lift cords, the upper ends of said lift cords being attached to said lift cord drums and being wound thereon when the drum is turned;

an electric motor connected to said drive shaft to drive the same;

means for driving each of said lift cord drums from said drive shaft; and

other means for driving each of said tape drums from said drive shaft, including speed-reduction gears and a clutch;

said clutch being operable to drive said tape drum through a predetermined angular distance between a first extremity of tilt in one direction and a second extremity of tilt in the other direction, said clutch disengaging the drive to said tape drum when the latter reaches either of said extremities and said drive shaft continues to turn;

said tape drum thereafter remaining stationary while said lift cord drum continues to turn with said drive shaft to raise or lower the blind.

2. In an electrically operated Venetian blind having a headrail, at least two ladder tapes depending from said headrail near opposite ends thereof, a plurality of vertically spaced, horizontally extending slats supported by said ladder tapes, a bottomrail attached to the bottom ends of said ladder tapes, and at least two lift cords extending downwardly from said headrail through aligned cord holes in said slats between the side tapes of said ladder tapes, the bottom ends of said lift cords being attached to said bottom rails, the improvement comprising:

a drive shaft extending lengthwise of said headrail and supported thereon for rotation;

a least one electric motor mounted on said headrail and connected to said drive shaft to drive the same;

a pair of hollow tape drums rotatably supported on said headrail in line with said ladder tapes, the upper ends of said ladder tapes passing on opposite sides of said tape drums and being attached thereto;

a pair of lift cord drums disposed concentrically within said hollow tape drums, the upper ends of said lift cords being attached to said lift cord drums and being wound thereon when the drum is turned;

each of said tape drums having a circumferential slot in the bottom portion thereof through which said lift cord passes;

other means for driving said tape drums from said drive shaft at a considerably slower rotational speed than that of said drive shaft, said other means including speed-reduction gears and a clutch;

said clutch being interposed between said speed-reduction gears and said tape drum, and being operable to drive the tape drum through a predetermined angular distance between a first extremity of tilt in one direction and a second extremity of tilt in the other direction, said clutch disengaging the drive to said tape drum when the latter reaches either of said extremities and said drive shaft continues to turn;

said tape drum thereafter remaining stationary while said lift cord drum continues to turn with said drive shaft to raise or lower the blind.

3. The invention as defined in claim 1, wherein said lift cord drum is of sufficient length to permit winding a plurality of turns of said lift cord thereon side by side; and

means for advancing said lift cord drum longitudinally along said headrail as said drum turns, whereby the lift cord is normally laid onto said drum in a single layer, with the individual turns of cord spaced closely together along the length of the drum.

4. The invention as defined in claim 1, wherein said means for driving each of said lift cord drums comprises a rotatable member mounted on said shaft and slidable lengthwise thereof, said member being driven by said shaft and having external threads on at least a portion thereof;

a stationary threaded member engaging said external threads on said rotatable member and causing the latter to move axially as it turns;

said lift cord drum being mounted on said rotatable member and having a driving connection therewith; and

said lift cord drum moving axially with said rotatable member as they turn together, whereby said cord is wound onto said drum in a single layer.

5. In an electrically operated Venetian blind having a headrail, at least two ladder tapes depending from said headrail hear opposite ends thereof, a plurality of vertically spaced, horizontally extending slats supported by said ladder tapes, a bottomrail attached to the bottom ends of said ladder tapes, and at least two lift cords extending downwardly from said headrail through aligned cord holes in said slats between the side tapes of said ladder tapes, the bottom ends of said lift cords being attached to said bottomrails, the improvement comprising:

a drive shaft extending lengthwise of said headrail and supported thereon for rotation;

at least one electric motor mounted on said headrail and connected to said drive shaft to drive the same;

a pair of hollow tape drums rotatably supported on said headrail in line with said ladder tapes, the upper ends of said ladder tapes passing on opposite sides of said tape drums and being attached thereto;

a pair of rotatable members mounted on said drive shaft within said hollow tape drums, said rotatable members being connected to said drive shaft to rotate therewith and being slidable lengthwise thereof;

each of said rotatable members having external threads on at least a portion thereof;

a pair of lift cord drums mounted on said rotatable members concentric with said tape drums, the upper ends of said lift cords being attached to said lift cord drums and being wound thereon when the drum is turned;

a threaded connection between each of said lift cord drums and its associated rotatable member, whereby the latter is caused to move axially with respect to the lift cord drum when there is relative rotational movement between them;

means on each of said rotatable members engageable with its associated lift cord drum to drive the latter when said rotatable member has turned through a predetermined angular distance from one extreme position thereof, said drum and rotatable member then turning as one;

a stationary threaded member engaging said external threads on said rotatable member and causing the latter to move axially as it turns, said lift cord drum moving axially with said rotatable member and turning therewith, whereby said cord is wound onto the drum in a single layer;

speed-reduction gears connected to said drive shaft to be driven thereby; and

clutch means between said speed-reduction gears and said tape drums, said clutch means being operable to drive the tape drum through a predetermined angular distance between a first extremity of tilt in one direction and a second extremity of tilt in the other direction, said clutch means disengaging the drive to said tape drum when the latter reaches either of said extremities and said drive shaft continues to turn;

said tape drum thereafter remaining stationary while said lift cord drum continues to turn with said drive shaft to raise or lower the blind.

6. The invention as defined in claim 5, wherein said electric motor is reversible in direction when the current is reversed in direction;

control means for selectively operating said motor in either direction to raise or lower the blind;

limit switch means operable to stop said motor when said blind is fully raised or fully lowered, said limit switch means including a pair of normally closed switches, one of which is serially connected to said motor to complete the circuit for running the motor in one direction, and the other being serially connected to said motor to complete the circuit for running the motor in the other direction;

said limit switch means having a pair of actuating members which are selectively depressed to open one or the other of said normally closed switches; and

a limit stop member mounted on said shaft and movable therewith, said limit stop member being engageable with one of said actuating members to open its associated switch when said shaft has moved longitudinally to a predetermined position, thereby stopping said motor.

7. The invention as defined in claim 6, wherein the other of said limit switch actuating members projects downwardly through the bottom of said headrail and is engageable by the top slat of the blind as the accumulated bundle of slats is raised to its fullest upward extremity.

8. In an electrically operated Venetian blind having a headrail, at least two ladder tapes depending from said headrail near opposite ends thereof, a plurality of vertically spaced, horizontally extending slats supported by said ladder tapes, a bottomrail attached to the bottom ends of said ladder tapes, and at least two lift cords extending downwardly from said headrail through aligned cord holes in said slats to points of attachment with said bottomrail, the improvement comprising:

a drive shaft extending lengthwise of said headrail and supported thereon for rotation;

a pair of tape drums rotatably supported on said headrail in line with said ladder tapes, the upper ends of said ladder tapes passing on opposite sides of said tape drums and being attached thereto;

a pair of lift cord drums rotatably supported on said headrail in line with said lift cords, the upper ends of said lift cords being attached to said lift cord drums and being wound thereon when the drum is turned;

at least two electric motors connected to said drive shaft at longitudinally spaced points thereon, each of said motors supplying a part of the torque required to drive said shaft, and said shaft serving to synchronize said motors;

control means for simultaneously energizing both of said motors;

means for driving each of said lift cord drums from said drive shafts; and

other means for driving each of said tape drums from said drive shaft, including speed-reduction gearing and a clutch;

said clutch being operable to drive said tape drum through a predetermined angular distance between a first extremity of tilt in one direction and a second extremity of tilt in the other direction, said clutch disengaging the drive to said tape drum when the latter reaches either of said extremities and said drive shaft commences to turn;

said tape drum thereafter remaining stationary while said lift cord drum continues to turn with said drive shaft to raise or lower the blind.

9. An electric Venetian blind comprising in combination:

a headrail having a plurality of ladder tapes depending therefrom at longitudinally spaced intervals, and a plurality of slats supported by said ladder tapes;

a drive shaft journaled on said headrail and extending longitudinally thereof;

a plurality of tape drums mounted on said headrail in line with said ladder tapes and connected to the top ends thereof, each of said tape drums being connected to said drive shaft to be driven thereby;

a plurality of lift cord drums mounted on said headrail at longitudinally spaced points thereon, each of said lift cord drums having a lift cord attached thereto;

a driving connection between each of said lift cord drums and said drive shaft;

a plurality of electric motors, each having an integral gear box containing a train of speed-reduction gears;

the final gear in said train of speed-reduction gears having an aperture in its center through which said drive shaft is inserted, said drive shaft being slidable longitudinally through said aperture and non-rotatable with respect to said final gear;

said electric motors and their associated gear boxes being spaced along said drive shaft, whereby the torque of the motors is applied to said shaft adjacent said tape drums and lift cord drums; and

control means for simultaneously energizing said motors.

10. An electric Venetian blind comprising in combination:

a headrail having at least a pair of ladder tapes depending therefrom, and a plurality of slats supported by said ladder tapes;

a drive shaft journaled on said headrail and extending longitudinally thereof, said drive shaft being movable axially with respect to said headrail;

at least two tape drums rotatably supported on said headrail in line with said ladder tapes and connected to the top ends thereof;

at least two lift cord drums rotatably supported on said headrail closely adjacent said tape drums, each of said lift cord drums having a lift cord attached thereto;

means for driving each of said lift cord drums from said drive shaft, including a rotatable member mounted on said shaft and driven thereby, said member having external threads on at least a portion thereof;

a stationary member threadably engaging said external threads on said rotatable member and causing the latter to move axially as it turns;

said rotatable member binding on said drive shaft and causing the latter to move axially therewith;

said lift cord drum being connected with said rotatable member for rotation and axial movement therewith, whereby said lift cord is wound onto said drum normally in a single layer, with the individual turns of cord spaced closely together along the length of the drum;

an electric motor having a gear box containing speed-reduction gears;

the final gear of said speed-reduction gears having an aperture in its center through which said drive shaft is inserted, said drive shaft being slidable longitudinally through said aperture and non-rotatable with respect to said final gear;

said final gear binding on said drive shaft and causing said motor and gear box to move axially therewith, said motor and gear box being slidable lengthwise in said headrail; and

other means for driving each of said tape drums from said drive shaft, including speed-reduction gearing and a clutch.

11. An electric Venetian blind comprising, in combination:

a headrail having at least a pair of ladder tapes depending therefrom and a plurality of slats supported by said ladder tapes;

a drive shaft journaled on said headrail and extending longitudinally thereof;

an electric motor mounted on said headrail and connected to said drive shaft to drive the same;

at least two tape drums rotatably supported on said headrail in line with said ladder tapes and connected to the top ends thereof;

means for driving each of said tape drums from said drive shaft, including a train of speed-reduction gears;

the first of said train of speed-reduction gears being connected to said drive shaft to be driven thereby;

the last of said train of gears being concentric with said tape drum, and having a cylindrical hub portion;

a clutch spring wrapped around said hub portion in firm frictional engagement therewith, the ends of said spring projecting outwardly from said hub portion;

first driving lug means on said tape drum engageable by one of said spring ends when said last gear is turning in one direction, whereby said tape drum is driven in said one direction, the pressure of said first driving lug means against said one spring end tending to wrap said clutch spring tighter around said hub portion;

second driving lug means on said tape drum engageable by the other of said spring ends when said last gear is turning in the other direction, whereby said tape drum is driven in said other direction, the pressure of said second driving lug means against said other spring end also tending to wrap said clutch spring tighter around said hub portion;

limit stop means engageable by the spring end that is not in driving engagement with one or the other of said driving lug means when said tape drum has turned to a predetermined angular position;

the engagement of said limit stop means by the said spring end causing said clutch spring to be unwound slightly, thereby releasing its frictional grip on said hub portion and allowing the latter to slip;

at least two lift cord drums rotatably supported on said headrail; and

means for driving said lift cord drum from said drive shaft.

12. An electric Venetian blind comprising, in combination:

a headrail having at least a pair of ladder tapes depending therefrom, and a plurality of slats supported by said ladder tapes;

a drive shaft journaled on said headrail and extending longitudinally thereof;

an electric motor mounted on said headrail and connected to said drive shaft to drive the same;

a pair of supporting brackets mounted on said headrail in line with said ladder tapes;

a hollow cylindrical drum rotatably supported by each of said brackets, said tape drum being connected to the top end of the associated ladder tape;

a cylindrical lift cord drum disposed concentrically within said tape drum, said lift cord drum having a lift cord attached thereto;

each of said tape drums having a circumferential slot in the bottom portion thereof through which said lift cord passes;

an elongated rotatable member mounted on said drive shaft and extending centrally through said lift cord drum and said tape drum, said rotatable member having external threads on at least a portion of its length;

said bracket having a stationary threaded portion engaging the threads on said rotatable member and causing the latter to move axially as it turns;

means on said rotatable member engaging said lift cord drum to drive the latter, said lift cord drum thereafter rotating with said rotatable member and

moving axially therewith, whereby said lift cord is wound onto the drum normally in a single layer, with the individual turns of cord spaced closely together along the length of the drum;

a train of speed-reduction gears journaled on said bracket at one end thereof, the first of said train of gears being mounted on said drive shaft and driven thereby;

the last of said train of gears being concentric with said first gear and having a cylindrical hub portion adjacent the end of the said tape drum;

a clutch spring wrapped around said hub portion in firm frictional engagement therewith, the ends of said spring projecting outwardly from said hub portion;

a first driving lug projecting axially from the end of said tape drum and overhanging said hub portion, said first driving lug being engeageable by one of said spring ends when said last gear is turning in one direction, whereby said tape drum is driven in one direction, the pressure of said first driving lug against said one spring end tending to wrap said clutch spring tighter around said hub portion;

a second driving lug projecting axially from the end of said tape drum and overhanging said hub portion, said second driving lug being engageable by the other of said spring ends when said last gear is turning in the other direction, whereby said tape drum is driven in said other direction, the pressure of said second driving lug against said other spring end also tending to wrap the clutch spring tighter around said hub portion; and

a limit stop on said bracket engageable by the spring end that is not in driving engagement with one or the other of said driving lugs when said tape drum has turned to a predetermined limiting position;

the engagement of said limit stop by the said spring end causing said clutch spring to be unwound slightly, thereby releasing its frictional grip on said hub portion and allowing the latter to slip.

13. In an electric Venetian blind of the class described, having a headrail, at least two ladder tapes depending from said headrail near opposite ends thereof, a plurality of vertically spaced, horizontally extending slats supported by said ladder tapes, and a bottomrail attached to the bottom ends of said ladder tapes, the improvement comprising:

a small-diameter lift cord, of the order of $\frac{1}{32}$" diameter, attached to said bottom rail and extending upwardly therefrom between the side tapes of each said ladder tapes;

each of said slats having a small-diameter cord hole provided therein through which said lift cord passes, said cord holes each being of the order of $\frac{3}{16}$" diameter;

said small-diameter lift cords and said small-diameter cord holes cooperating to maintain said slats in precise alignment with respect to one another as the blind is raised; and

motor-driven means for tilting the blind and for raising and lowering the same.

14. In an electric Venetian blind having a headrail, at least two ladder tapes depending therefrom, a plurality of slats supported by said ladder tapes, and lift cords for raising and lowering the slats, the improvement comprising:

a drive shaft journaled on said headrail and extending longitudinally thereof;

tape drums mounted in said headrail on said drive shaft in line with each of said ladder tapes, the top ends of said ladder tapes being connected to said tape drums;

lift cord drums mounted on said drive shaft in line with said lift cords, said cords being attached to said lift cord drums and being wound thereon normally in a single layer when he drum is turned;

a plurality of low voltage, reversible D.C. motors mounted in said headrail adjacent said tape drums, each of said motors having a gear box with a train of speed-reduction gears, the final gear in said train being slidably mounted on said drive shaft, in driving engagement therewith;

remote control means for selectively driving said motors in either direction;

means for driving said lift cord drums from said drive shaft at the same rotational speed as the latter;

means for driving said tape drums from said drive shaft at a substantially lower speed; and

clutch means enabling said tape drums to stop turning while said lift cord drums continue to turn.

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