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An Automatic Panel Operator

FIELD OF THE INVENTION

The invention relates to an operator for moving a panel in one direction, such as closing door or window. The operator includes a motor, gear unit, winding drum and pulling cable. The motor can be DC motor driven by either battery or AC power supply through AC-DC adapter, or AC motor.

BACKGROUND OF THE INVENTION

Automatic door and window operator are well known in the art. There are two types of the operator. One is the type that typically comprises a spring or gravity power device to close the window or door once it is pulled open. The other is that driven by motor through driving chain or belt which are placed on the top or bottom of the window or door. The first type of the closer requires using very complex braking system, thus it is very expensive to make them. Meanwhile, when people open the door or window they have to overcome the spring or gravity force to push them open. It is inconvenient particularly for the old and children.

The second type is very much for both closing and opening of windows or doors. The typical applications are those using a photo sensor to trigger the motor to operate when people are passing through the door as can be seen from U.S. Pat. No.4738052 and No.4893435. This type of systems shall be always installed with the specific size of windows or doors, thus are very expensive and inflexible to adapt to different sizes of panels. Further they are used for sliding windows and doors only and not suitable for casement type of panels. Some motorized casement window operator was developed as can be seen in U.S. Patent No. 4945678. But they are unwieldy and complicated, rendering them awkward and difficult with regard to both installation and use. Their big size of these operator by that design are not suitable for the window using grille in front of them due to very small gap between them. Nonetheless, no any operator can operate both sliding and casement panels.

OBJECT OF THE INVENTION

Accordingly, it is a primary object of the invention to provide a low cost automatic operator to close or pull panels, such as windows or doors, or any extendible device.

Another object of the invention is to provide such an operator that can be flexibly adaptable to any size of panels that are already or going to be installed.

Another object of the invention is to provide such an operator that can be built in a compact size to easily fit in the neighborhood of a window or door and etc.

Another object of the invention is to provide such an operator that can be used for both casement and sliding type of the panels.

The invention may be better understood with reference to the illustrations of embodiments of the invention as follow.

SUMMARY OF THE INVENTION

A panel operator in accordance with this invention comprises a housing with opening and a driving mechanism. The driving mechanism comprises a motor, gear unit, control means for motor stopping and cable winding mechanism. The cable winding mechanism comprises a pulling cable, winding means and guiding means. The pulling cable is wound around winding means with one end being fixed on it and the other end be extended out through the housing opening and fixed on a panel or panel frame. The winding means is engaged with the motor through the gear unit and being driven by it for rotation and the guiding means is positioned at the housing opening and guides the pulling cable to move by angles ranged from 0-180 degree wide.

The winding means and guiding means preferably comprise a winding drum, and the winding drum is engaged with the gear unit and the pulling cable is wound around it;

The guiding means preferably comprises a pulley, and the pulley is rotated around a shaft mounted at the housing opening;

The guiding means preferably comprises two pulleys. The pulleys are rotated around its own shaft mounted in parallel at the housing opening and is sit on the same horizontal level. The pulling cable is extended via the gap formed by the two pulleys and out from the housing opening, and one of said pulleys supports and guides the pulling cable for a moving angle ranged from 0-90 degree and the other 90-180 degree;

A method of operating a panel comprises providing a housing with an opening, connecting a pulling cable of a cable winding mechanism to a panel for rotating or sliding, providing engagement between a motor, gear unit and winding means and transmitting electrical power via a motor and gear unit to rotate the winding means, winding the pulling cable around the winding means, therefore pulling the panel according to desire, and guiding moving direction of the pulling cable through the housing opening with angles ranged from 0-180 degree.

DRAWINGS

Referring now to the drawings which form a part of this original disclosure:

FIG. 1 is a perspective view of the panel operator with a built in stop switch being triggered by a stopper on a pulling cable;

FIG. 1a is a perspective view of the panel operator with a built in stop switch facing in opposite to one in Fig. 1;

FIG. 2 is a top plan view of the panel operator taken along line 2-2 in FIG. 1;

FIG.3 is a right side elevated view of the panel operator taken along line 3-3 in FIG. 1;

FIG. 4 is a top plan view of the panel operator taken along line 2-2 in FIG. 1 showing a pair of bevel gears and a motor with vertical running direction to that of the gear unit driven by it;

FIG. 5 is a right side elevated view of the panel operator taken along line 3-3 in FIG. 1 showing a pair of bevel gears and a motor with vertical running direction to that of the gear unit driven by it;

FIG. 6 is a perspective view of the internal structure of a stop switch with detailed exposure of the mounting bracket for the stop switch;

FIG.7 is a top plan view of an enlarged portion of the panel operator taken along circle line in FIG.2;

FIG. 8 is front side elevated view of panel operator shown in FIG. 1 with sectional elevated view on the internal bottom part of the stop switch;

FIG. 9 is a circuit diagram of the control circuit for the panel operator in FIG. 1;

FIG. 10 is a perspective view of a window using the panel operator in FIG. 1a for first applications;

FIG. 11 is a perspective view of a window using the panel operator in FIG. 1 for the second application;

FIG. 12 is a perspective view of a window using the panel operator in FIG. 1 for the third application;

FIG. 13 is a perspective view of a window using the panel operator in FIG. 1a for the fourth application;

FIG. 14 is a perspective view of window using the panel operator in FIG. 1a for the fifth application;

FIG. 15 is a perspective view of a window using the panel operator in FIG. 1a for the sixth application;

FIG. 16 is a perspective view of a window using the panel operator in FIG. 1 for the seventh application;

FIG. 17 is a perspective view of a panel operator with a built-out stop switch;

FIG. 18 is a perspective view of a window using the panel operator in FIG. 17 for sliding window application;

FIG. 19 is a perspective view of a panel operator with a built-out rotatable stop switch;

FIG. 20 is a perspective view of the rotatable mechanism for the rotatable stop switch;

FIG. 21 is a perspective view of the panel operator shown in FIG. 19 with sectional elevated view on internal structure of the rotatable switch;

FIG. 22 is a perspective view of a window using the panel operator in FIG. 19 and a stopper to trigger the stop switch for sliding window application;

FIG. 23 is a top plan view of a panel operator with dual sets of motor, gear unit, stop switch but common control circuit;

FIG. 24 is a perspective view of a window using the panel operator in FIG. 23 and a stopper to trigger the stop switch for casement window application;

FIG. 25 is a perspective view of the panel operator with simplified structure showing bigger opening slots with a removable protective cover;

FIG. 26 is a right side elevated view of the panel operator shown in FIG. 25 with simplified structure.

FIG. 27 is a circuit diagram of the control circuit for the panel operator using a current sensor to stop the motor.

FIG. 28 is a circuit diagram of the control circuit with detailed components for the panel operator using a current sensor to stop the motor.

FIG. 29 is a perspective view of the panel operator mounted on a window using current sensor and proximity sensor.

FIG. 30 is a perspective view of the panel operator of a different embodiment.

FIG. 31 is a perspective view of the internal structure of the panel operator in Fig. 30.

FIG. 32 is a right side elevated view of the panel operator shown in FIG. 30.

FIG. 33 is a perspective view of the bracket structure inside the panel operator in Fig. 30.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows the panel operator 10, comprising driving device 1, pulling cable 2, fixing washer 3 and stop switch 4. Figure 1a shows the same panel operator 10 with its stop switch 4a in opposite facing. Figure 2 and 3 show the detailed structure of the driving device 1, and it comprises a gear unit 11 for speed reduction and motor 12, guiding pulley 13, winding drum 14, control circuit 15 and enclosure 16. The motor 12 has an output shaft 121. The winding drum 14 has a drum shaft 141 having longitudinal axis. The drum shaft 141 can be fixedly or rotatably disposed in the enclosure 16. The former allows the winding drum 14 to rotate about it and the latter requires both be connected together and rotate about the axis on two fixed bearings (not show) on its two ends. The motor 12 shall be controlled and activated by the control circuit 15. The control circuit 15 may not be necessarily enclosed inside the enclosure 16. It can be built in a separate casing with proper wiring connection to the motor 12 and other electrical components which are installed inside the enclosure 16.

As shown in Figure 1, 1a, 2 and 3, the enclosure 16 is a rectangular shaped box with a narrower width. On one end of the enclosure 16, there is an opening 161. The opening 161 is extended over nearly full length of the narrower width side and a certain length of the long side of the enclosure 16. The stop switch 4 is mounted at the opening 161. The stop switch 4 has a triggering lever 41 and it is extended along the full length of the opening 161. Along the length of the triggering lever 41 there is an opening slot 411. Because the two direction opening of the opening 161, thus opening slot 411 has two sections of different facing. One is the slot 411' on the narrower width side of enclosure and other is the opening slot 411'' on corner of the long side of the same. The pulling cable 2 is extended out from the driving device 1 through the opening slot 411. These two opening slots 411' and 411'' allow the pulling cable 2 to be pulled in or out by multi directions and wide angle. This makes universal applications of the panel operator possible. The various applications will be discussed in full details later on.

Meanwhile, the enclosure 16 has three mounting holes 162 for the driving device to be mounted where required for the various applications. The stop switch 4 and opening 161 can be located either above the middle line Q of the enclosure 16 or below it. Preferably if the stop switch 4 and opening slot 161 is above it, the mounting holes 162 shall be below the line. This relative positioning of the stop switch 4 (i.e., the opening 161 and opening slot 411)

and mounting holes 162 will help to easily and comfortably meet requirement of mounting the panel operator 10 in the applications to be described below. However, the ways other than the mounting holes 162 to mount the panel operator 10 can easily be achieved in consideration of the applications by those who are skill in the art.

The pulling cable 2 is a flexible rope either made of the strings of metal, plastic or other materials. The different diameter of the winding drum 14 and the number of wounds of the pulling cable 2 wound on it will give different total length of the pulling cable 2. The different total length of the pulling cable 2 retracted from the winding drum 14 will give a different maximum pulling distance to operate different sizes of panels. This will be discussed in details later on. At the end of the pulling cable 2, a stopper 2a is fixed on it, which has bigger diameter than that of the pulling cable 2 and the width of the opening slot 411. The fixing washer 3 will be fixed onto a panel such as window or door by a screw to connect driving device 1 with them together and transmit driving power from driving device 1 to them. The fixing washer 3 can be replaced with a easily releasable latch on the pulling cable 2 and ring hook on the panel (not show) to allow users easily to disconnect the pulling cable 2 from the panel for the manual opening and closing without connection with driving device 1. It can be also replaced with an eye (not shown) formed by the pulling cable itself.

In Figure 2-8, detailed structure of the stop switch 4 is shown. The stop switch 4 further comprises a spring 42, a shaft 43, limit switch 44 and bracket 45. As shown clearly in Figure 6, the bracket 45 is formed with a C shaped body 451 and has two flanges 452 at bottom. The bracket 45 is mounted by riveting the two flanges 452 with the two opposite long sides of the enclosure 16 through the holes 453. Between top and bottom plates of the C shaped body 451, the pulley shaft 131 formed by a screw with threads on the bottom part is mounted. The pulley 13 is rotated around (not shown in Figure 6 but 2 and 3) the pulley shaft 131 with supporting of a spacer 132. and its edge is extended a little from opening slot 411 out of the enclosure 16. Therefore when the pulling cable 2 is turned around the pulley 13, it will be supported and guided by the pulley 13 with movement angle of 180 degree as shown with solid cable line and dot line in Figure 7. The bottom part 131' of the shaft 131 is further extended down through a hole of the bottom plate of the C shaped body 451 and fastened by a nut 133 as shown in Figure 8. The spacer 132 with smaller diameter than that of pulley 13 provides the clearing room for the inward and outward movement of the triggering lever 41 and same time to support the pulley 13 with smaller rotating friction. On the middle of the C

shaped body 451 has also a hole 455 to allow the pulling cable 2 to go through. On the top of the C shaped body 451, the limit switch 44 is mounted with screws 442 through the holes 454.

As can be seen more clearly in Figure 2, 6 and 7, the shaft 43 is also mounted between top and bottom plates of the C shaped body 451, but its top part is extended out from the top plate to allow mounting the spring 42. The triggering lever 41 has a long vertical hole on one end sitting around the shaft 43 and the spring 42 is held around the shaft 43 with one end being fixed on it (as shown by dot lines in Figure 7). The other extended end of the spring 42 springs against the triggering lever 41 to push it outward. The other end of the triggering lever 41 is extended along the opening 161 and finally goes into inside of the enclosure 16 so that the spring 42 will not push the triggering lever 41 out of the enclosure 16. The inner side of the triggering lever 41 is touched against the hinge lever 441 of the limit switch 44. Therefore, when the triggering lever 41 is pushed inward with one end being hinged around the shaft 43, it will push the hinge lever 441 rightward to switch the limit switch 44. Due to the above opening slot structure of the stop switch 4, it also allows the stopper 2a to press the triggering lever 41 and trigger the limit switch 44 when it is pulled inward from wide directions and angles of 180 degree. This will again ensure to make various applications with the panel operator 10 possible. Meanwhile, the load rate of the spring 42 selected should be bigger than the moving friction of the pulling cable 2 but smaller than motor pulling force. Therefore, the moving friction will not move and trigger the stop switch 4 but only the motor force can do by the stopper 2a. Once the stopper 2a is removed with the pulling cable 2 being pulled outward, both the triggering lever 41 and hinge lever 441 is resumed to the original position by the force of the spring 42 and ready for next time triggering.

It can be seen in Figure 2 and 3 that the gear unit 11 is a sequential gear train with a spur pinion 111 mounted on the motor shaft 121 on one end and bigger spur gear 112 mounted on the drum shaft 141 on the other. Between the two there could be the number of stages of gear sets depending on speed and torque requirement etc. This is easily decided by those skilled in the art. Therefore the gear unit 11 is coupled with the motor 12 through a spur pinion 111. The spur pinion 111 is engaged with the second spur gear 113. The last gear 112 of the gear unit 11 is coupled co-axially with the winding drum 14. Both can be built in one piece made of plastic or other material molding or connected by suitable pins or methods (not shown). With the gear unit 11 with 3 stages of gear sets as shown in Figure 2 and 3, when the motor

12 runs in counter clockwise the winding drum 14 will rotate in clockwise by power transmission of the gears to pull in the pulling cable 2 and trigger the stop switch 4.

Figure 4 and 5 show an alternative gear unit 11', which uses a bevel gear 111' to engage with the motor 12'. Coupling with the bevel gear 111' is a big bevel gear 112', and two bevel gears form an angle of 90 degrees of rotating transmission. Therefore, the motor 12' runs in a vertical direction to that of the gear unit 11'. Hence, when the motor 12' runs in clockwise the winding drum 14 will rotate in clockwise by power transmission of this gear unit with the same three stages to achieve same function as mentioned above. This structure of the gear unit 11' with bevel gears can reduce the width of the whole enclosure 16, thus that of the driving device 1 as normally motor length is bigger than its diameter. It allows the panel operator 10 to be installed where windows or doors do not have sufficient space or gap to mount the panel operator 10. The advantage of the smaller width will become obvious when detailed description on various applications is made later on.

As normally manually rotating friction of motors is very small, as long as the gear ratio of the gear unit 11 can be made below a proper level, ordinary people can retract the pulling cable 2 from the driving device 1.

Another version of the driving unit 1 as shown in Figure 1a gives alternative orientation of the stop switch 4, thereby different operating direction of the pulling cable 2. Though detailed structure of this alternative driving unit will not be discussed, those skilled in the art could easily develop this by repositioning the gear unit 11, motor 12 and winding drum 14 in Figure 2 by 180 degree turning around the central line Q. If the stop switch 4 is positioned as shown in Figure 1a (above line Q), the pulling cable 2 shall be again rewound and retracted out on the top of the winding drum 14 to go through the pulley 13 on about the same horizontal level.

Figure 9 shows the detailed circuit diagram of the control circuit 15 for the panel operator 10 using a DC Motor as an example. An AC Motor can also be used but the circuit will be different. It comprises a micro processor 121, motor 12, limit switch 44, manual operating switch 122, triggering device 123 (rain sensor, photo sensor, timer, remote controller etc), MOSFET 124 and resistor 125 and 126. The power supply is preferably DC power supply at 5Volt for control circuit and 12Volt DC for the motor driving circuit. The Gate of the

MOSFET 124 is connected to an I/O (output) port of the micro-processor 121 with its Source to ground of the power supply. One terminal of the motor 12 is connected to 12 volt and the other to the Drain of MOSFET 124. One terminal of manual operating switch 122 and the normal open terminal of the limit switch 44 are connected each to the I/O ports of the micro processor 121 with each also being connected to 5 V via resistor 125 and 126 respectively, and the other (the common terminal for limit switch 44) to the ground. The triggering device 123 will have similar connection. It depends on types of triggering devices, it may either require power supply to operate or through similar resistor to be connected to the power line. Once the hinge lever 441 is pressed down, the limit switch 44 is switched from 'open' to 'close' to send the micro processor 121 a pulse signal. The operating process of the control circuit 15 will be discussed as follows.

Before the operating process is discussed we assume the pulling cable 2 is already retracted to a certain length and the stopper 2a is away from the stop switch 4 for a distance. When the triggering device 123 is triggered, it will also send a pulse signal to the microprocessor 121. The micro processor 121 is so programmed that it switches on its output to switch on MOSFET124, therefore powers up the motor 12. The motor terminal connection is set up in such a way that when the power of this direction is applied, the motor 12 starts to run counter clockwise (or motor 12' in clockwise). At the same time it will drive the gear unit 11 (or gear unit 11') which then drives winding drum 14 clockwise to wind up the pulling cable 2 around it until the stop switch 4 is pressed by the moving-in stopper 2a and then the limit switch 44 is triggered. Consequently it sends the above- mentioned pulse signal to the micro processor 121. The micro processor 121 is so programmed that when it detects the signal it will switch off its output terminal connecting to the Gate of MOSFET 124. Hence it will be switched from 'Close' to 'Open', thus switching off the motor 12, and stopping the rotating of the gear unit 11 and winding drum 14.

However, if the pulling cable 2 is not retracted for any distance and stopper 2a is pressing against the stop switch 4, the micro processor 121 will not detect any pulse signal from I/O (input) connecting the stop switch 4. It is so programmed that it will not take any action even though the triggering device 123 is sending a same pulse signal as above mentioned to it. The manual operating switch 122 is installed for a manual closing operation instead of automatic one activated by the triggering device 123. The operating process is the same as the above described.

The detailed discussion for closing operation and various applications will be made below by using both casement and sliding windows as an example, which have window frame fixed on the interior wall and a number of window panels. However, the principles of the invention are applicable to other closure panels like doors etc.

Figure 10 shows a sliding window 20 installed with the panel operator 10 with its driving device 1 mounted on the bottom plate of window frame 201 which has a flange 201' holding the window panel 202. The fixing washer 3 is mounted on the bottom sash surface of the window panel 202 at the position to maintain the pulling cable 2 as about same horizontal level as the opening slot 411, actually as the opening slot 411' in this application. This will give smooth moving of the pulling cable 2 and avoid nonsense switching due to too big friction on the triggering lever 41 by the bent pulling cable 2. This desirable positioning is helped by the structure of the opening slot 411 above the middle line Q and the mounting holes 162 below it. Obviously once the driving device 1 is mounted (with screws or fasteners) through the mounting holes 162 on the bottom plate of window frame 201 on a proper position, the opening slot 411' will be easily ensured to be above the upper edge of the flange 201'. Therefore it can be easily to maintain the pulling cable 2 or its movement on the about same horizontal as them. Meanwhile, the driving device 1 and fixing washer 3 should also be so positioned that, at the closing position of the window panel 202, the distance from the opening slot 411' to the fixing point of the fixing washer 3 should be a bit shorter than that between the stopper 2a and the latter point. This will give the correct working distance for the stopper 2a to trigger the stopper switch 4 at time that the window 20 is nearly closed. The operation process of the panel operator 10 is described as follows.

Before the panel operator 10 operates, the window panel 202 has been pushed open manually with the pulling cable 2 being retracted out from it and the control circuit 15 is in the ready mode. When the panel operator 10 is activated by the triggering device 123 through the control circuit 15, the pulling cable 2 will be retracted to the left direction. Therefore the window panel 202 is moving to the closing direction. When it is nearly getting closed, the stopper 2a will touch against the opening slot 411' and push the stop switch 4, actually the limit switch 44 from 'open' to 'close' to stop the motor 12 or 12'. Thus the window panel 202 stops.

Normally in interior wall a window grille is installed in front of the window like window 20 to prevent children to climb over. Consequently there is very small gap between the window and window grille. However the driving device 1 of the narrower width is easily fit in and operated.

Figure 11 shows a sliding window 21 of two same wide panel 213'' and 213' mounted with the panel operator 10. Its driving device 1 is mounted on the top of the left plate of the window frame 211. Its opening slot 411'' faces outward and is positioned out of the outer edge line of the window frame 211 to accommodate the operation of the pulley 212. In this application as shown in figure 11, a pulley 212 is mounted and positioned on a little right of the middle point of the top plate of the window frame 221. The pulling cable 2 is turned around the pulley 212 backward to be mounted on the top left sash of a window panel 213' with the fixing washer 3. The pulley 212 has a semi circle cover 212a to prevent the pulling cable 2 from dropping off from its roller 212b. The cover 212a is fixed together or formed into one piece by plastic molding with the roller shaft 212c and mounted on the top plate of the window frame 211 by screws 214. In this application, the stopper 2a is mounted on the pulling cable 2 at a distance a little longer than the width of the window panel 213'' from the fixing washer 3 to allow to trigger the stop switch 4 at the time of the window panel 213' being closed. The positioning requirement and operating process is similar to the above described for Figure 10¹.

Figure 12 shows a sliding window 22 mounted with the panel operator 10. Its driving device 1 is mounted on the right facing surface of the right sash of a window panel 221 with the opening slot 411'' facing leftward. In this application, the fixing washer 3 is mounted on the inner side of the top plate of the window frame 222 as can be seen from Figure 12 after the flange 222' of the window frame 222 is partially removed. Of course the fixing washer 3 can be also mounted on the outer surface of the flange 222' (dot line). In this case, the driving device 1 shall be mounted on a bit more offset from the central of the edge width of the window panel 221. As the panel operator 10 is mounted on the window panel 221, it will be moving together with it. The positioning and operating process is similar to the above described for Figure 10 and 11. Again, the pulling cable 2 tends to be extended out from the opening slot 411'' and the stopper 2a tends to touch against it, rather than 411'.

From the two applications in Figure 11 and 12, the advantages of the narrower width of the driving device 1 is shown again. If this is too big, it would be blocked by the window frame before the window panel is fully opened. Hence, the narrower width allows the operated window panels to be opened for bigger opening span.

Figure 13 shows a casement window 23 mounted with the panel operator 10. Its driving device 1 is mounted on the bottom plate of window frame 231 with the opening slot 411'' facing the window panel 232' of two window panels 232. In this application, the fixing washer 3 is mounted on the bottom sash surface of the window panel 232' at the position to maintain the pulling cable 2 as same horizontal level as the opening slot 411(actually 411'') for the same purpose. The positioning requirement and operating process is similar to the above described for Figure 10. To maximize the pulling force, preferably the driving device 1 is mounted as close to the center of the window 23 as possible without being obstructed to running of the pulling cable 2 by the window panel 232''. In this case the pulling cable 2 tends to be extended out from the opening slot 411'' and the stopper 2a tends to touch against it as the casement window panel 232' is being pulled inward for closing.

Figure 14 shows a sliding window 24 of four window panels 241 and two tracks using the panel operator 10 to operate two of them at the same time. Its driving device 1 is mounted on the bottom plate of window frame 242 with its opening slot 411'' facing the window panel 241. In this application, a pulley 243 of the same structure as pulley 212 is mounted on the bottom sash of the window panel 241'. The pulling cable 2 is turned around the pulley 243 backward to be mounted on the window panel 241'' with the fixing washer 3. In this application, a stopper 244 is fixed on the protection cover (not shown in details but same as cover 212a) of the pulley 243 and it has a bigger hole to allow the pulling cable 2 go through and moving. The stopper 244, i.e., the pulley 243 should be positioned on the window panel 241' at the same horizontal level as the opening slot 411, in this application actually 411'. They should also be mounted at the point where the stopper 244 should touches against the opening slot 411' when the window panel 241' and 241'' are about to be closed. This positioning will ensure the stopper 244 to trigger the stop switch 4 at the time of the window panel 241' and 241'' being closed. In this application, a positioning stopper 245 is mounted on the top plate of the window frame 242 and a positioning stopper 246' and 246'' on the top sash of the window panel 241' and 241'' respectively. These positioning stoppers are used to avoid that when one window panel say 241' is pushed to open the other say 241'' follows

with the pulling cable 2 being pulled out. This will result in that the window will not be opened. The process of the application is described in details below.

When the window panel 241' is pushed to open, due to the positioning stopper 245 and 246'', the window panel 241'' will not follow it. Therefore the window panel 241' will pull out the pulling cable 2 by the pulley 243. When the window panel 241'' is pushed open, the positioning stopper 245 and 246' will stop the window panel 241' to follow. In this case, the pulling cable 2 is pulled out through the pulley 243 with the moving window panel 241''. To open both window panels 241' and 241'' in this application, the two window panels must be pushed outward at the same time. When the two window panels 241 are open fully, the pulling cable 2 is extended out over the length of three times of width of the window panel (assumed they have same width). Hence this application requires two time longer length of the pulling cable 2.

Figure 15 shows an alternative embodiment for the above application of a sliding window 25 of four window panels 251 and two tracks using the panel operator 10 to operate two of them at the same time. Its driving device 1 is mounted on the bottom plate of window frame 252 through the fixing washer 3. They are positioned and operate in the similar way as described for the application in Figure 10. However, in this application, a pulley 253 of the same structure as the pulley 212 is mounted on the top of the window frame 252 through a bracket 254 at a distance from a central line A of about width of window panels 251 (assumed they have the same width). A pulling cable 255 is rotatably engaged around it with one end of being turned backward to be mounted on the left top sash of the window panel 251' and the other on the right top sash of the window panel 251'' through its bracket 256' and 256'' respectively. The pulling cable 255 has a length about same as the sum of widths of the window panel 251' and 251''. As shown in Figure 15, only when the window panel 251'' is pushed to open, the window panel 251' will be pulled to open by the pulling cable 255 via the pulley 253. When the panel operator 10 is triggered to pull the pulling cable 2 inward it pulls the window panel 251' to close position. At the same time, the window panel 251' pulls the window panel 251'' to close position too by the pulling cable 255 via the pulley 253.

The same application methods as shown in Figure 11 and 12 can be applied for the panel operator 10 to operate two of four window panels at the same time with aid of the above mentioned pulley 253 and pulling cable 255 etc.

Figure 16 shows a sliding window 26 of three panels 261 and tracks using the panel operator 10 to operate two window panels 261' (on the right) and 261'' (on the middle) at the same time. Its driving device 1 is mounted on the bottom plate of window frame 262 and one end of pulling cable 2 is fixed on the bottom sash of the window panel 261' through the fixing washer 3. They are positioned and operate in the similar way as described for the application in Figure 10. For this type of the sliding windows, when a window panel 261' is manually pushed to close position, the window panel 261'' will be pulled together through a pair of engaging flanges on the edge of the window panel 261' and 261'' respectively (not shown). It will be the same situation as the manual operation when the panel operator 10 is used.

The panel operator 10, i.e., the driving device 1 in applications as shown in Figure 10, 13, 14, 15 and 16 can be also mounted on the top plate of the corresponding window frames. This is particularly suitable for door operating and other similar panel operation as so required.

Figure 17 shows another embodiment of the invention with the panel operator 70 comprising a stop switch 71 built outside its driving device 72. As shown in Figure 17, the stop switch 71 comprises only a limit switch with a hinge lever 711 and the stop switch 71 is mounted inside an enclosure 73 which has an opening 731 on the top side to allow the hinge lever 711 of the stop switch 71 to operate. The enclosure 73 has two holes 732 with each in the same positions as each of the two mounting holes 713 of the stop switch 71 (only one shown on the opening section) to form two through holes for mounting the stop switch 71. The stop switch 71 is connected electrically via a wiring cable 74 with the driving device 72. As shown in Figure 17 on the stop switch 71, the wiring cable 74 goes into the enclosure 73 and is connected with the terminals 712 of the stop switch 71. In this embodiment, the driving device 72 has also an opening 721 to allow the pulling cable 75 to be pulled in and out. The opening 721 has the same shape and opening facings as those of the opening 161 of the panel operator 10 as shown in Figure 1, but the triggering lever 41 is saved. Therefore the opening slot height of the opening 721 can be shorter. Further the stopper 2a is also saved, but a fixing washer 76 is still used and connected with the pulling cable 75. As the stop switch 71 can be mounted anywhere on the panels with extension of the wiring cable 74, this will allow proper positioning of the stop switch 71 with ease to ensure the hinge lever 711 to touch directly on the surface of an operated panel. Detailed description on operating the panels will be made below with an example of window application.

Figure 18 shows the application on a sliding window 27 with the panel operator 70. Its driving device 72 is mounted on the bottom plate of its window frame 271. The fixing washer 76 is mounted on the right bottom sash of a window panel 272. The stop switch 71 is also mounted on the window frame 271 with a L-shaped bracket 273. The positioning of the stop switch 71 shall be horizontally on the same level as the bottom sash of the window panel 272 to allow the hinge lever 711 touch against its surface. Further it shall be located just on left bottom corner of the window frame 271, at which the window panel 272 is fully closed, and the hinge lever 711 shall also stand out with a reasonable length into the opening gap of the window panel 272 when it is open. All these positioning allow the sash of window panel 272 to trigger the stop switch 71 and send a signal to the driving device 72 to stop the driving motor (not shown) when it is getting closed.

The embodiment of the built out stop switch gives flexibility or suitability where the stopper 2a is not allowed to be used due to very small gap of window panels and the window frame, particularly for the applications shown in Figure 12. For various other applications in regards with the embodiment it is simply to mount the stop switch 71 on the window frames along A line as shown in Figure 10, 11, 12, 13, 14, 15 and 16. A line is a right position for the applications that the hinge lever 711 is pressed down by window frame when the window panel is getting fully closed. To avoid mess of wiring connection for application in Figure 12, it can also be mounted on sash of window panel. However, the positioning of the stop switch 71 is not very critical compared to the stop switch 4 and stopper 2a for the previously discussed applications. To accommodate the different length of the wiring cable 74 required for different applications and sizes of windows and neat wiring layout, it can be rolled back around a cable drum (not shown) like the winding drum 14 with a longest possible total length. For the application in Figure 12 ideally the stop switch 71 should be on the moving window panel 221 to avoid mess of the wiring cable 74 when it is moving. In this case, the hinge lever 711 will be touched and triggered by the inner surface on the top of the right plate of the window frame 222.

The stop switch 71 can be replaced with a photo sensor for the panel operator 70 to suit all the above applications with the stop switch 70. Hereby triggering a limit switch by pressing or releasing of the window frame is replaced with triggering the sensor by reflecting light sent from a transmitter of the sensor for the receiver to pick up the reflection. It can be also

replaced with a proximity sensor, for an example, a magnetic proximity switch sensor, which has a magnet and switch. Detailed configuration and structure using this sensor for the panel operator can easily be achieved in consideration of the applications by those who are skill in the art.

Application flexibility or suitability of this embodiment is not limited to the above-described situations. It also allows stop positioning of a panel at any location where the controlled panel and wiring cable of the limit switch and sensor can go, as long as the moving panel can trigger them directly or indirectly in the above way at a preset location. That means the panel like window or door may not necessarily stop at only one or a closing position, and it can be other locations too. This would give the invention with more applications.

Figure 19 shows another embodiment of the invention with the panel operator 80 comprising a stop switch 81 attached on the body of its driving device 82. Again, the driving device 82 has an opening slot 821 to allow a pulling cable 83 to be pulled in and out. Thus it has the same function and shape as the above-mentioned opening slot 721. The stop switch 81 is the same as the above stop switch 71 comprising a hinge lever 811. In this embodiment, the stop switch 81 is rotatable by means of a rotating mechanism 84 as shown in detail in Figure 20 and 21 to provide different triggering angles for various applications.

As shown in Figure 20 and 21, the rotating mechanism 84 is located inside of the driving device 82 and just below the stop switch 81. It comprises a mounting bracket 841, a shaft 842, a latch member 843 and pin receiving member 844, a spring 845 and spring holding member 846. The shaft 842 can be formed together with the latch member 843 by plastic molding. The shaft 842 goes up through a hole (not shown) of the driving device 82 and the mounting bracket 841 is mounted on top of the shaft 842 with a screw. With screws through two holes of the mounting bracket 841 and also the stop switch 81, the two are connected together. The shaft 842 also goes down through a center hole on the pin receiving member 844. On the bottom of the shaft 842 is the spring holding member 846 mounted with a screw (not shown) again with it. Between the spring holding member 846 and pin receiving member 844 the spring 845 sit around the shaft 842. Figure 21 also shows a guiding pulley 822 and its mounting bracket 823 with same function and design as previously described for the panel operator 10. The mounting holes 824 to mount the driving device 82 is positioned below the guiding pulley 822 again for convenient mounting in relation to window frame plate and

window panel sash, though the driving device 82 shall stand a bit higher over the window frame.

The latch member 843 is formed with a plurality of pins on its bottom side. The pin receiving member 844 has the holes with same number and diameter as those of the above pins. All the holes and pins are arranged with a same space apart and on same diameter circle to allow the pins be inserted in the holes freely and different rotating angles. The holes are preferably defined by a tapered surface to guide the pins into the holes. Furthermore, it is preferred that the outer end of the pins be pointed to facilitate them into the holes. To adjust the facing angle of the stop switch 81, one has to firstly pull it up and turn it to the angle required, and then put it down to have the pins of the latch member 843 to engage with the nearest holes of the pin receiving member 844.

Figure 22 shows an application with the panel operator 80 for a sliding window 28 of two window panels 281. Its driving device 82 is mounted on the bottom plate of the window frame 282. The pulling cable 83 is extended out with one end being mounted on the bottom sash of the window panel 281 together with a window stopper 283 by two screws. The window stopper 283 is tall and wide enough to touch and trigger the hinge lever 811 when the pulling cable 83 is pulling leftward the window panel 281. The mounting positions of the panel operator 80 and window stopper 283 (the pulling cable 83) should be arranged in such way that the window stopper 283 shall touch and trigger the stop switch 81 when the window panel 281 is about to be fully closed. By properly mounting the window stopper 283 and adjusting the facing angle of the stop switch 81, the panel operator 80 can be used for various applications in Figure 10, 12, 14, 15 and 16. The casement window application as shown in Figure 13 may not require to use the window stopper 283 as the bottom sash surface of the window panel 232' can trigger the stop switch 81 when it is getting closed. The one as shown in Figure 11 is not suitable due to the distance between the stop switch 81 and the moving window panel 213'.

A photo sensor can also replace the stop switch 81 with aid of the rotating mechanism 84 for the above applications using the stop switch 81. Hereby the window stopper 283 or the surface of the bottom frame of the window panel 281 will reflect the light sent from a transmitter of the sensor for the receiver to pick up the reflection light. It can be also replaced with a proximity sensor, for an example, a magnetic proximity switch sensor, which has a

magnet and switch. Detailed configuration and structure using this sensor for the panel operator can easily be achieved in consideration of the applications by those who are skill in the art.

By relocating the stop switch 81 to the position as shown in dot line in Figure 19, such panel operator can be used for the applications in Figure 10, 14, 15 and 16 without the window stopper 283 in the same triggering method as the panel operator 70. However, the stop switch 81 must be adjusted to face the front surface of the window panel sash in the various applications and such panel operator should be also mounted in the position line A for firm triggering by window panel sash. Further the hinge lever 811 should be also extended long enough to allow the window panels to trigger it or release it. The similar adjustment shall be made for using a photo sensor in the same applications.

Figure 23 shows the structure of a panel operator 90 with two sets of gear units 91 and 91', motor 92 and 92' and stop switch 93 and 93' with one set on the right and the other on left disposed inside of the enclosure 94. A common control circuit 95 is in center location. The panel operator 90 with this type of structure is useful for the casement window 29 with two window panels 291 and 291' as shown in Figure 24. Due to the specific application, the stop switches 93 and 93', i.e., the opening slots (not shown) for the pulling cable 96 and 96' moving in and out need have only one direction of facing, to the sash front surface of the window panel 291 and 291'. The stop switch 93 and 93' is made with the components including a triggering lever 931 and 931' and limit switch 932 and 932' etc in similar structure and function of the described above panel operator 10. The pulling cable 96 and 96' of the same type wound around the winding drum 97 and 97' and pulley 98 and 98' respectively of the same type are again connected to the bottom sash of the window panel 291 and 291' respectively through a similar fixing washer. Due to the 'dual' sets of structure, each of window panel 291 and 291' can be manually pushed to open independently or with one open the other still closed. However, no matter to where the window panels 291 and 291' are opened, with the common control circuit 95 they shall start to be pulled after a triggering device triggers the control circuit 95. They will stop at fully closing position together after the stopper 961 on the pulling cable 96 and that on the pulling cable 96' (not shown in Figure 24) trigger the stop switch 93 and 93' respectively. For this embodiment, the control circuit 95 shall include two more input I/O for one more limit switch and manual operating switch. It also shall comprise one more output I/O and MOSFET device for one more motor. The

programming for the micro-processor shall be modified accordingly and easily by those skilled in the art.

Figure 25 and 26 show another embodiment of a panel operator 100 using a winding drum 101 to replace the function of the guiding pulley to guide the pulling cable 102 to be pulled in or out in multi directions. The vertical edge of a side opening 103 is a bit on the left of the left side surface of drum 101. The vertical edge of front opening 104 is a bit on the right of the axis C of a shaft 105 of the drum 101 as shown in Figure 25. The front surface of the drum 101 stands out a bit at the latter. All these ensure the pulling cable 102 has 180 degree of movement angles. To prevent the dust from going into enclosure 106 and affect the performance of the driving components, a movable protection cover 107 is used. It has 2 pins 108 on the left of the bottom and top edges respectively as shown in Figure 25. The pin 108 can be pushed down and bounced back by aid of a spring coil (not shown) sitting below the pin in the pin holes. On the top and bottom of the opening 103 and 104, there are two holes 109 respectively to receive the pins 108. If the application requires using the side opening 103, the protection cover 107 is inserted onto the opening slots with its most area sitting on the front opening 104. If it is the front opening 104, then side opening 103. The protection cover 107 can also assist to hold the pulling cable 102 from being loose out.

As can be seen from Figure 26, a similar gear unit 110, motor 111 and control circuit 112 is also used for the same purposes and in similar operation. Though it is possible to install two sets of the stop switch like the stop switch 4 on each opening slot 103 and 104, it is too complicated and more expensive. Therefore the stop switch 71 and 81 or using a current sensor as a stop switch to be discussed in the next paragraph are more suitable for the panel operator 100. Meanwhile its various applications with panel operation will be same as discussed above.

Figure 27 shows another embodiment using a current sensor 127 as a stop switch to stop the motor. Two terminals of the current sensor 127 are connected between the Source of MOSFET 124 and ground line and another terminal of the current sensor 127 is connected to the same I/O port (input) of the micro-processor 121 as one for the limit switch 44. Figure 28 shows a detailed circuit of the current sensor 127. Its sensor resistor 152 is connected between the Source of MOSFET 124 and ground line. One terminal of resistor 153 is connected to the junction between the Source of MOSFET 124 and sensor resistor 152, and

the other end is connected to the inverting input of a comparator 157 and it is also connected through a capacitor 154 to ground. Resistor 155 and 156 form a voltage divider and the junction between the two is connected to the non-inverting input of comparator 157. Therefore it generates a reference voltage at the non-inverting input of comparator 157. When the current of the running motor reaches to a level which turn to a voltage high than the sum of the said reference voltage and threshold voltage of the comparable 157, the comparable 157 will turn its output from 'High' to 'Low'. The microprocessor 121 will receive this signal and the program is so made that it will turn its output from 'High' to 'Low' to switch off the MOSFET 124. Therefore it will stop the running motor. The operating process of the current sensor 127 with various applications is described below.

We can use sliding window in Figure 10 and casement window in Figure 13 to describe the applications of the panel operator with the current sensor 127. The shape and dimension of the panel operator using current sensor as a stop switch can be same as the panel operator 10. The only difference is the panel operator in this embodiment has no any mechanical stop switch and cable stopper like stop switch 4 and stopper 2a. Others like positioning and mounting of the panel operator on the windows will be similar or same.

Again we assume the pulling cable 2 is already retracted to a certain length. In application as in Figure 10, after the triggering device 123 is triggered, through same program, the motor 12 will run. Therefore the window panel 202 is moving to the closing direction. At the moment that the left sash of window panel 202 is touching the left plate of window frame 201, due to increasing blocking force against the window panel 202, thus the increasing load on the motor 12, its current will increase. Once it reaches to the level which generate a voltage higher than the said sum of voltages, the comparator 157 will turn from 'High' to 'Low' therefore the micro processor 121 will detect this signal and switch off the MOSFET 124. At last the motor 12 and window panel 202 will stop.

As for the application as shown in Figure 13 but with the panel operator using the current sensor, it will has similar situation as above discussed and mounting and positioning will be similar as previously discussed as in Figure 13. Again once the triggering device 123 is triggered, the motor 12 will start to run and pull in the window panel 232'to close by the same program. At the moment that the sash of the window panel 232'is touching the window frame 241, again the blocking force causes increasing the load of the motor 12 and thus its

current. Once it reaches the above-mentioned level, the output of the comparator 157 will turn from 'High' to 'Low' and micro-processor 121 will switch off the MOSFET 124 by the same program. Thus finally the motor 12 and window panel 232' stop.

Applications with the panel operator using the current sensor 127 in Figure 11, 12, 14, 15 and 16 will have same process as above discussed, therefore not be discussed further. Again herewith by applying a stopper like the positioning stopper 245 and 246'(246'') in the location where the panel can be moved, the panel operator in this embodiment can also stop it in any location at desired by a blocking force of the stopper, not only one or a closing position like a window or door.

Above two application examples assume the pulling cable 2 is retracted out for a certain length, i.e., the window panel has been opened for a certain distance. However, if it is closed, with the above mentioned circuit configuration, the microprocessor 121 may not distinguish this closing condition of a window panel. Therefore, it will react whenever the triggering device 123 is triggered or the manual operating switch 122 is pressed. But it will immediately detect an over-current signal from the current sensor 127 and switch off the motor 12.

To avoid the above mentioned nonsense triggering and operating, a proximity sensor 128 can be used to provide the microprocessor 121 with a signal that a window panel has be moved away from the closing position. The connection of this device with the control circuit is shown in Figure 27 in dot line. Take a magnetic proximity switch as an example and of course other type of switch or sensors with same function can also be used. The magnetic proximity switch has two parts one is the switch 128' and the other is the magnet 128'' as shown in Figure 29. The switch can be a normally open switch. That means it forms the same circuit as the manual operation switch 122 with a resistor (not shown) being connected to power line. One terminal of the switch 128' is connected to one of I/O port (input) of microprocessor 121 and the other to the ground. As shown in Figure 29, The magnetic 128'' is mounted on a window panel and the switch 128' can be built on a driving device like the driving device 1. The positioning of the two parts should be conducted in the way that at the closing position of a window panel, the two parts are getting close enough to cause the switch 128' to switch from 'Open' to 'Close'. On the other hand, once the window panel is pushed open over a required distance, the magnet 128'' should get away from the switch 128' for a similar distance too. Thus the switch 128' shall turn from 'Close' to 'Open' position.

In this embodiment, The microprocessor 121 shall be so programmed that it will react signals from triggering device 123 or operating switch 122 only after it detects that the switch 128' has turned from 'Close' to 'Open' position. With this device and so programming, it eliminates the nonsense triggering and operating.

Servo and step motor control can also be adopted to save the limit switch and its complicated triggering structure. However, these make the cost very high due to expensive servo and step motor and their control circuit, compared to the one using the current sensor for panel ending positioning and stopping.

Figures 30-33 show another embodiment of the invention using the panel operator 50. The panel operator 50 has an enclosure 51 as shown in Figure 30. Inside the enclosure 51, as shown in Figure 31, are a motor 52, gear box 53, pulling cable 54, winding drum 55 and pulley unit 56, control circuit 57 and 4 screws 58 (only 3 shown) connecting the pulley unit 56 and gear box 53.

In this embodiment, the shaft (not shown) of the motor 52 shall be engaged through a pinion gear (not shown) with the gear box 53 and its axis shall be in parallel to that of the keyed shaft 531 of the gear box 53. The gear box 53 can be easily made from a standard gear box of round (or cubic) shape by those skilled in the art, which normally is structured with chain of gear sets with all the gear shafts in parallel to that of the motor 52 and keyed shaft 531. The winding drum 55 with a central keyway 551 is coupled directly on the keyed shaft 531.

As shown in Figure 31 and 33, the pulley unit 56 has a U shape steel bracket 561 with longer section 571, middle section 572 and shorter section 573. The longer section 571 has 4 screw holes 574 to allow the screws 58 to be inserted through to the four receiving threaded holes (not shown) on the gear box 53 to fix bracket 561 onto it. On the middle section 572 of the pulley bracket 561 are two threaded holes 575. These holes are spaced apart to allow mounting the two pulleys 562 side by side with minimum gap in between by coupling with the two pulley shafts 563. The upper threaded ends of the pulley shafts 563 are screwed in and extended out from the hole 575 and are fastened by screw nut 563' on the top of middle section 572. The other ends of the two pulley shafts 563 are round shaped flanges 563'' with diameter bigger than that of the pulley shafts 563 and the central hole of the pulleys 562. The

length of the two pulley shafts is same. With this structure, the two pulleys 562 can be held and rotated between the flanges 563'' and middle section 572 on the same horizontal level. On the longer section 571 and shorter section 573 is a hole 576 and 577 to allow the shaft 564 to be mounted between the two sections. The mounting method can be riveting the two ends of the shaft 564 into the two holes. A pulley 565 is rotated around the shaft 564 and easily shifted horizontally on the shaft 564 due to smooth and relative loose coupling between the two. The keyed shaft 531 is extended out through a hole 578 of the longer section 571 to couple with the winding drum 55.

The enclosure 51 may be formed by two coupled semi opened housings made of plastic or other material and 4 screws 511 are used to fasten the two housings together to house the above mentioned assembled components. On the enclosure 51 there are molding formed curved section 512 on each side, mounting holes 513 and opening slot 514 for the pulling cable 54. Figure 32 shows the internal structure of an assembled panel operator 50. It can be seen that the pulleys 562 (only one shown) are located near the opening slot 514 and the winding drum 55 is just sit between curved section 512 of enclosure 51. As shown in Figure 31 and 32, one end of the pulling cable 54 is fixed on the winding drum 55 and it is rolled around the winding drum 55. It is rolled out away from the winding drum 55 and continue be rolled around the pulley 565 and going through the gap formed by two head-to-head C shaped channels of two pulleys 562. It finally goes out from opening slot 514 that is just located near the gap. Further from Figure 32 it can be seen clearly that the section 512 is used to hold and prevent the cable 54 from loosening out or jammed inside the enclosure 51. To make sure these, the gap between inner side of the section 512 and outer edge of two protection flanges 552 of the winding drum 55 must be smaller than the diameter of the pulling cable 54. This curved section for protection can be also added into the enclosure 16 around the winding drum 14 for the panel operator 10 (not shown for clarity purpose) with the same structure requirement as above. The curved section can be also formed with the enclosure 16 by plastic molding or a separate ring and then fixed on the inner wall of the enclosure 16.

From Figure 32 it can be seen that the outer edge of the pulleys 562 is extended out from the opening slot 514 for a small distance. This will allow the pulling cable 54 like that of the panel operator 10 to be pulled in and out in wide angles of 180 degree. As shown in Figure 31, when it is operated in angle smaller than 90 degree the pulling cable 54 is rotated around

the pulley 562 on the right hand side. While it in angle bigger than 90 degree it around the other on the left side. This structure will achieve same performance as that of the panel operator 10. Therefore the panel operator 50 can be also used for the various window applications discussed above in Figure 10-16. However, unlike the panel operator 10 previously described, its opening slot does not need to be L shaped.

The control circuit 57 with power cable 57' can be the same circuit schematic as shown in Figure 9 or one as shown in Figure 27. For the former the limit switches or sensor built outside the panel operator should be used as a stop switch as the structural space does not allow a built in stop switch. And for the latter the stop switch is a current sensor. The control circuit 57 can also be built outside of the enclosure 51 and be housed with a separate casing (not shown). In this case, a cable from the control circuit 57 needs to be connected into the enclosure 51 with the motor 52.

It will be appreciated that the above description was by way of example only. Many variations on the invention will be obvious to those skilled in the art and such obvious variations are within the scope of the invention as described herein whether or not expressly described.

ABSTRACT

A compact panel operator is workable in various methods with a set of panels like door or windows having a fixed frame and one or more movable sashes of sliding type or casement. The panel operator includes a housing, motor, gear unit, control means for motor stopping and cable winding mechanism. The cable winding mechanism comprises a pulling cable, winding means and guiding means. The housing has an opening slot wide enough to allow the pulling cable to be pulled in and out with wide angles ranged within 0-180 degree. The pulling cable is wound around winding means with one end being fixed on it and the other end be extended out through the housing opening and fixed on a panel or panel frame. The winding means is engaged with the motor through the gear unit and being driven by it for rotation and the guiding means is positioned at the housing opening and guides the pulling cable to move by angles ranged from 0 to 180 degree wide. The panel operator can be used to automatically pull an opened panel to be closed by triggering signal of a photo sensor, rain sensor, timer or remote controller. At moment of fully closing of the panel, a stop switch of the control means for motor stopping is activated to switch off the motor to stop pulling the panel.

CLAIMS

1. A panel operator comprising:
 - a housing with opening;
 - a driving mechanism, said driving mechanism comprising a motor, gear unit, control means for motor stopping and cable winding mechanism; said cable winding mechanism comprising pulling cable, winding means and guiding means; said pulling cable being wound around winding means with one end being fixed on it and the other end be extended out through said opening and fixed on a panel or panel frame; the said winding means being engaged with said motor through said gear unit and being driven by it for rotation; said guiding means being positioned at said opening and guiding said pulling cable to move with angles of 0-180 degree wide.
2. The panel operator of claim 1 wherein said winding means and guiding means comprising a winding drum, said winding drum engaged with said gear unit and said pulling cable is wound around it.
3. The panel operator of claim 1 wherein said guiding means comprising a pulley, said pulley being rotated around a shaft mounted at said opening.
4. The panel operator of claim 1 wherein said guiding means comprising two pulleys, said pulleys being rotated around its own shaft mounted in parallel at said opening and being sit on the same horizontal level; said pulling cable being extended via the gap formed by said two pulleys and out from said opening, one of said pulleys supporting and guiding said pulling cable for moving angles of 0-90 degree and the other 90-180 degree.
5. The panel operator of claim 1 to 4 wherein said guiding means comprising a pulley built outside of said housing, said pulley comprising a protection cover preventing said pulling cable from dropping off from it, said pulley being rotated around a shaft mounted on a fixed panel tracking frame for said panel to slide on, said pulling cable being turned around said pulley and connected to said panel while said housing being mounted on said fixed panel tracking frame.
6. The panel operator of claim 1 to 4 wherein said guiding means comprising a pulley built outside of said housing, said pulley comprising a protection cover preventing said pulling cable from dropping off from it, said pulley being rotated around a shaft mounted on one of two panels movable on a same tracking frame, said pulling cable

- being turned around said pulley and connected to the other panel while said housing being mounted on said tracking frame.
7. The panel operator of claim 1 to 4 wherein said guiding means comprising a pulley built outside of said housing, said pulley comprising a protection cover preventing said pulling cable from dropping off from it, said guiding means also comprising a stand along pulling cable with one end being fixed on right (or left) one of two panels movable on a same tracking frame and the other end being turned around said pulley and connected to the left (or right) panel, and said pulley being mounted on said tracking frame supporting said panels and positioned on the right (left) at a distance at least by said right (left) panel width from the central line; said pulling cable (one extended from said housing) being connected to the right (or left) panel while said housing being mounted on said tracking frame.
 8. The panel operator of claim 1 wherein said gear unit comprising a pair of gears with transmission angel of 90 degree;
 9. The panel operator of claim 1 wherein said control means for motor stopping comprising limit switch and triggering lever built inside of said housing.
 10. A panel operator as recited in Claim 9, wherein said triggering lever comprising a slot, said pulling cable on said panel mounting end being mounted with a stopper with its profile bigger than that cable diameter, said slot having opening width bigger than the diameter of the said pulling cable but smaller than that of said stopper.
 11. The panel operator of claim 1 wherein said control means for motor stopping comprising a limit switch or photo sensor or proximity sensor to send the signal of motor stopping, said limit switch or photo sensor or proximity sensor being built outside of said housing or built on a rotatable shaft mounted on the top of said housing with connection by electrical cable.
 12. The panel operator of claim 1 wherein said control means for motor stopping comprising a current sensor.
 13. A method of operating a panel comprising:
 - providing a housing with an opening;
 - connecting a pulling cable of a cable winding mechanism to a panel for rotating or sliding;
 - providing engagement between a motor, gear unit and winding means and transmitting electrical power via a motor and gear unit to rotate winding means;

- winding said pulling cable around said winding means, therefore pulling said panel according to desire;
- guiding moving direction of said pulling cable through said opening with angles of 0-180 degree.

' As the gap between the sash of window panels and the window frame is normally small, the driving unit 1 should be positioned as high as possible to maintain the pulling cable 2 running on a horizontal level to reduce the likely friction between the window panel 223' and pulling cable 2, particularly the stopper 2a. In this case, the pulling cable 2 tends to be extended out from the opening slot 441" and the stopper 2a tends to touch against it, rather than 441'.