Sept. 14, 1943. E. H. LUNKEN ET AL 2,329,280

ELECTRICAL WINDOW OPERATOR AND TENSION LIMITING DEVICE

Original Filed Feb. 15, 1939 5 Sheets-Sheet 1

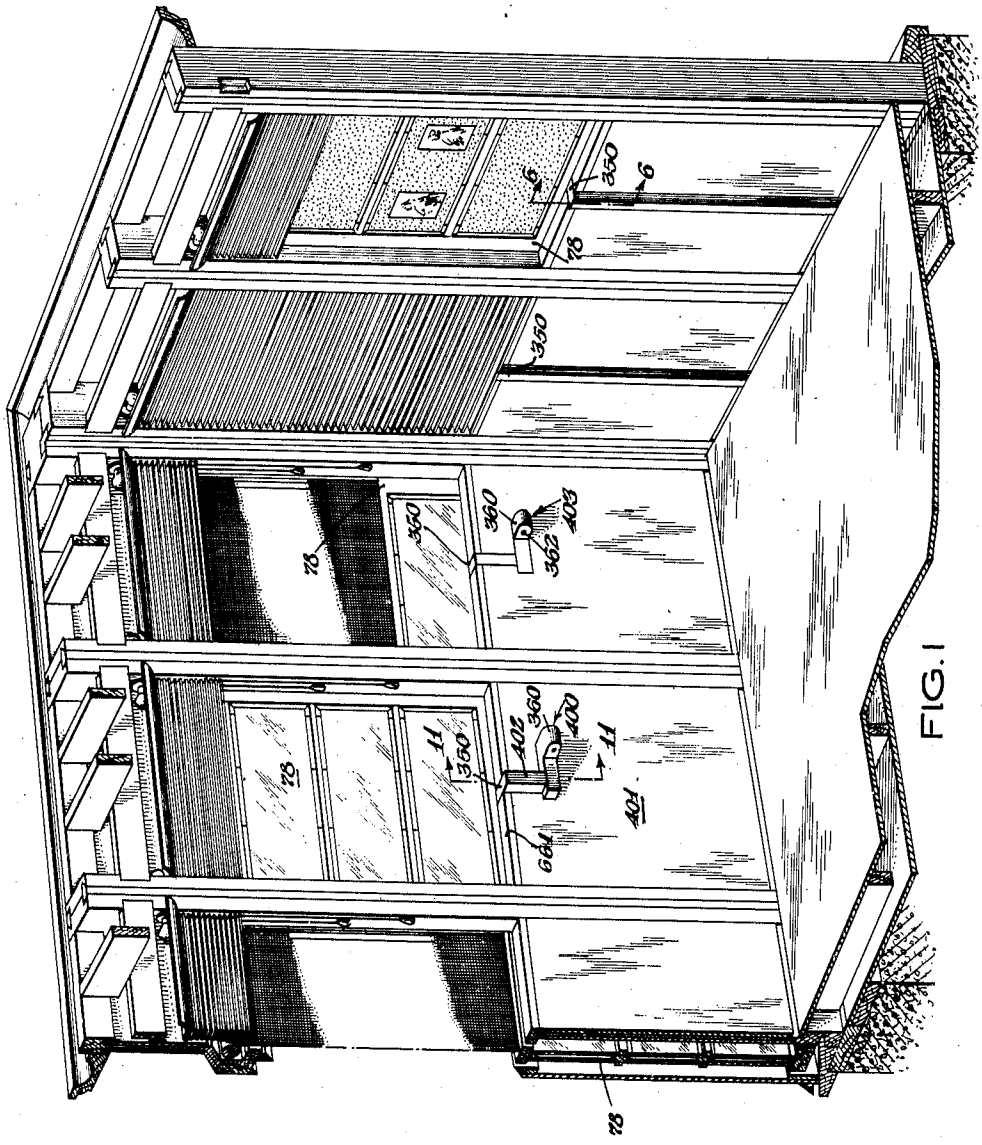


FIG. 1

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ELECTRICAL WINDOW OPERATOR AND TENSION LIMITING DEVICE

Original Filed Feb. 15, 1939 5 Sheets-Sheet 2

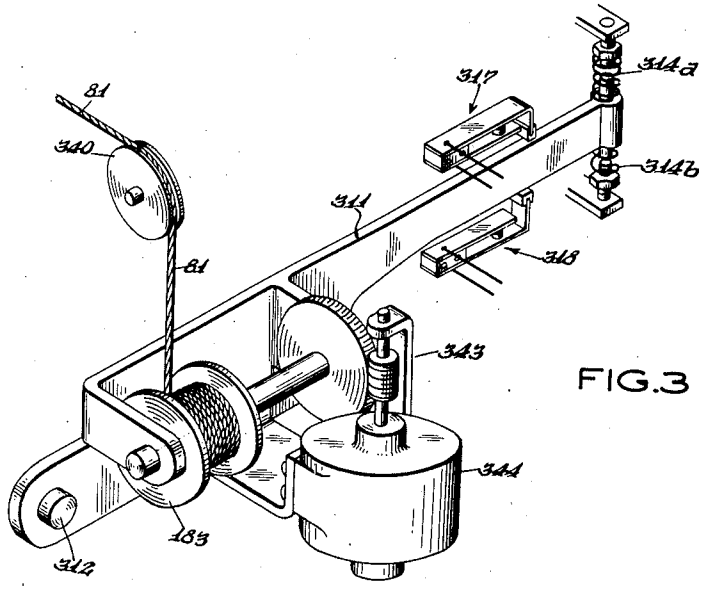


FIG. 3

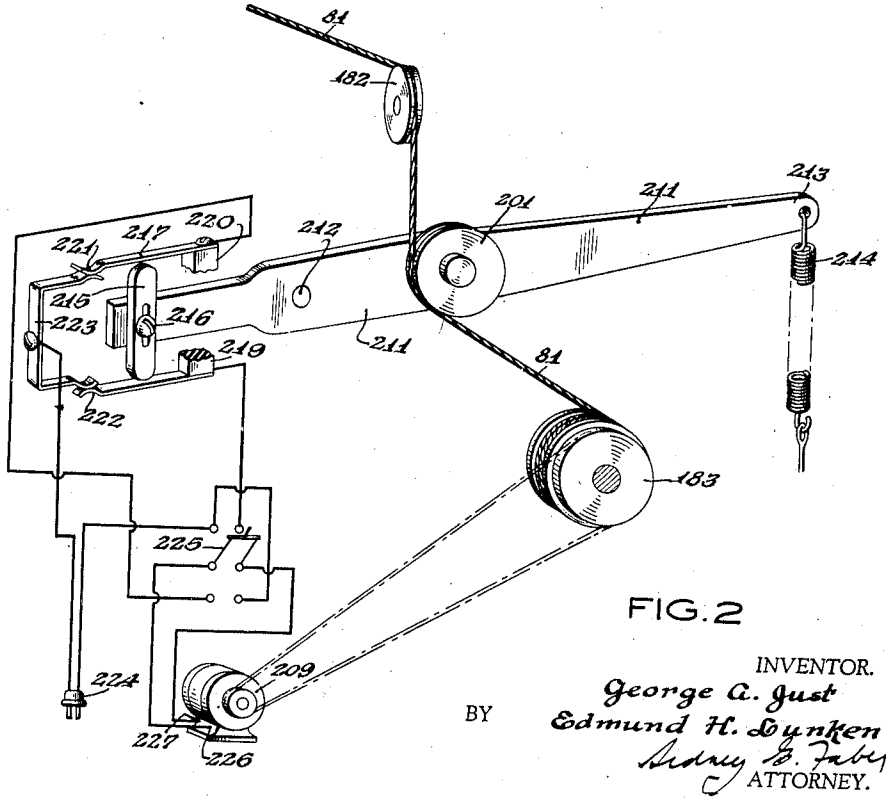


FIG. 2

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ELECTRICAL WINDOW OPERATOR AND TENSION LIMITING DEVICE

Original Filed Feb. 15, 1939 5 Sheets-Sheet 3

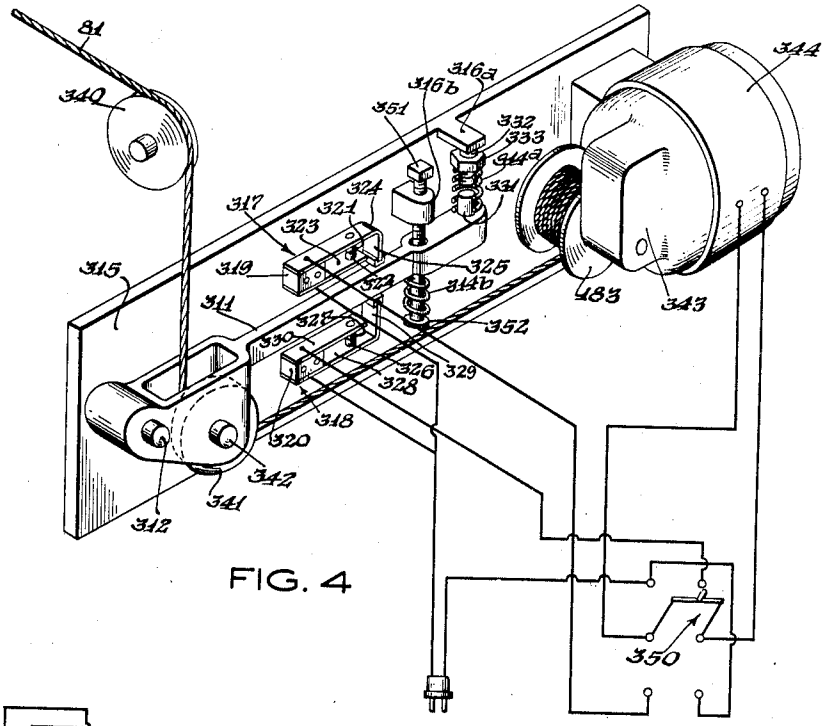


FIG. 4

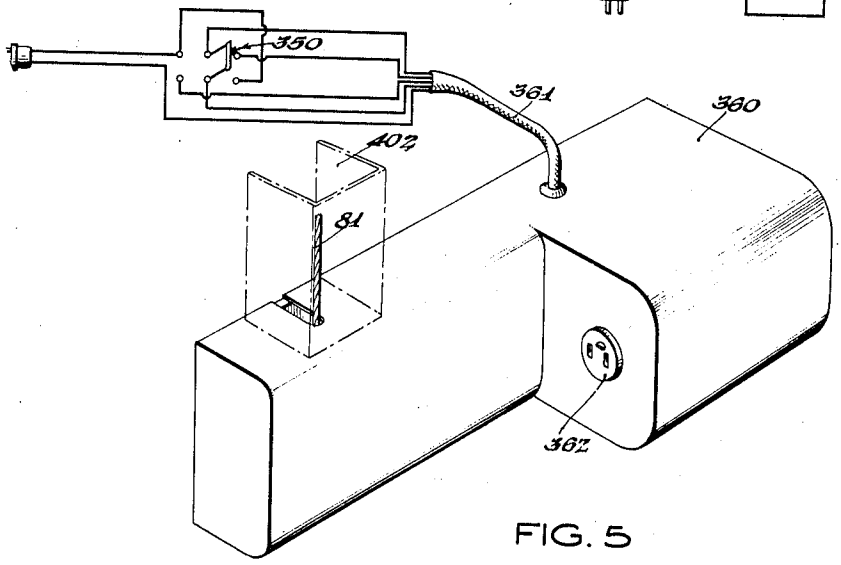


FIG. 5

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ELECTRICAL WINDOW OPERATOR AND TENSION LIMITING DEVICE

Original Filed Feb. 15, 1939 5 Sheets-Sheet 4

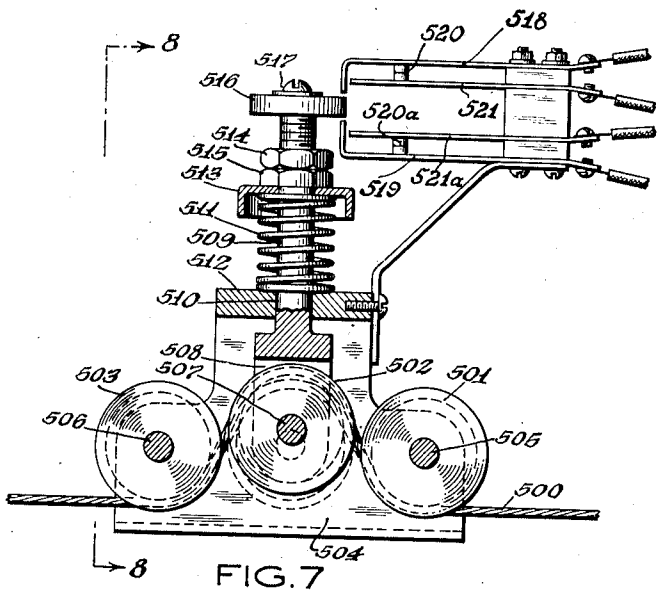


FIG.7

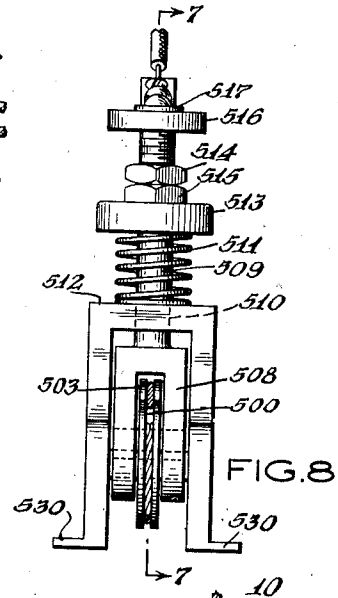


FIG.8

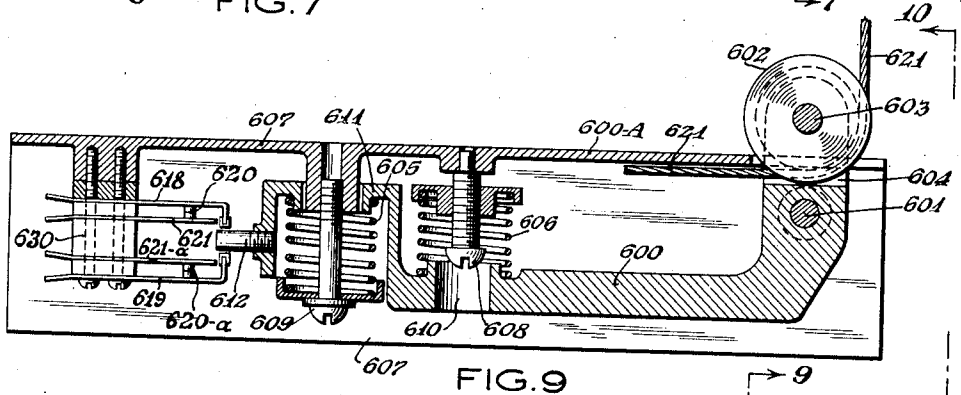


FIG.9

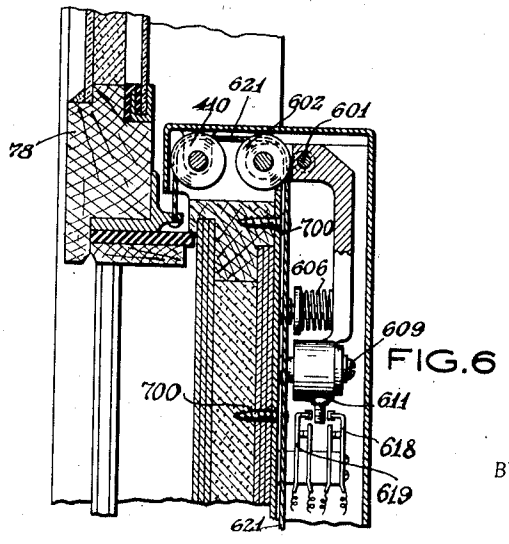


FIG.6

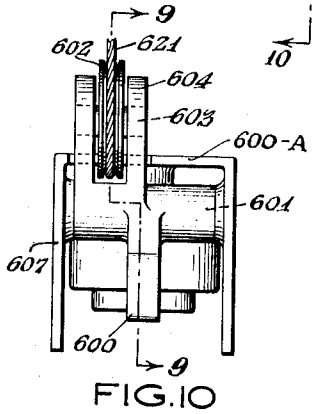


FIG.10

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ELECTRICAL WINDOW OPERATOR AND TENSION LIMITING DEVICE

Original Filed Feb. 15, 1939 5 Sheets-Sheet 5

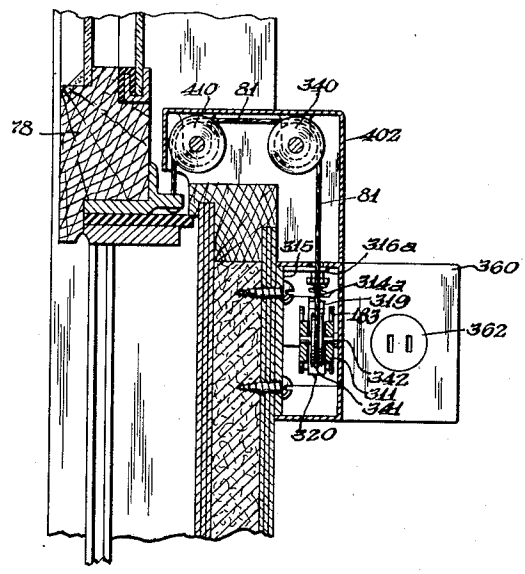


FIG.11.

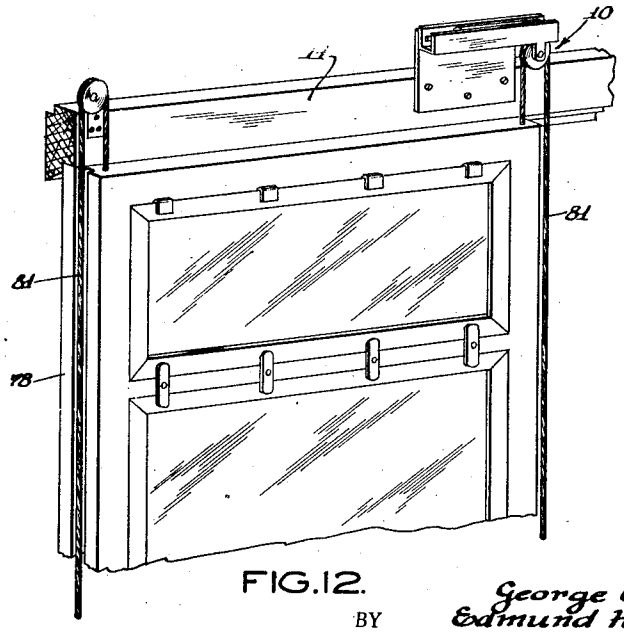


FIG.12.

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UNITED STATES PATENT OFFICE

2,329,280

ELECTRICAL WINDOW OPERATOR AND TENSION LIMITING DEVICE

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Original application February 15, 1939, Serial No. 256,430. Divided and this application September 20, 1939, Serial No. 295,766

1 Claim. (Cl. 268—124)

This invention is a true division of our application Serial No. 256,430, filed February 15, 1939, and relates generally to novel methods and means for operating closures for buildings, including window sashes and doors.

In cur above-mentioned application, we have described a novel window construction which, in addition to other elements therein set forth and claimed, also describes a window sash support which need not rely upon counter-weights, spring balances, or other types of balances for its operation, which would require a simple and inexpensive housing, rather than the complicated housings theretofore in use.

One element which contributed to such simplification of the window unit as a whole is the type of operator which itself is simple, inexpensive and, if desired, automatic in operation.

Accordingly, an object of this invention is to provide a sliding closure operator which is convenient in use, simple and economical in manufacture, and which will not rely on counterweights or balancing of any kind for its operation.

A further object is to so arrange said operator that it may readily be used not merely for sliding window sashes, but also for sliding doors, or closures of any kind; and so that it may be used for raising and lowering any object including the end of a door or window hinged at the top; and so that it may be used irrespective of the direction of movement, horizontal, or vertical, of the sliding member.

Another and important object of the present invention is to provide an electrically controlled operator which through a cable will raise or lower the sliding closure to which the cable is attached, said operator having limiting means responsive to variations to a predetermined extent from a predetermined constant in the tension on the cable for bringing the operator automatically to a halt when such predetermined limits are reached.

Still another object is to provide an operator which will function automatically between predetermined limits in the opening or closing of hinged or otherwise movable closures.

A still further important object of the present invention is to provide switching mechanism responsive to increased and decreased tension of a cable, cord, chain or thread irrespective of the use to which or the mechanism in which such members are applied.

Still another object of this invention is to provide an electrically controlled window operator which will raise or lower a sash which need not be counterbalanced.

Many of the mechanical aspects of the present operator of this application are set forth in our application Serial No. 296,118, filed on September 22, 1939.

Other objects and uses of this invention will in part be apparent and in part be pointed out in the following description taken in connection with the drawings, in which:

Figure 1 is a view in perspective showing a series of window units, each having one form of our novel operator.

Figure 2 is a schematic view of a system for our novel operator.

Figure 3 illustrates in perspective schematic view a commercial adaptation of our operator.

Figure 4 is a view in perspective of our preferred form of operator.

Figure 5 is a view in perspective of the outer covering of the operator of Figure 4.

Figure 6 is a cross-sectional view on line 6—6 of Figure 1 showing the application of our operator of Figure 9 to the window units of Figure 1.

Figure 7 illustrates a modified application of the tension limiting element of our operator and is a cross-section on line 7—7 of Figure 8.

Figure 8 is an end view on line 8—8 of the member of Figure 7.

Figure 9 illustrates a further modified application of the tension limiting element and is a cross-section on line 9—9 of Figure 10.

Figure 10 is an end view of the element of Figure 9 taken from line 10—10 thereof.

Figure 11 is a cross-sectional view on line 11—11 of Figure 1 corresponding to Figure 6, but showing the operator of Figure 4 as applied to the window units of Figure 1.

Figure 12 is a view in perspective showing a modified mounting of the tension device on the window unit.

Referring now to the drawings, we have shown in Figure 1 a series of window units corresponding exactly to the window units shown in Figure 1 of our application Ser. No. 256,430 filed February 15, 1939, of which the present application is a true division.

The sash 18 of each of these window units is arranged to slide in a vertical plane in a manner which will be obvious from an inspection of the drawings in order to open or close the window vent.

Whereas in our prior application we show a manual operator connected to each of said window units, we have also illustrated therein an

electrical method for operating each of said units; said electrical method therein disclosed corresponds exactly to the method shown in Figure 2 of the present application which is divided out of our aforementioned prior application.

In each of the instances herein described, the operator may function properly irrespective of variations in the weight of the sash due to breakage of panes thereof, addition or removal of storm panels, removal of the screen or any spring tension exerted through the screen or any other cause.

Ordinarily in the construction of window units, for instance, various space consuming and expensive means must be provided for counterweighting, counterbalancing, spring balancing or other forms of balances and operators for windows. In our aforementioned application, we have described window units which require no such space consuming and uneconomical means but which by reason of the operators, mechanical, manual or electrical therein described, may be constructed very simply and inexpensively without weight boxes or balances of any kind.

This has been made possible by the use either of the manual operator specifically described in the aforementioned application and in the copending application Serial No. 296,118 filed Sept. 22, 1939, and by the electrical operator likewise described in the aforementioned application Serial No. 256,430, and more particularly set forth in the present application.

Referring now to Figure 2, we have diagrammatically illustrated one method by which a wind-up drum 183 may be rotated for raising or lowering a sash which is suspended by the cable 81. The cable 81 may be attached to the bottom or top or any other suitable portion of the sash as hereinafter described; it is led over the pulleys 182 past the idler 201 onto the wind-up drum 183. The idler 201 is rotatably mounted on the lever 211. The lever 211 rotates about its fulcrum 212, one end thereof 213 being engaged by the spring 214 which limits its rotation.

The opposite end of the lever carries an insulated non-electrically conductive member 215 fastened thereto in any suitable manner as, for instance, by the screw 216, permitting adjustment of the member 215. It will thus be noted that any increase in the pull of the cable 81 upon the idler 201 will cause the end 213 of the lever 211 to rise against the tension of the spring 214 while any decrease in the tension of the cable 81 upon the idler 201 will permit the spring 214 to pull the end 213 of the lever 211 in a downward direction.

Such motion will be translated through the fulcrum 212 to the opposite end of the lever where the member 215 will be caused to move in a correspondingly opposite direction. Where the wind-up drum 183 is caused to rotate in a direction for raising the window, then a certain tension equal approximately to the weight of the window sash will be applied upon the cable 81, thus tending to raise the idler 201. The spring 214 is adjusted to resist the rise of the end 213 of the lever when such normal tension is applied upon the idler 201 by the cable 81. When, however, the window is raised to the fully closed position, then any further rotation of the wind-up drum 183 will place increased tension upon cable 81 by reason of the fact that the sash has been brought to a complete stop. Such increased tension will thus cause the cable 81 to tend to straighten out, thereby raising the idler 201 and the end 213 of the lever 211 against the tension of spring 214. This will correspondingly cause the insulated member 215 at the opposite end of the lever 211 to be depressed.

Any suitable snubbing arrangement may, if necessary, be provided to resist the tendency of the lever 211 to "hunt" a balancing position when the raising or lowering operation is commenced.

When the window sash is thereafter lowered, the full weight of the window is still borne on the cable 81 so that the idler 201 tends to remain in the selected neutral position. When, however, the window sash reaches the bottom of its path, then the weight of the window sash is no longer borne by the cable 81 so that the cable furnishes no resistance to the tendency of the spring 214 to pull the end 213 of the lever arm 211 and the idler pulley 201 in a downward direction, and the insulated member 215 is correspondingly caused to rise.

When therefore, an electrical motor 209 is connected in any suitable manner to drive the drum 183, then, when the circuit is made from the terminals 226 and 227 of the motor through the double-throw, double-pole switch 225, and the power supply 224 through the member 223 to the spring switch 222 mounted by the member 219, the motor rotates in a direction to wind-up the cable 81 on the drum and thus raise the window. When the window sash is fully raised and increased tension upon the cable 81 causes the depression of the member 215 in a manner hereinbefore described, the member 215 then bears against the switch 222 and breaks the circuit at that point which energizes the motor to rotate the drum in that particular direction, thus stopping the rotation of the motor and therefore the rotation of the drum.

When, thereafter, the double-throw, double-pole switch is then turned to engage the opposite circuit, the polarity of the motor is reversed, the motor rotates in the opposite direction, connection having been made through the spring switch 221 mounted by the member 220 and through the member 223 to the motor 209. When the window sash is thereafter by this lowering action of the motor brought to a stop at the bottom of its path, the decrease in the tension on the cable 81 permits the member 215 to rise in the manner hereinbefore described to bear against the switch 217, thus breaking the contact 221 and thus breaking the circuit to the motor for that particular direction of rotation, thereby halting the rotation of drum 183.

It should be noted that the operation may be brought to a stop and/or reversed at any point and that it is not necessary to complete the movement in one direction before commencing the motion in the other.

By this means, the wind-up cable, tape or chain, 81 and the associated drum may thus be connected in a member to be electrically operated. Suitable releasable braking mechanism may be applied on the shaft of the motor 209 or upon the shaft of the drum 183 or at any other desired position, such braking mechanism being, if desired, operated by a solenoid in the electrical circuit, said solenoid being actuated to release the brake when any circuit is closed through the double-throw, double-pole switch 225, or the drum 183 may be geared directly to the motor through worms or worm gears of sufficiently high gear ratio to be self locking.

The connection between the motor 209 and the drum 183 may be made by appropriate gearing,

by belt drive, or by any other suitable means. The electrical motor 209 and the accompanying electrical circuit is shown merely as an illustration of one method of electrically operating the sash raising and lowering device. Other methods using other types of motor and other types of circuits will be obvious to those skilled in the art.

A single motor may be used in connection with and to control the sash of a single window unit or the sashes of a plurality of window units; or a single switching mechanism may be used to control a plurality of motors each mounted on and operating an individual window unit; or individual switches and motors may be provided for each window unit; and remote control of the motors and operators may also be provided, as well as automatic trips to close the windows during a rain storm and operated by a suitable water-trip or capsule; thermostatic, photo-electric or capacity screen control may likewise be used.

Obviously where the connection between the motor and the drum is a high ratio gear train, then the friction developed in the gear train itself will serve to prevent reverse rotation thereof, and thus serve to brake the drum and hold the window sash in any wholly raised or partially raised position in which it may be left.

Thus where a worm gear connection is used between the motor and a drum with the high gear ratio being at the motor end so that the drum when driven is driven very slowly, then the friction developed in the worm gears is sufficient to resist a substantial force against the low ratio end of the system with sufficient resistance to overcome the weight of the sash suspended from the cable and thereby to support the window in any wholly or partially raised position and to lock the window.

It will be understood that any type of reversible motor may be used, the motor having the necessary windings and circuit connections which will be clear to those skilled in the art to be controlled by the switches above mentioned. In special cases, it may even be possible to use a separate motor for raising the sash and another for unwinding the drum to lower the sash, appropriate connections being again made to the switches. Or the motor may be used merely to wind up the cable and a solenoid brake release utilized for controlling the unwinding of the cable.

In Figure 4 we have illustrated a modified form using, however, the same circuit connections and switching means. We have found that while the system of Figure 2 is operative and performs the functions required of it in the raising and lowering of sliding closures and in the operation of the switches within predetermined limits of tension on the cable 81, the use of a single spring 214 makes it relatively difficult to adjust this member and it becomes desirable to have separate adjustable compression springs which will control the movement of the lever; such adjustability also avoiding the necessity for a snubbing arrangement to resist "hunting" of the lever.

Accordingly, in the structure of Figure 4 which represents a diagrammatic illustration of the preferred form which we have found most efficacious in use, the lever 311 is pivoted on the bearing 312. The motion of the lever 311 about its bearing is limited by the springs 314a and 314b, the operation and function of which will be hereinafter described. The bearing 312 preferably is mounted on back plate 315. The limiting springs 314a and 314b likewise are limited in final effect by the abutments 316a and 316b which also are mounted on the back plate 315.

Switches 317 and 318 are switches of a type which are normally closed and are mounted on the insulated blocks 319 and 320 which may also be mounted on the back plate 315 in any suitable manner.

The switch 317 comprises preferably a pair of contacting points 321 and 322 which under normal conditions are pressed together, closing any circuit therebetween. Contact point 322 is mounted on plate 323 which is mounted on one side of the block 319. Contact 321 is mounted on spring plate 324 which is mounted on the opposite side of the block 319. The spring plate 324 has an insulated projection 325 extending towards the lever 311 in such a manner that a rise of the free unpivoted end of the lever will cause it to strike against the extensions 325 thereby raising the spring plate 324 causing the contact points 321 and 322 to separate and thus breaking the circuit therebetween.

In the same manner contacts 326 and 327 are respectively mounted on spring plate 328 having the insulated extension 329 and plate 330 which are themselves attached to either side of the insulated block 320.

A dropping of the free unpivoted end of the lever 311 will cause the same to press against the extension 329 of the spring blade 328 thus causing a separation of the contacts 326 and 327 and an opening or disconnection of the circuit in which those contacts are placed.

In order to obtain exact adjustment compression, spring 314a is provided between the unpivoted end of the lever and the abutment 316a and tends to resist the raising of the lever. As will be seen, the spring is captured on the extending pin 331 of the lever and the threaded pin 332 of the abutment 316a. The nut 333 may be adjusted on the threaded pin 332 in order to adjust the load under which the spring will permit a sufficient rising of the unpivoted end of the lever to cause a breaking of the circuit between the contacts 321 and 322.

The same or similar arrangement may be followed for the spring 314b which may be readily adjusted to resist a dropping of the end of the unpivoted end of the lever to break the circuit between the contacts 326 and 327. In this case, adjustable screw 351 is mounted in member 316b and has an enlarged end 352 which captures spring 314b between itself and the body of the lever. Where the weight of the sash or tension thereon varies, rotation of screws 333 and/or 351 will reset the lever in balancing position.

Obviously the only force which will cause a rise of the unpivoted end of the lever will be tension upon cable 81. Accordingly, spring 314a will necessarily be required to resist greater compression than spring 314b. If this operator is used, therefore, in connection with a window sash support by cable 81, then the cable 81 passing over the pulley 340 which changes the direction thereof and passes over the idler 341 which is freely mounted upon the pin 342 carried by the lever 311. Thence the cable passes to the wind-up drum 183 which preferably through a suitable worm gear system 343 is driven by the motor 344. The spring 314a is adjusted so that it will not permit any substantial rise of the unpivoted end of the lever 311 under the influence of the normal weight of the sash upon the cable 81, it being noted, however, that any pull on the cable 81 will tend to raise the idler pulley 341 and nor-

mally tend to cause the unpivoted end of the lever 311 to rise. Accordingly, when the wind-up drum 183 is rotated in a direction to cause the winding up of the cable 81 and the corresponding rise of the sash, then the spring 314a will tend to prevent the raising of the unpivoted end of the lever. If, however, the switch to the motor driving the wind-up drum is left on after the sash has been raised to its greatest height or stopped, then continued functioning of the motor will cause a continuous rotation of the wind-up drum 183, thus exerting a greater tension on the cable 81 than would be normally exerted by the window sash itself. The compression spring 314a is so adjusted that under the influence of such super-normal tension upon the cable and therefore on the idler pulley 341 it will permit a raising of the unpivoted end of the lever 311. The raising of this unpivoted end of the lever 311 will cause the lever to strike against the extension 325 of the spring blade 324 which carries the contact 321 and thus break the circuit through said contacts and stop the operation of the motor in that direction but leaving the circuit closed for operation in the opposite or opening direction.

If the sash should stick or be caught at any point in its travel, there will be no overload on the circuit and no fuse will blow. The appropriate switch in the operator will simply be opened.

The worm gear connection 343 between the motor 344 and the drum 183 by its own internal friction furnishes a suitable brake to prevent the dropping of the window sash and automatically locks it at any point. It should be noted that the contacts 326—327 closing the circuit to the reverse position of the motor thus remain closed during the raising operation so that when the switch 350 is thrown to make a circuit through the contacts 326—327, the motor may operate to turn the drum 183 in an unwinding direction, thus permitting the dropping of the sash connected to the cable 81. As soon as the dropping operation begins, the lever arm 311 returns to its balancing condition predetermined by the weight of the sash which remains upon the cable 81 and the contacts 321 and 322 are immediately closed.

However, the circuit in the lowering position of the sash is made through the contacts 326 and 327. The lever arm is prevented from dropping down to disengage these contacts principally by reason of the fact that the weight of the sash upon the cable 81 tends to counterbalance the effect of the spring 314a upon the end of the lever arm 311, keeping it in a neutral position. Spring 314b serves to provide a finer adjustment tending to limit "hunting" of a balancing position.

When the window sash reaches its lowest point or stops because of sticking or other cause and can descend no further, then continued rotation of the motor will cause a slackening of the cable 81; the tension on the cable 81 thus decreases, no resistance is then offered to the influence of the compression spring 314a by the weight of the window sash and the said spring may then drive the unpivoted end of the lever down so that it strikes the extension 329 of the spring blade 328 thus separating the contacts 326 and 327 and breaking the circuit to the motor once more and causing the motor to cease its operation in that direction.

It will be noted, however, that the contacts 321, 322 are now in closed position so that a throwing of the switch so that the motor is reversed and the current flows through those contacts will cause a raising of the window sash.

Spring 314b is provided principally to obtain greater delicacy of adjustment. Obviously, it need not be as strong as spring 314a and obviously should not overcome in any respect the tendency of spring 314a to depress the unpivoted end of the lever arm when the weight of the sash is removed from the cable 81 by the fact that the sash has dropped to its lowest limit.

Instead therefore of having a single spring which is subject to extension and compression, only a compression spring is necessary and for delicacy of adjustment an additional compression spring preferably of lesser tension may be provided acting opposite to said first spring in order to prevent any hunting and therefore to exert a slight snubbing effect and to make the adjustment more accurate.

A suitable cover 360 such as that shown in Figures 1 and 5 may be provided beneath the sill. The switch may be led out through a cable 361 to the sill 66 and the cable 81 may be led out in any suitable manner to the guide pulleys 340 or 182. Both the wiring 361 and the cable 81 may be concealed in suitable portions or arrangements of the spandrel.

It will, of course, be obvious that while the form just described is the preferred form, many other arrangements may be used. Thus, for instance, the lever arm assembly 311 with the associated switches, springs and idler pulleys 341 may be mounted just beneath the window sill. Or the cable 81 may be led over a suitable guide pulley to the mechanism which, if desired, may be located in any other suitable concealed position as, for example, in the cellar below where it may be operated by a motor 344 in the manner herein described.

Likewise the whole switching mechanism may itself be located in some concealed position. Also as shown specifically in Figure 5, an outlet 362 may be provided, the terminals of which are connected into the wires of the circuit between the lever 311 and the motor 344 so that a suitable switch 350 upon an extension cable may be plugged into said outlet, the switch being left in any suitable position for use away from the window where that is desired or convenient.

Various electrical outlets may likewise be provided if desired on the cover 360 to facilitate the plugging in of lamps or other electrical devices near the window.

In Figure 3 we have shown a modified arrangement which, however, is not necessarily the preferred form but it may nevertheless be used in exactly the same manner. In this case, the only essential difference is that the motor and drum are themselves mounted upon the lever arm 311. Otherwise, the lever arm and the operation of the switches 317 and 318 is the same as that previously described in connection with Figure 4. The operation of the springs 314a and 314b is the same as that previously described in connection with Figure 4. The operation of the motor 344 and the worm gear connection 343 and the drum 183 is the same as that previously described in connection with Figure 4; the lever arm 311 is pivoted upon the pin 312 for the purposes and in the manner hereinbefore described. The only essential difference is the elimination of the idler 341 and the movement of the drum

183 so that it with its motor is likewise mounted upon the lever arm 311 by suitable brackets.

In this case, the pull on the lever arm 311 is not occasioned by the drawing of the cable 81 over an idler pulley which by reason of the change in direction induced thereby produces a resultant of forces tending to raise the lever, but by the cable itself being strung directly to the drum which produces a direct and immediate force upon the lever by means of its direct tension upon the drum.

The raising of the window sash attached to the cable 81 will therefore cause the lever arm 311 to rise when the sash reaches its uppermost limit or when the sash is otherwise prevented from rising and therefore when tension on the cable increases in the manner hereinbefore described and the unwinding of the drum to its lowermost limit so that the tension upon the cable 81 is reduced will permit a dropping of the lever arm 311 to shut off the motor rotation in that direction in a manner hereinbefore described. Obviously, therefore, should the sash stick in its movement in either direction, the circuit will not be overloaded thus blowing fuses, but the switch will operate to shut off the motor.

While this apparatus furnishes an advantage in that all of the parts thereof are mounted on a single member, the corresponding disadvantage is that a slight shift of the axis of the drum with respect to the cable which is to be wound up thereon by reason of the movement of the lever arm 311 between the limits imposed by springs 314*a* and 314*b* tends to cause a grinding of the turns of the cable 81 upon each other, thus tending to create a slight amount of additional wear which in ordinary use is hardly material and a slight amount of noise in the operation of the drum by reason of this grinding effect which likewise is hardly material.

The principle, however, is the same as that set forth in connection with the previously described forms of this operator, it being solely a matter of selection which modification is desired for a particular use.

In Figure 1, we have shown the manner in which the cover 360 of the device of Figures 4 and 5 may be placed in window units so that the device may be used to operate the same. They may, as seen at 400 be attached to the spandrel 401 with a suitable housing 402 being provided for the cable. Or as seen at 403, they may be partially or wholly embedded in the spandrel.

The switch 350 may, as seen, be mounted in the sill or at different points on the device.

Obviously, the switch may be mounted at the side of each window or at any other point in the room, or it may be connected by an extension cord to the socket 362 and placed anywhere in the room at the convenience of the user. And, if desired, a plurality of switches controlling the same circuit may be mounted at different parts of the room.

Also, the mechanism may clearly be mounted at varying points. Thus, it may be in the cellar below and the cable led thereto in any manner as through the spandrel 401; while the switch may be located in the room for ready accessibility.

As will be clearly seen from the cross-sectional view of Figure 11, the cable 81 may in the embodiment shown, be attached to the bottom rail of the sash 78 and led over idler 410 to the idler 340 whence it passes over the pulley 341 on the lever 311 for purposes already herein described.

A single switch may also be utilized, if desired, to control a plurality of units.

And, where desired, a single mechanism may be utilized to control several units, suitable clutch arrangements being provided to connect the wind-up drum of any particular unit to the motor and lever. Or each unit may have its own wind-up drum and lever and a suitable clutch may be provided to connect the motor to the particular one to be operated. These latter expedients, in view of the economy and inexpensiveness of a complete mechanism may, however, not be necessary in practice.

While this disclosure has been described, where examples were required, in connection with the operation of a window sash, it is obvious that it may be used in connection with any closure member or other member which is to be raised, lowered, swung, moved or slid. It can obviously be applied to a window or door, an end of which is to be lifted or rotated outwardly or inwardly or to various types of closure members.

Obviously in its basic form this invention is directed to the switching of electrical mechanism in accordance with variations in tension upon a cable. In this connection, therefore, and in this expression of the invention in its purest form, this idea may be applied to almost any embodiment where the limitation of the tension upon a cable, thread, tape or sheet becomes important.

It may be noted that the tension limiting device may in appropriate cases be connected to and operated by the apparatus which it controls through any suitable system of links, levers and other mechanical connecting means.

In any embodiment, where tension is placed upon a cable by means of a motor and the tension of the cable is not to exceed a certain upward limit, then the use of a switching off device will prevent the exceeding of such an upward limit.

Likewise, the use of such a device will, if desired, provide an indicator as to the reaching of said upward limit.

Also, where a cable is used in any embodiment where the tension is not to fall below a lower limit, then this device can, if desired, be so connected as to switch off or on any motor which is operating or is to be operated when the tension reaches such lower limit or to switch off or on any signal which may be desired.

Such tension limiting device may be used to control electrically any other form of power supply including hydraulic or steam plants by controlling the valves or other controls therefor by solenoids, relays or other electrical devices in circuit with the switching device of the present invention, the said switching device being responsive to variations in pressure or tension of selected portions of the machine.

Thus in Figure 7, we have illustrated a device which is an adaptation of the present limiting switch of our window operator but which nevertheless functions in exactly the same manner. The cable 500, the tension of which is to be controlled, is led beneath the pulley 501 over the pulley 502 and again beneath the pulley 503. The pulleys 501 and 503 are mounted on the base or casting 504 of the device by means of the pins 505 and 506. The pulley 502 is by means of the pin 507 mounted in the bifurcated end 508 of the reciprocating bolt 509. The bolt 509 extends through the hole 510 in the base or main portion of the casting 504. The bolt 509 is maintained in selected or neutral position by means

of the compression spring 511 which is captured between the top 512 of the casting 504 and the spring seat or cap 513 mounted on the bolt. The position of the cap 513 is adjustable by means of the nuts 514 and 515 in order to obtain a predetermined compression of the spring 511. As will be noted, then the spring 511 tends to drive the bolt 509 upwardly. The upper end of the bolt carries an insulated washer 516 held in place, for instance, by the screw 517 but which also may, if desired, be adjustable in its position. When the cable 500 is led beneath the pulleys 501 and 503 but threaded over the pulley 502, any tension thereon tends to pull the bolt 509 down against the compression of the spring 511. Any relaxation of such tension permits the spring 511 to pull the bolt upwardly once more. When, for instance, a continuing tension having specific limits (say 5 to 8 pounds) is to be applied upon the cable then the spring is so adjusted that when the cable passes beneath the pulleys 501 and 503 and over the pulley 502 and while the cable remains at such tension, the washer 516 mounted on the bolt 509 will be maintained in a neutral position between the spring elements 518 and 519 which are insulated from each other and form the frame of the device. Should the tension upon the cable 500 be increased beyond the upper selected limit, then the tendency of the cable to straighten out will tend to pull the bolt downwardly into the position shown by the dotted lines wherein the washer 516 will depress the spring element 519. Should tension be relaxed beyond the lowermost selected limit, then the spring 511 will tend to drive the bolt upwardly so as to raise the spring element 518. The spring elements 518 and 519 may then be connected in circuit with different devices including relays, switches, signals and alarms for operating or stopping the operation of motors of various kinds for the application of brakes or for the operation of signals or warnings.

Thus, for instance, in weaving it is frequently desirable that a predetermined tension be maintained upon the various threads. When the tension is increased beyond a definite limit as by the snagging of a particular thread, then the thread may be broken and the cloth when finished may be impaired. Likewise, should tension be decreased upon a particular thread, then that thread may be loose in the finished cloth and the cloth likewise be impaired. Accordingly, it becomes important to stop the weaving machine immediately upon a change in the tension of any particular thread beyond the limits fixed. For this purpose a plurality of devices of the type shown in Figures 7 and 8 may be utilized, one for each thread, so as to insure the continuing predetermined tension on the thread within fixed limits. Where the weaving machine is electrically driven, the circuit thereto may be made through the spring elements 518 and 519 and the contacts 520 and 520a to the members 521 and 521a. Thereafter, when tension upon any single one of the threads 500 is changed, either by the breaking thereof, the tightening thereof, or the loosening thereof, the striking of the washer 516 against either the element 518 or 519 will serve to break the circuit to the motor and cause the stopping thereof. Or where desired, the change in position of any of the spring elements 518 and 519 may serve to operate a relay which will open the circuit to the weaving machine. Or the movement of either of the elements 518 and 519 may serve to operate a relay which will brake the machine or operate valves or cut-offs of the machine in the event that the machine is not electrically operated.

While the device of Figures 7 and 8 has been described in connection with weaving, obviously it may be used in any connection where a tension limiting device on a cable, cord, thread, tape or chain may be desirable. It may be used in the weaving of wire mesh; in the knitting of various articles; in wire drawing where the wire is pulled at a predetermined tension through dies of fixed diameter. It may be used in paper manufacture. It may be used in printing where in this case the printed sheet is led under and over drums corresponding to the pulleys 501, 502, and 503. It may be used to control or give a warning of any change in tension of any member of any device.

The device herein described may, if desired, be used to provide an alarm system wherein any increase or decrease of tension on a cable connected to a door or window or other opening will serve to operate an alarm. Likewise, an indicating pointer may be applied to any portion of the bolt and a suitable stationary scale provided to show the position of the bolt with respect to the members 518 and 519 and to provide an indication as to the proximity of the tension on the particular cable, cord, tape, or sheet to the maximum or minimum limit.

The device of Figures 7 and 8, as will be seen, may be mounted to operate in any position. The casting thereof may thus have legs 530 by which it may be attached or mounted upon any object and in any plane.

This type of tension limiting device may take other forms as illustrated in Figures 9 and 10 in which a lever 600 is pivoted at 601 and carries at one end thereof a pulley 602 which is freely mounted on a pin 603 extending through the bifurcated end 604 of the lever 600.

The opposite end of the lever may be limited in its rotation by the adjustable compression springs 605 and 606 which may be adjustably mounted in the casting 607 by the adjustable screw 608 and 609, the compression springs 605 and 606 limiting the movement of the lever in either direction. A suitable perforation 610 may be made in the lever 600 to permit the head of the screw 608 to be exposed for adjustment purposes and part of the lever may be deformed as at 611 in order to provide a suitable abutment for the springs. The opposite end of the lever may also carry a projecting bolt 612 which will operate against the spring members 618 and 619 which are in abutment through the contacts 620 and 620a with the members 621 and 621a in exactly the manner hereinbefore described in connection with Figures 7 and 8. Each of these members is insulatingly mounted on the insulating block 630. Thus when tension of the cable 621 upon the pulley 602 is at a predetermined limit then the lever is in balance about its pivot 601 and the member 612 is in balance or neutral between the spring members 618 and 619. Should tension be increased upon the cable 621 then the pulley 602 is dragged so that that end of the lever rotates about the pivot 601, thus causing the member 612 to be depressed, thus pushing the spring member 619 away from the member 621a breaking the contact at 620a. Likewise, when tension is relaxed upon the cable 621 and therefore upon the pulley 602, the lever may rotate in the opposite direction about its pivot 601 and the member 612 may strike against the

spring member 618, thus again breaking the contact. As will be seen, suitable legs or supports 622 may be provided for the casting in order to permit its mounting in any position or in any plane, although only the base plate 600A is actually necessary since it may support the lever and the springs and the switches and may be provided with suitable perforations for screws 700 (Figure 6) or other attaching means. The springs 605 and 606 may each be individually adjustable in order to provide for maximum and minimum limits. Thus it will be seen that this device, although its original utility is in connection with limiting the operation of any electrical window operator, may nevertheless be applied to any use wherein tension limits on cables, chains, tapes, cords, wires, threads, or sheets are to be maintained.

As seen in Figure 6, this arrangement is also readily mountable for operation of a window unit in the manner heretofore described. The plate 600A need merely be screwed to the spandrel and a suitable shield placed thereover or it may be mounted within the spandrel. The motor and drum may be beneath the device, in the cellar below or in or on the jamb alongside, the cable 621 being led thereto in any suitable manner.

The present tension limiting device when used in controlling window sash operation may be mounted in various locations. As seen in Figure 12, the device 10 may be mounted above the head stop 11 of the sash, the cable 81 passing thereover to the drum and motor controlled by the device. As also seen in Figure 12, the device may, if desired, be used on only one of a plurality of cables supporting a structure; and, by its adjustment to the tensions on the particular cable, control one or several motors operating the cables. The cables 81 of Figure 12 may preferably be operated by a single motor and wound on one or two drums controlled thereby; although they may be operated by separate motors controlled by the device 10.

It will also be noted that devices and controls of the present type are readily applicable to all types of windows where variations in tension on a cable assists in control—to all types of doors and especially overhead doors—to all types of closures—and to all other operations wherein variations in tension of a cable can be used to assist in controlling the operation.

It will also be obvious that in connection with a window operator which is to be electrically driven and which is so arranged that the operation thereof is automatically stopped when the window sash is open or closed or stuck in any intermediate position, various other automatic devices may be utilized. Thus, for instance, a thermostatic switch may be coupled into the circuit for the motor and upon increase or decrease in temperature may cause the motor to operate in one direction or the other to close or open the window. Likewise, capsules which become conductive upon the presence of moisture may be placed in the circuit to the motor in order to cause the same to operate to close the window sash should a rainfall commence. Likewise, also, photocells may be connected in the circuit or to operate relays to open or close the window sash upon changes in light conditions. In addition, also, capacity screens may be connected in circuit or to operate relays to effect the operation of the motor for purposes of burglar-proofing any room in which units operated by our operator are mounted.

The utility of this device will now be obvious and the use thereof in connection with various instrumentalities will be clear, and the many variations thereof in construction and use will now be obvious to those skilled in the art. We prefer, therefore, to be limited not by the specific disclosures herein, but only by the appended claim.

We claim:

A member biased for movement in a predetermined direction and an operator therefor; a cable connecting said operator and said member; said operator comprising an electric motor and a wind-up drum; said cable being wound on said drum; switching means in circuit with said motor for actuating said motor selectively to wind-up or unwind said drum; said cable coacting with and normally balancing a lever biased for movement in a direction opposite to that in which the pull of the cable is exerted; variations in the tension on the cable resulting in a corresponding movement of the lever; and two switching means normally in closed circuit arrangement with said motor and disposed on either side of and in the plane of movement of said lever; movement of said lever beyond a predetermined degree opening one of said switches; one of said switches being in circuit with said motor only when said motor winds up said cable and being arranged to be opened only when the tension of said cable exceeds a predetermined constant; the other of said switches being in circuit with said motor only when said cable is unwound and being arranged to be opened only when the tension of said cable is below a predetermined constant.

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