Dec. 2, 1969 C. R. MOSS 3,481,074

DOOR OPENER

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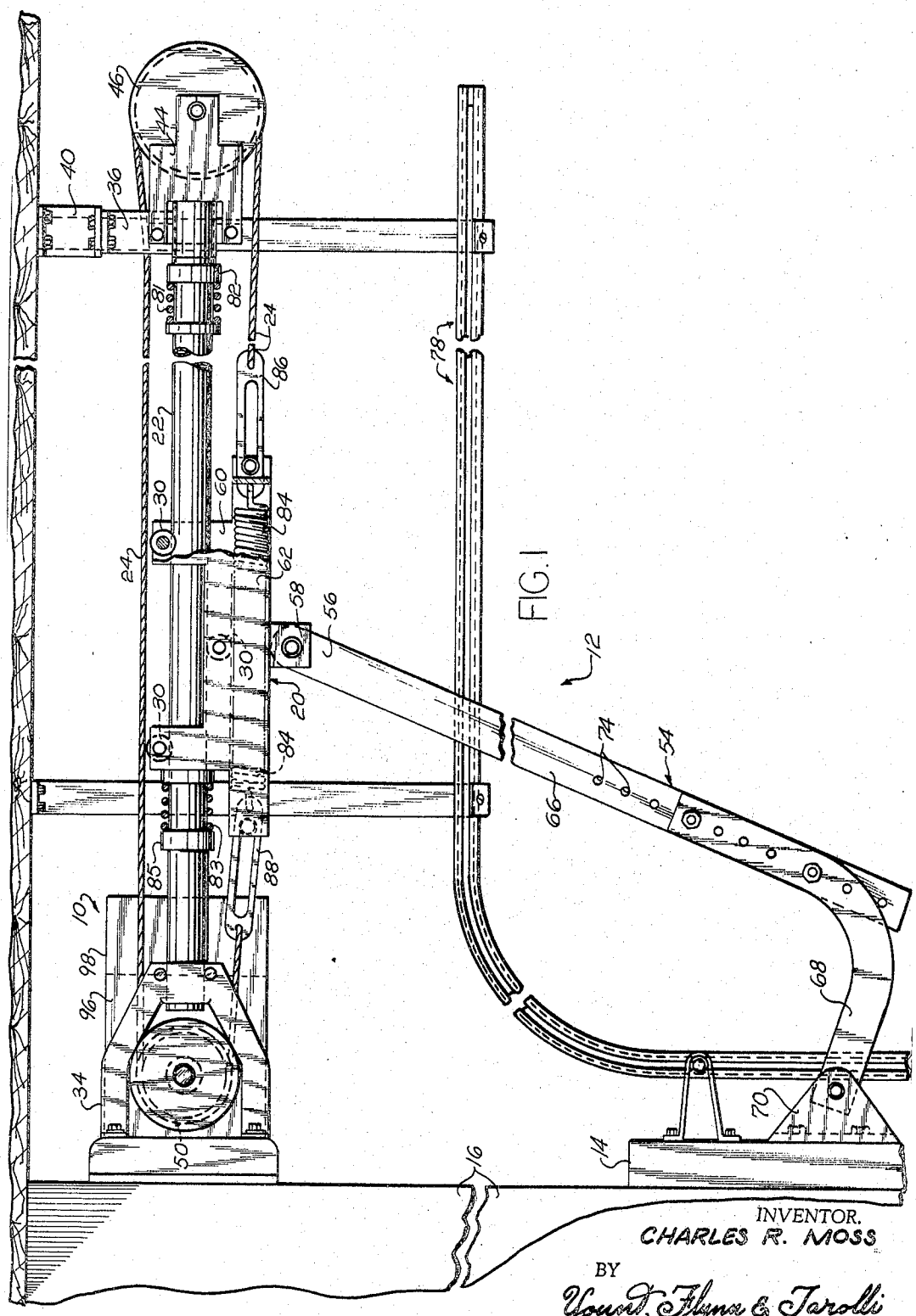


FIG. 1

INVENTOR.
CHARLES R. MOSS

BY
Yount, Flynn & Tarolli
ATTORNEYS

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DOOR OPENER

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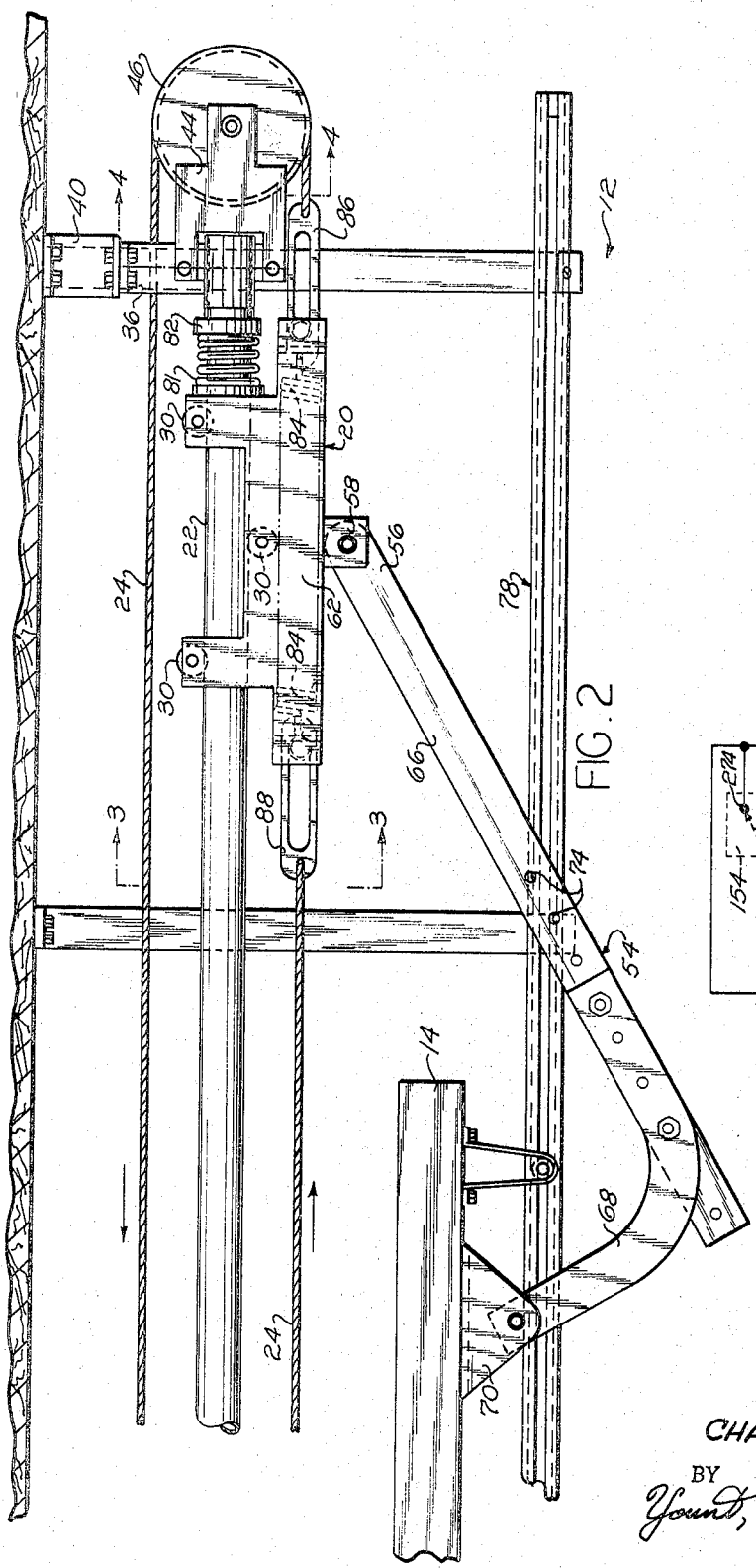


FIG. 2

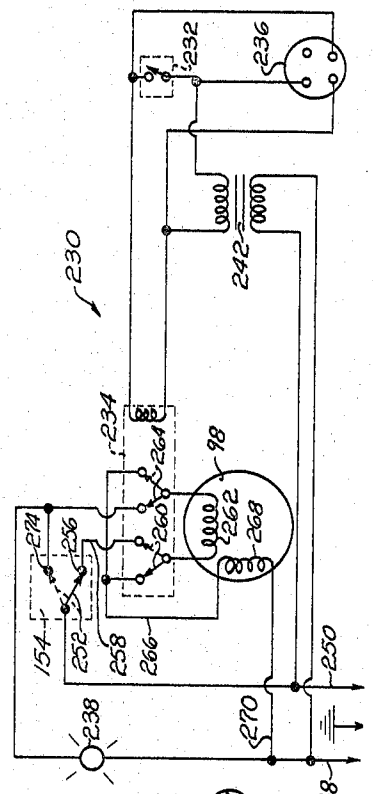


FIG. 9

INVENTOR.
CHARLES R. MOSS
BY
Yount, Flynn & Tarolli
ATTORNEYS

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DOOR OPENER

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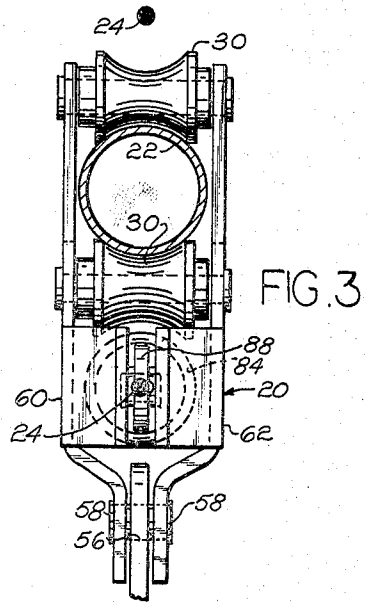


FIG. 3

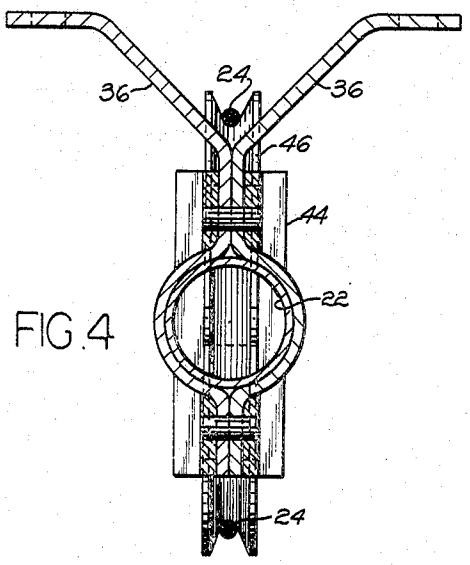


FIG. 4

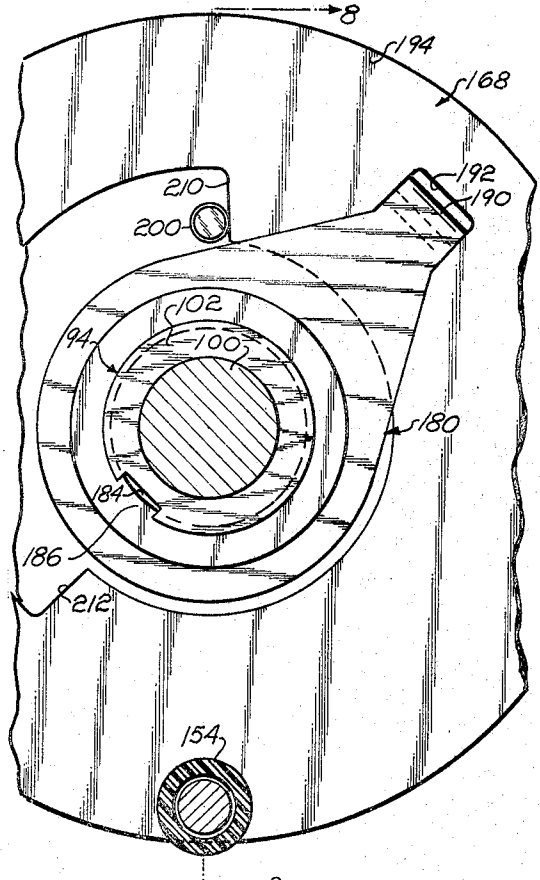


FIG. 7

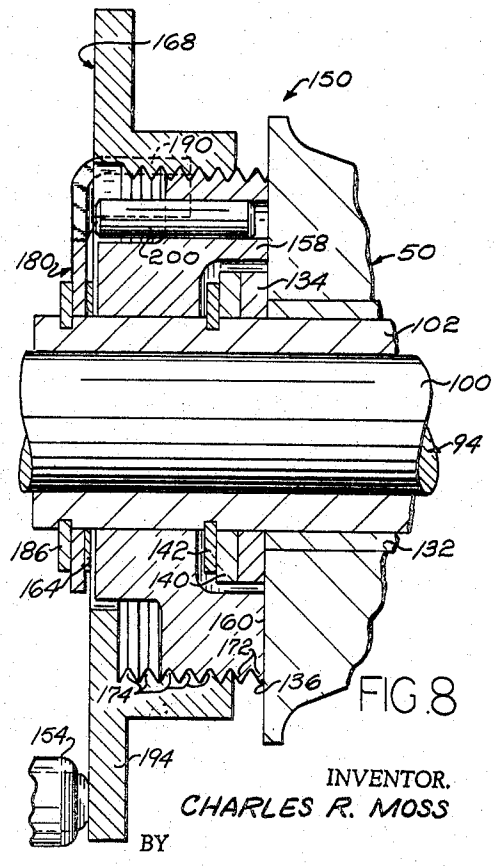


FIG. 8

INVENTOR.
CHARLES R. MOSS
BY
Yount, Flynn & Tarolli
ATTORNEYS

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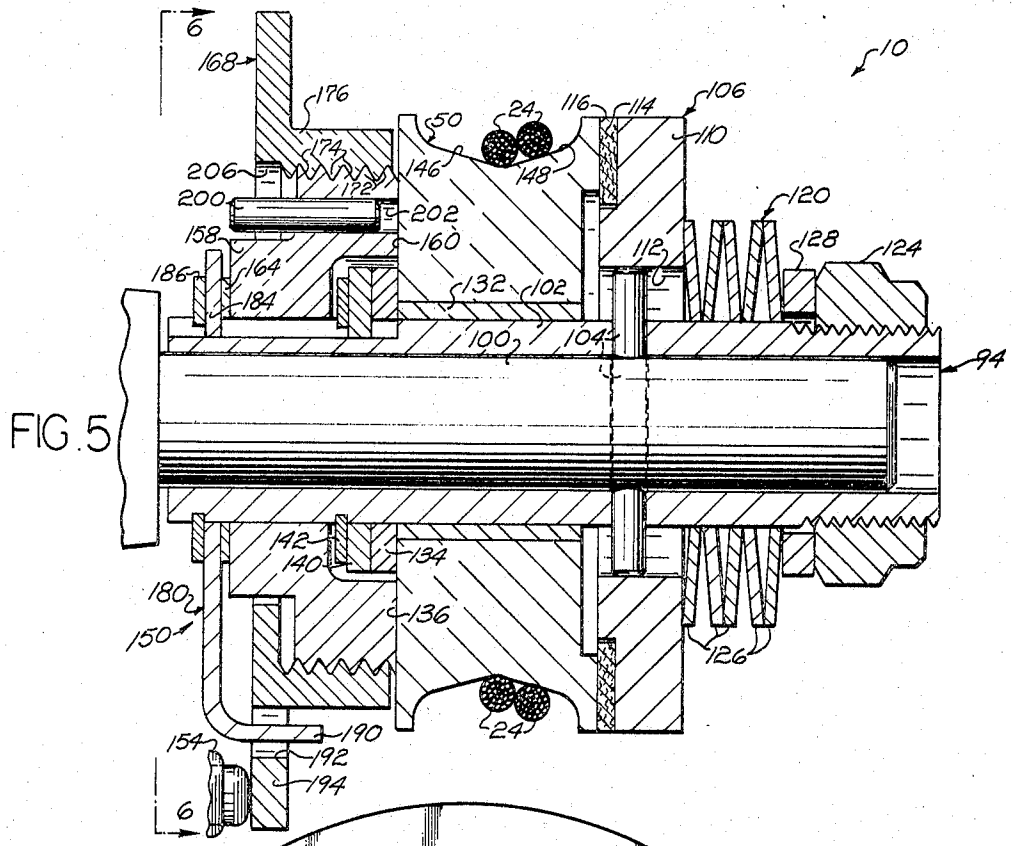


FIG. 5

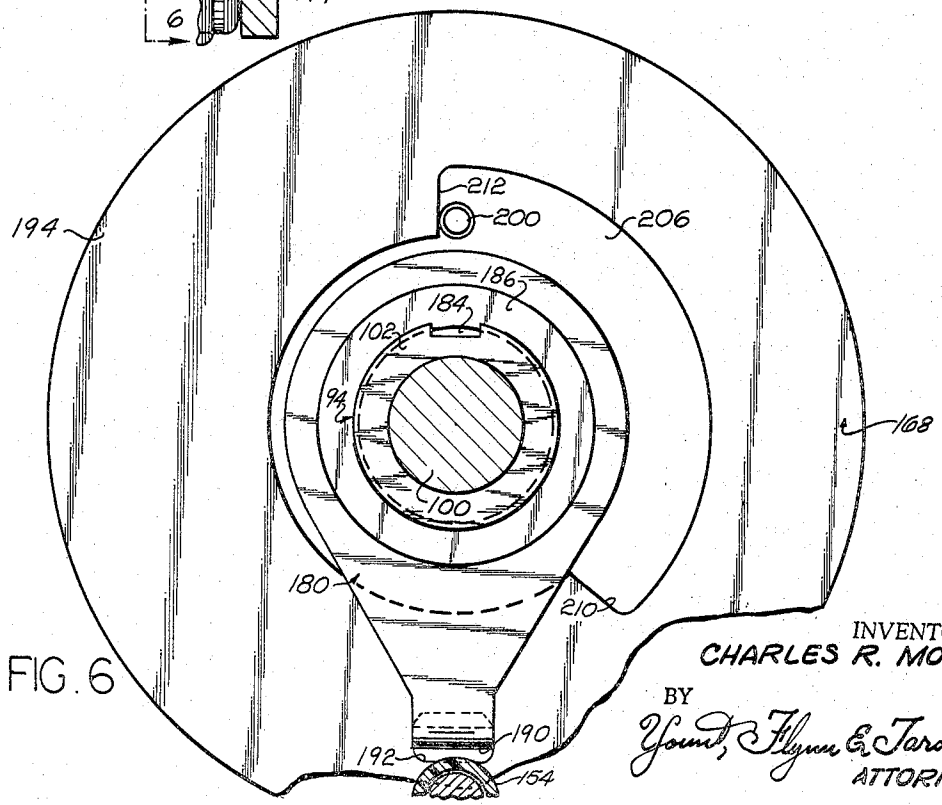


FIG. 6

INVENTOR.
CHARLES R. MOSS
BY
Young, Flynn & Jarolli
ATTORNEYS

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DOOR OPENER

Charles R. Moss, Lyndhurst, Ohio, assignor to Eaton Yale & Towne Inc., Cleveland, Ohio, a corporation of Ohio

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Int. Cl. E05d 15/38; E05f 15/16
U.S. Cl. 49—28 16 Claims

ABSTRACT OF THE DISCLOSURE

Disclosed herein is a door operator assembly including a drive mechanism for moving a door between a closed position and an open position and back to the closed position. The drive mechanism includes a drive pulley rotatably mounted on a drive shaft and connected by a cable to a carriage which is movable along a track to thereby pull the door from the closed position to the open position. A torque transmitting assembly drivingly connects the drive pulley to the drive shaft and enables the drive shaft to be rotated relative to the drive pulley when a load in excess of a predetermined magnitude is applied to the drive pulley in either direction of pulley rotation. An actuator assembly is mounted on the drive shaft and includes a threaded member which is moved axially along the drive shaft to actuate a switch and thereby stop the operation of the door opener assembly.

This invention relates generally to a drive mechanism and more particularly to a drive mechanism for opening a door.

It is an object of this invention to provide a new and improved, relatively compact and inexpensive, drive mechanism for opening a door.

It is another object of this invention to provide a new and improved drive mechanism mounted on a drive shaft and operatively connected to a door for moving the door between a closed position and an open position and for actuating a switch to stop the operation of the drive mechanism when movement of the door is arrested.

It is another object of the invention to provide a drive mechanism for operating a door between a closed position and an open position, said drive mechanism comprising a drive shaft adapted to be connected to a source of power, a drive pulley rotatably mounted on said drive shaft and drivingly connected to the door, torque transmitting means for transmitting torque from the drive shaft to the drive pulley to thereby move the door from the closed position to the open position and for enabling relative rotation to occur between the drive pulley and the drive shaft in response to the door encountering an obstacle, switch means for controlling the operation of the drive mechanism, and an actuator assembly for operating the switch means upon the occurrence of relative rotation between the drive pulley and drive shaft.

It is another object of this invention to provide a new and improved drive mechanism in accordance with the preceding paragraph and wherein the actuator assembly includes an actuator means having a first set of threads formed thereon and a base having a second set of threads formed thereon in meshing engagement with the first set of threads to thereby enable the actuator means to be moved in an axial direction relative to the base upon the occurrence of relative rotation between the drive pulley and the drive shaft.

It is another object of this invention to provide a new and improved drive mechanism for moving a door between a closed and an open position, said drive mechanism including a drive shaft adapted to be connected to

a source of power, a drive pulley mounted on the drive shaft and drivingly connected to the door, torque transmitting means mounted on the drive shaft and frictionally engaging one side of the drive pulley for drivingly connecting the drive pulley to the drive shaft to thereby move the door between the closed and open positions and for enabling the drive shaft to rotate relative to the drive pulley, switch means for controlling the operation of the drive mechanism, and an actuator assembly mounted on the drive shaft in frictional engagement with another side of the drive pulley, the actuator assembly including actuator means movable in an axial direction relative to the drive pulley to operate the switch means upon the occurrence of the rotation of the drive shaft relative to the drive pulley to thereby stop operation of the drive mechanism.

It is another object of this invention to provide a new and improved door opener assembly for moving a door between closed and open positions, the door opener assembly comprises a drive shaft adapted to be connected to a source of power, a drive pulley mounted on the drive shaft, a carriage connected to the door and movable along a track to move the door between the closed and open positions, cable means having more than one turn around the drive pulley for drivingly connecting the carriage to the drive pulley, the drive pulley having a concave surface for lessening the cable scuffing effect of wrapping of the cable upon itself and for promoting engagement of the turns of the cable with the drive pulley, drive means mounted on the drive shaft and engaging the drive pulley for transmitting torque from the drive shaft to the drive pulley to thereby move the carriage to operate the door between a closed and open position and for enabling the drive shaft to rotate relative to the drive pulley when a load applied to the drive pulley is equal to or greater than a predetermined magnitude to thereby arrest movement of the carriage along the track, switch means for controlling the operation of the door opener assembly, and an actuator assembly for operating the switch means, said actuator assembly including an actuator member mounted on the drive shaft in a coaxial relationship with the drive pulley for movement in an axial direction along the drive shaft to operate the switch means when the load applied to the drive pulley is of sufficient maguitude to result in rotation of the drive shaft relative to the drive pulley.

These and other objects and features of the invention will become more apparent upon a consideration of the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is an elevational view of a door opener assembly for moving a door from the closed position (shown) to an open position;

FIG. 2 is an elevational view, similar to FIG. 1, of a portion of the door assembly with the door in the open position;

FIG. 3 is an enlarged sectional view, taken along the line 3—3 of FIG. 2, illustrating the mounting of a carriage of the door opener assembly on a guide track;

FIG. 4 is an enlarged sectional view, taken along the line 4—4 of FIG. 2, further illustrating the structure of the door opener assembly;

FIG. 5 is a sectional view, on an enlarged scale, of a drive mechanism for operating the door opener assembly of FIG. 1, the drive mechanism being illustrated in a condition in which the door is closed;

FIG. 6 is a fragmentary elevational view, taken along the line 6—6 of FIG. 5, further illustrating the structure of the drive mechanism;

FIG. 7 is an enlarged fragmentary elevational view, similar to FIG. 6, illustrating the drive mechanism when the door is in the open position;

FIG. 8 is a fragmentary sectional view, taken along the line 8—8 of FIG. 7, further illustrating the drive mechanism; and

FIG. 9 is a schematic illustration of a control circuit for the door opener assembly of FIG. 1.

This invention provides a reversible drive mechanism which is particularly well adapted for use in opening and closing a door. The drive mechanism includes a drive pulley which is mounted on a drive shaft and drivingly engages a cable connected to the door. When a load in excess of a predetermined amount is applied by the cable to the drive pulley, an actuator assembly is operated to actuate a switch to stop the operation of the drive mechanism. A drive mechanism **10** constructed in accordance with the present invention is illustrated in FIG. 1 in a door operating assembly **12** for operating a door **14** of a building **16** between a closed position of FIG. 1 and an open position of FIG. 2.

In addition to the drive mechanism **10**, the door operating assembly **12** includes a carriage **20** which is mounted on a track **22** and is moved by a cable **24** along the track to open and close the door **14**. The carriage **20** is mounted on the track **22** by a plurality of rollers **30** which engage the tubular track **22** in the manner shown in FIGS. 1 and 3. The tubular track **22** is supported at one end by a support bracket **34** which is connected to a wall of the building **16**. An opposite end of the track **22** is connected by diverging mounting brackets **36** (FIG. 4) to a support member or strut **40** which is connected to a ceiling of the building **16**. The brackets **36** engage opposite sides of a support bracket **44** upon which an idler pulley **46** is rotatably mounted. The cable **24** extends between a drive pulley or capstan **50** and the idler pulley **46**.

The carriage **20** is connected to the door **14** to pull the door upwardly from the closed position of FIG. 1 to the open position of FIG. 2 and to regulate downward movement when the door is moved from the open position of FIG. 2 to the closed position of FIG. 1. Accordingly, a towbar assembly **54** is connected at an upper end **56** (see FIG. 3) to downwardly extending mounting ears **58** formed on side sections **60** and **62** of the carriage **20**. The towbar assembly **54** includes an upper portion **66** which is connected to a lower portion **68**. The lower portion **68** of the towbar assembly **54** is pivotally connected to a bracket **70** mounted on the door **14**. Suitable apertures **74** are provided in the upper towbar portion **66** to enable the length of the towbar assembly **54** to be adjusted. A support or guide track **78**, of known construction, is provided for guiding the movement of the door between the closed and open positions.

Operation of the drive mechanism **10** results in the drive pulley **50** being operated in a counterclockwise direction (as viewed in FIG. 1) to move the carriage **20** and door **14** from the closed position of FIG. 1 to the open position of FIG. 2. When the carriage reaches a position corresponding to the open position for the door **14**, the carriage engages a stop member **82** which is fixedly connected to the guide track **22**. The counterclockwise rotation of the drive pulley **50** is then stopped or halted by frictional engagement or binding of the cable **24** on the drive pulley. A tensioning spring **84** is connected to the cable **24** by brackets **86** and **88** to insure that the cable is held in a taut binding engagement with the drive pulley **50**.

The direction of rotation of the drive pulley **50** is reversed to enable the door **14** to be moved gradually from the open position of FIG. 2 to the closed position of FIG. 1 as the cable **24** is paid out by a run from the drive pulley **50**. When the door reaches the closed position of FIG. 1, the carriage **20** engages a shock absorbing compression spring **83** located in surrounding relationship to the tubular track **22** and a stop member **85** as the door **14** engages a door sill to stop or arrest the movement of the carriage along the guide track **22**.

The drive mechanism **10** (see FIG. 5) includes the drive pulley **50** which is mounted on a drive shaft assembly **94** which is driven through a gear reduction assembly **96** by a motor **98** (FIG. 1). The drive shaft assembly **94** includes a shaft **100** which is drivingly connected to the gear reduction assembly **96** and upon which a sleeve **102** is mounted. The shaft **100** and sleeve **102** are fixedly interconnected by a pin **104**. The sleeve **102** is used in association with the shaft **100** since the sleeve can be readily machined or worked to form recesses for engaging components of the drive mechanism **10**.

A friction clutch or torque transmitting assembly **106** is mounted on the drive shaft assembly **94** to transmit driving forces or torque from the drive shaft assembly to the drive pulley **50** upon rotation of the drive shaft assembly. The torque transmitting assembly **106** also enables drive shaft assembly **94** to rotate relative to the drive pulley **50** when an amount of torque equal to the torque transmitting capacity of the assembly **106** is being transmitted to the drive pulley. The torque transmitting assembly **106** includes a circular clutch or base plate **110** mounted on the drive shaft assembly **94** in a coaxial relationship with the drive pulley **50**. The base plate **110** has a radially extending slot **112** in which the pin **104** is received to retain the base plate **110** against rotation relative to the drive shaft assembly **94** while enabling the base plate **110** to be moved axially along the drive shaft. An annular friction disk or ring **114** is secured to the base plate **110** and pressed into frictional engagement with an annular side or friction surface **116** of the drive pulley **50** by a spring assembly **120**. The spring assembly **120** is also mounted on the drive shaft assembly **94** and presses the base plate **110** and friction ring **114** axially toward the drive pulley **50**. Thus, the torque transmitting assembly **106** is mounted on the drive shaft assembly **94** in a coaxial relationship with the drive pulley **50** for drivingly interconnecting the drive shaft **94** and drive pulley **50**.

The torque or load which can be transmitted by the assembly **106** to the drive pulley **50** is determined, in part, by the pressure which the spring assembly **120** exerts on the base plate **110**. Since the weight of the door with which the drive mechanism **10** is associated can vary in different environments, an adjusting nut **124** is threaded onto the drive shaft assembly **94** for axial movement relative to the drive shaft to enable the pressure exerted by the spring assembly **120** against the base plate **110** to be adjusted. In the present instance, the spring assembly **120** includes a plurality of Belleville washers **126** which are relatively compact and easily assembled on the drive shaft assembly **94**. A spring retaining washer **128** is provided between the nut **124** and the Belleville washers **126**.

When a load in excess of the torque transmitting capability of the assembly **106** is applied to the drive pulley **50** by the cable **24**, the drive pulley **50** is held against rotation while the drive shaft assembly **94** is rotated by the motor **98**. Such a relatively large load is applied to the drive pulley by engagement of the carriage **20** with one of the stops **82** or **85** when the door **14** is moved to open or close position or encounters an obstruction intermediate the stops. Sliding or slipping then occurs between the drive pulley **50** and torque transmitting assembly **106** and the drive shaft assembly **94** is rotated relative to the drive pulley. To facilitate this relative movement between the drive pulley **50** and drive shaft assembly **94**, a sleeve bearing **132** is mounted within the drive pulley **50** for engagement with the drive shaft assembly **94**. A thrust washer of bearing **134** is engaged by a radially extending end surface **136** of a drive pulley and is held by a keyed lock washer **140** and retainer ring **142** against axial movement relative to the drive shaft assembly **94** under the

influence of the pressure exerted by the torque transmitting assembly **106** against the opposite radially extending end surface **116** of the drive pulley.

When a relatively large load is applied to the drive pulley **50** and relative rotation occurs between the drive pulley and the drive shaft assembly **94**, the drive pulley **50** is held by the cable **24** against rotation under the influence of torque transmitted by the assembly **106**. To insure that slipping or relative motion does not occur between the cable **24** and the drive pulley **50**, the cable is wound for one and a half turns around the drive pulley. In addition, the drive pulley **50** includes inwardly sloping or concave surfaces **146** and **148** which tend to make the turns of the cable center themselves against the drive pulley without crossing each other or moving laterally outwardly relative to the drive pulley. The surfaces **146** and **148** promote this orientation of the cable by causing the turns of the cable to tend to move toward the center of the drive pulley where they engage the drive pulley and each other without crossing to frictionally retard relative movement between the drive pulley **50** and the cable. In one illustrative embodiment of the invention, the surfaces **146** and **148** have an included angle of approximately one hundred and fifty degrees. Of course, it is contemplated that the drive pulley **50** could be formed with a shape other than the specific illustrated shape and that the cable **24** could be wound around the drive pulley for any desired number of turns. The tapered surfaces **146** and **148** also lessen cable scuffing caused by the natural tendency of the cable to overlap during winding on the pulley **50** by reducing the work necessary to skid the underlying wrap of cable toward the center of the pulley **50**.

An actuator assembly **150** is provided for operating a control switch **154** to stop the motor **98** and, at the same time, provide for a reversal of the direction of operation of the motor on the next subsequent operation of the drive mechanism. The actuator assembly **150** is mounted on the drive shaft assembly **94** in a coaxial relationship with the drive pulley **50** and includes a generally circular base or body **158** which is rotatable relative to the drive shaft assembly. The actuator base **158** has an annular end surface **160** which is pressed into frictional engagement with the end surface **136** of the drive pulley **50** by a wave spring **164**. The surface **160** of the actuator base **158** engages the end surface **136** of the drive pulley **50** to transmit torque between the drive pulley **50** and the actuator assembly **150**.

The switch **154** is operated by an actuator member **168** mounted on a base **158** for movement in an axial direction relative to the drive shaft assembly **94** and the base **158**. The actuator member **168** is movable between a first position, shown in FIG 5, immediately adjacent to switch **154** and a second position (FIG. 8) in which the switch **154** is actuated or operated by the member **168**. Opening the door 14 results in the actuator member being moved to the second position to actuate the switch **154**. Closing the door **14** results in the actuator member **168** being moved to the first position to release the switch **154**.

This axial movement of the actuator member **168** is brought about by an interaction between a first set of threads **172** extending in an axial direction around an outer surface of the actuator base **158** and a second set of threads **174** formed internally of an axial section **176** of the actuator member **168**. The actuator member **168** is rotated relative to the actuator base **158** by a drive dog or member **180** when relative rotation occurs between the drive pulley **50** and drive shaft assembly **94**. Accordingly, the drive member **180** is retained against rotational and axial movement relative to the drive shaft assembly **94** by a key section **184** and a lock or snap ring **86**. An axially projecting end portion **190** of the drive member **180** extends through an opening **192** in a flange portion **194** of the actuator member **168** (see FIG. 6) to interconnect the drive member **180** and actuator member **168**. Thus, when relative rotation occurs between the drive shaft assembly **94** and the actuator body **158**, the drive member **180** rotates the actuator member **168** relative to the actuator body **158** to move the actuator member **168** axially of the actuator body **158** under the influence of the threads **172** and **174** to thereby operate the switch **154**.

A stop or pin **200** is fixedly mounted on the actuator body **158** for limiting rotation and consequently axial movement, of the actuator member **168** relative to the actuator body **158**. The stop **200** is fixedly mounted in a hole or recess **202** in the actuator body **158** and extends axially outwardly into an arcuate recess **206** formed in the radially extending flange portion **194** of the actuator member **168** (see FIG. 6). When the actuator member **168** is rotated from the first position (FIGS. 5 and 6) wherein the door **14** is open to the second position (FIGS. 7 and 8) wherein the door **14** is closed, a radially extending end or stop surface **210** of the arcuate opening **206** is moved into engagement with the stop member **200** to stop or arrest the rotation of the actuator member **168** relative to the actuator body **158**. Similarly, when the actuator member **168** is rotated from the second position (FIGS. 7 and 8) to the first position (FIGS. 5 and 6), a second or opposite stop surface **212** engages the stop member **200** to limit the rotation of the actuator member **168**.

When the drive mechanism **10** is operated to raise the door **14** from the closed position to the open position, the drive pulley **50** rotates in a counterclockwise direction (as viewed in FIG. 1) to pull the carriage **20** along the guide track **22** to the position shown in FIG. 2. When the door **14** is opened, the carriage **20** engages the shock absorbing compression spring **81** located in surrounding relationship to the tubular track **22** and the stop member or collar **82** to halt or arrest the forward movement of the carriage. The rotation of the drive pulley **50** is then halted by a binding engagement between the cable **24** and the drive pulley. The load which is applied to the drive pulley **50** by the cable **24** is then of sufficient magnitude to overcome the frictional torque transmitted by the assembly **106** from the drive shaft assembly **94** to the drive pulley. Therefore, relative movement or slipping occurs between the drive pulley **50** and the torque transmitting assembly **106**. However, the actuator assembly base **158** is held against rotation by the frictional engagement of the end surface **160** of the actautor base with the end surface **136** of the drive pulley **50**.

The drive member **180** continues to rotate with the drive shaft assembly **94** relative to the actuator base **158** and drive pulley **50**. Therefore, when the door **14** reaches the open position, the actuator member **168** is rotated in a counterclockwise direction (as viewed in FIG. 6) relative to the actuator body **158** by the drive member **180**. As the actuator member **168** is rotated relative to the actuator body **158**, the meshing sets of threads **172** and **174** on the actuator member and body interact to move the actuator member **168** axially relative to the drive shaft assembly **94** from the position shown in FIG. 5 to the position shown in FIG. 8 to operate the switch **154**. Operation of the switch **154** deenergizes the motor **98** to halt the rotation of the drive shaft assembly **94**. It should be noted that immediately after actuation of the switch **154**, the stop surface **210** engages the stop pin or member **200** (see FIG. 7). Therefore, the stop member **200** will prevent further rotational and axial movement of the actuator member **168** relative to the actuator body **158** so that the force applied to the switch **154** does not become excessive. The actuator assembly **150** can then be rotated as a unit relative to the drive pulley **50** by overcoming the frictional forces between the surface **136** of the drive pulley and the surface **160** of the actuator body **158**. This enables the actuator assembly **150** to

oppose any coasting or inertial forces transmitted from the motor **98** and reduction gear assembly **96**.

Upon the next subsequent operation of the drive mechanism **10**, the direction of rotation of the motor **98** is reversed by the switch **154**, in a manner to be explained in greater detail subsequently, to rotate the drive pulley **50** in a clockwise direction as viewed in FIG. 1. The clockwise rotation of the pulley **50** pulls the carriage **20** toward the drive mechanism **10** to close the door **14**. When the door **14** is moved into the closed position, the door engages an associated door sill and the carriage **20** engages the stop member or collar **85** to thereby limit the movement of the carriage. Of course, the collar **85** could, if desired, be moved to the left of the position shown in FIG. 1 to enable the movement of the carriage **20** to be arrested only by engagement of the door **14** with the associated sill.

When the movement of the carriage **20** is stopped, the rotation of the drive pulley **50** is also stopped by a binding action between the cable **24** and the drive pulley **50** in a manner similar to that previously explained. The rotation of the drive shaft assembly **94** will then be continued to enable the drive member **180** to rotate the actuator member **168** relative to the actuator body **156**. As the actuator member **168** is rotated relative to the actuator body **158**, the sets of threads **172** and **174** cooperate to move the actuator member axially relative to the drive shaft **94** from the position shown in FIG. 8 to the position shown in FIG. 5 to release the control switch **154**.

If the door **14** should encounter an obstruction while moving from the open position to the closed position, the downward movement of the door will be halted or arrested and the cable **24** will stop the rotation of the drive pulley **50**. Rotation will then occur between the actuator member **168** and the actuator body **158** to move the actuator member inwardly to release the switch **154** in the manner previously explained. This operation of the switch **154** results in the motor being deenergized. Thus, the single control switch **154** is operative to stop the operation of the drive mechanism **10** when the door is moved to either the open or closed position and when the door engages the obstruction during movement from the open to the closed position. Of course, if the door should engage an obstruction while moving from the closed to the open position, the drive mechanism would be operated in much the same manner as if the carriage **20** had engaged the stop collar **82** to thereby stop the operation of the drive mechanism.

A control circuit **230** for controlling the operation of the drive mechanism **10** is shown in FIG. 9. The control circuit **230** includes the reversing switch **154** which is operated by the actuator assembly **150** to stop the operation of the drive mechanism and to reverse the direction of rotation of the motor **98** on the next subsequent operation of the drive mechanism. A start button or key **232** is provided in the control circuit for operating a stepper or control relay **234** to initiate operation of the drive mechanism **10** to move the door **14** between the closed and open positions. A receiver plug **236** is also provided for connecting the control circuit **230** to an optional remote control device. In addition, the circuit **230** advantageously includes a light **238** for illuminating an area adjacent to the door **14** when the door is in the open position.

The circuit **230** is shown in FIG. 9 with the door in the closed position and the control switch **154** in the normal or released position of FIG. 5. Upon actuation of the push button **232**, electrical energy is conducted from a transformer **242** to a coil **244** of the relay **234** to operate the relay from the position shown in solid lines in FIG. 9 to the position shown in dashed lines in FIG. 9. Operation of the relay **234** completes a circuit for energizing the motor **98** from power lines **248** and **250**. This circuit includes a movable contact member **252** of the control switch **154** which is in engagement with a fixed contact **256**, a lead **258**, a movable contact **260** of the stepper relay **234**, a field coil **262** of the motor **98**, a second movable contact **264** of the stepper relay **234**, and a lead **266** which is connected to the armature coil **268** of the motor **98**. The armature coil **268** is in turn connected by a lead **270** to the power line **248**. Thus, actuating the start switch or push button **232** operates the relay **234** to energize the field coil **262** of the motor **98** to rotate the drive pulley **50** in a counterclockwise direction, as viewed in FIG. 1, to thereby move the door **14** from the closed position to the open position in the manner previously explained.

When the door **14** moves to the open position of FIG. 2, the control switch **154** is actuated, by the actuator member **168** in the manner previously explained. Actuation of the control switch **154** moves contact **252** into engagement with the fixed contact **274**, as shown in dashed lines in FIG. 9. This completes a circuit to energize the light **238** and opens the previous circuit to de-energize the motor **98**. The control switch **154** remains in the operated position, indicated in dashed lines in FIG. 9 until the door is closed.

When the start button **232** is again actuated to move the door **14** from the open position to the closed position, the relay **234** is again stepped to move the contacts **260** and **264** from the position shown in dashed lines to the position shown in solid lines in FIG. 9. This operation of the relay **234** energizes the motor for rotation in a direction opposite to its previous rotation so that the drive pulley **50** is rotated in a clockwise direction as viewed in FIG. 1. Thus, the field coil **262** is energized from the power line **250** through the movable contact **252** of the control switch **154** and the movable contact **264** of the relay **234** which is in a position shown in solid lines in FIG. 9. The circuit is completed to the power line **248** through the movable contact **260** of the relay **234**, the line **266**, the armature coil **268** and the line **270**. When the door **14** reaches the closed position, the rotation of the drive pulley is halted or arrested and the actuator assembly **150** operates the control switch **154** to the position shown in solid lines in FIG. 9 to de-energize the motor **98** and the light **238**.

In view of the preceding description, it will be apparent that I have provided a drive mechanism **10** which is particularly well adapted for use in a door operator assembly. However, it is contemplated that the illustrated structure of the drive mechanism **10** will be varied somewhat when the drive mechanism is to be used in other environments. It is also anticipated that the structure of the door opener assembly **12** will be varied in many different ways. For example, the particular structure of the guide track **22**, carriage **20** and towbar assembly **54** could be varied without affecting the operation of the drive mechanism **10**. It is further contemplated that the particular structure of the various components of the drive mechanism will be changed or modified by those skilled in the art. Therefore, it is intended to cover by the appended claims any such modifications or changes as fall within the true spirit and scope of the invention.

What is claimed is:

1. A drive mechanism for operating a door between a closed position and an open position, said mechanism comprising a rotatable drive shaft adapted to be connected to a source of power, a drive pulley rotatably mounted on said drive shaft and operatively connected to said door, torque transmitting means for transmitting torque from said drive shaft to said drive pulley to thereby move said door between said positions and for enabling relative rotation to occur between said drive pulley and said drive shaft upon said drive pulley encountering a predetermined resistance to rotation, switch means for controlling the operation of said drive mechanism, and an actuator assembly for operating said switch means, said actuator assembly including a base mounted for rotation with said drive pulley, actuator means mounted

on said base and rotatable relative to said base in one direction to actuate said switch means upon said relative rotation between said drive pulley and said drive shaft, and stop means mounted on said base for retaining said actuator means against continued rotation in said one direction relative to said base after operation of said switch means by said actuator means.

2. A drive mechanism as set forth in claim 1 wherein said actuator assembly further includes a first set of threads formed on said actuator means and a second set of threads formed on said base in meshing engagement with said first set of threads to thereby enable said actuator means to be moved in an axial direction relative to said drive shaft and said base upon said relative rotation between said drive pulley and said drive shaft.

3. A drive mechanism as set forth in claim 1 wherein said actuator assembly further includes a drive member connected to said drive shaft for rotating said actuator means relative to said base upon said relative rotation between said drive pulley and said drive shaft.

4. A drive mechanism as set forth in claim 1 wherein said base frictional engages said drive pulley to retard relative rotation between said base and drive pulley, said base being movable relative to said drive pulley against the influence of said frictional engagement by rotation of said drive shaft relative to said drive pulley after engagement of said actuator means with said stop means.

5. A drive mechanism as set forth in claim 1 wherein said torque transmitting means, said drive pulley and said actuator assembly are mounted in a coaxial relationship on said drive shaft for rotation with said drive shaft to move said door between said positions.

6. A drive mechanism for operating a door between a closed position and an open position, said mechanism comprising a track, a carriage mounted for movement along said track to move said door between said positions a rotatable drive shaft adapted to be connected to a source of power, a drive pulley rotatably mounted on said drive shaft, cable means for drivingly connecting said carriage to said rive pulley, spring means for resiliently urging said cable means into binding engagement with said drive pulley to thereby prevent slipping between said cable means and said drive pulley, torque transmitting means for transmitting torque from said drive shaft to said drive pulley to rotate said drive pulley to move said cable means and carriage to operate said door between said positions and for enabling relative rotation to occur between said drive pulley and said drive shaft upon said drive pulley encountering a predetermined resistance to rotation, switch means for controlling the operation of said drive mechanism, and an actuator assembly for operating said switch means, said actuator assembly including a base mounted for rotation with said drive pulley and actuator means drivingly connected with said shaft and operatively connected to said base for axial movement relative to said base and drive shaft to actuate said switch means upon said relative rotation between said drive pulley and said drive shaft.

7. A drive mechanism as set forth in claim 6 wherein said cable means is wrapped around said drive pulley for more than one turn and said drive pulley has a sloping surface for promoting centering of the cable on said drive pulley.

8. A drive mechanism for moving a door between a closed position and an open position, said drive mechanism including a drive shaft adapted to be connected to a source of power, a drive pulley rotatably mounted on said drive shaft and adapted to be drivingly connected to said door, torque transmitting means mounted on said drive shaft and frictionally engaging one side of said drive pulley for drivingly connecting said drive pulley to said drive shaft to thereby move said door between said positions and for enabling said drive shaft to rotate relative to said drive pulley, switch means for controlling the operation of said drive mechanism, and an actuator assembly mounted on said drive shaft in frictional engagement with another side of said drive pulley, said actuator assembly including actuator means drivingly connected to said shaft and movable in an axial direction relative to said drive pulley for operating said switch means upon the occurrence of said rotation of said drive shaft relative to said drive pulley to thereby stop operation of said drive mechanism.

9. A drive mechanism as set forth in claim 8 wherein said actuator assembly includes a body means operably associated with said drive pulley and having threads for engaging corresponding threads on said actuator means, said actuator means being moved in said axial direction relative to said drive pulley by an interaction between the threads on said body means and the threads on said actuator means when said drive shaft is rotated relative to said drive pulley.

10. A drive mechanism as set forth in claim 9 wherein said body means is rotatable with said drive shaft relative to said drive pulley.

11. A drive mechanism as set forth in claim 9 wherein said actuator assembly includes stop means mounted on said body means for arresting movement of said actuator means in said axial direction relative to said drive pulley with said threads on said body means in meshing engagement with said threads on said actuator means after said actuator means has moved through a sufficient distance to operate said switch means.

12. A drive mechanism as set forth in claim 8 wherein said torque transmitting means includes a base means drivingly connected to said drive shaft and movable in an axial direction relative to said drive shaft, friction means mounted on said base means for engaging said drive pulley to drivingly interconnect said drive pulley and said drive shaft through said base means, and said spring means engaging said base means for resiliently pressing said friction means against said drive pulley.

13. A drive mechanism as set forth in claim 12 wherein said torque transmitting means further includes means for adjusting the pressure applied by said spring means in pressing said friction means against said drive pulley.

14. A door opener assembly for moving a door between closed and open positions, said assembly comprising a rotatable drive shaft adapted to be connected to a source of power, a drive pulley rotatably mounted on said drive shaft, a track, a carriage operatively connected to said door and movable along said track to move said door between said closed and open positions cable means having more than one turn around said drive pulley for drivingly connecting said carriage to said drive pulley, said drive pulley having a generally concave surface for promoting winding of said cable near the center of said drive pulley, drive means mounted on said drive shaft and engaging said drive pulley for transmitting torque from said drive shaft to said drive pulley to thereby move said carriage to operate said door between said closed and open positions and for enabling said drive shaft to rotate relative to said drive pulley when a load applied to said drive pulley by said cable means is equal to or greater than a predetermined magnitude to thereby arrest movement of said carriage in one direction along said track, switch means for controlling the operation of said door opener assembly, and an actuator assembly for operating said switch means, said actuator assembly including an actuator member mounted on said drive shaft for movement in an axial direction along said drive shaft to operate said switch means when the load applied to said drive pulley by said cable means is of sufficient magnitude to result in rotation of said drive shaft relative to said drive pulley.

15. A drive assembly as set forth in claim 14 wherein said actuator assembly further includes a body means mounted on said drive shaft in engagement with said drive pulley for transmitting up to a predetermined amount of torque from said drive pulley to said actuator assembly and for enabling relative rotation to occur be-

tween said drive pulley and actuator assembly after operation of said switch means by said actuator member.

16. A drive assembly as set forth in claim 15 wherein said drive assembly further includes a first set of threads formed on said body means and a second set of threads formed on said actuator member and engaging said first set of threads, said actuator member being moved axially along said drive shaft by an interaction between said sets of threads when said drive shaft is rotated relative to said body means to thereby actuate said switch means.

References Cited

UNITED STATES PATENTS

2,757,327	7/1956	Oliver	318—265
2,922,638	1/1960	Smith	160—188 X

J. KARL BELL, Primary Examiner

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