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SAFETY SWITCH FOR DE-ENERGIZING A DRIVING MOTOR IN THE EVENT OF STOPPAGE OF A SHAFT DRIVEN THEREBY

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Fig. 1

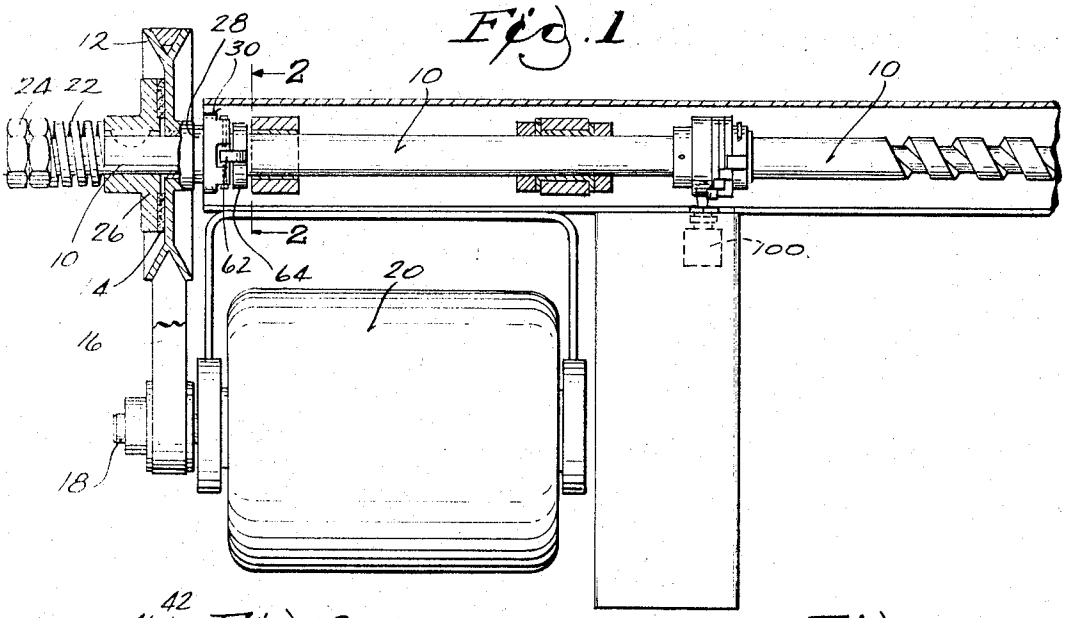


Fig. 2

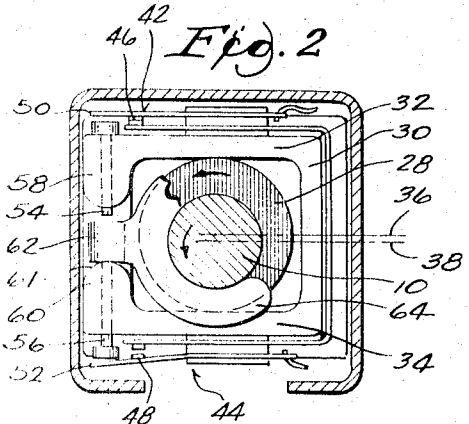
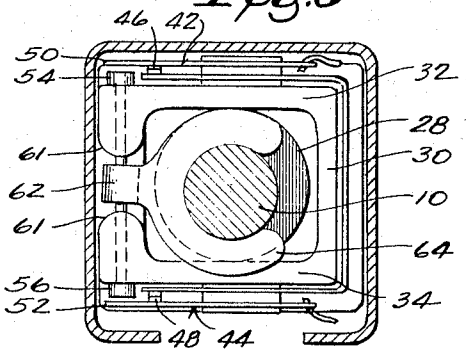


Fig. 3



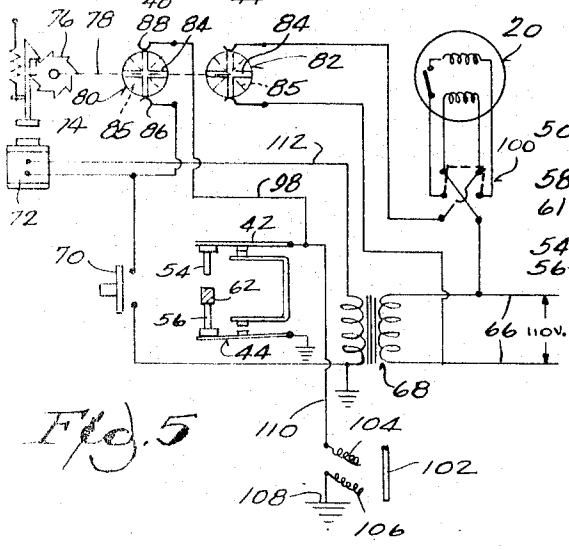
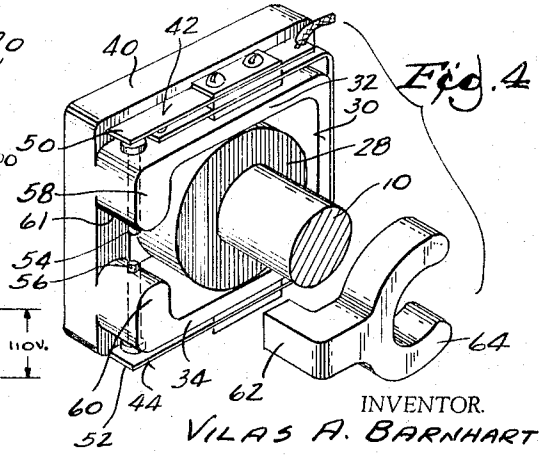


Fig. 5

Fig. 4



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SAFETY SWITCH FOR DE-ENERGIZING A DRIVING MOTOR IN THE EVENT OF STOPPAGE OF A SHAFT DRIVEN THEREBY

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This invention relates to a safety switch for de-energizing a driving motor in the event of stoppage of a shaft driven thereby.

An example of apparatus in which the device is useful is the door opener shown in my application Serial No. 316,740, filed October 16, 1963 and pertaining, specifically, to a lost motion accumulator in a reversible drive.

In the door opening mechanism selected to exemplify the invention, there is a screw shaft which may be rotated by power in either direction when the door is to be opened or closed. The impulse which initiates door movement is momentary. Hence, a stepping switch functions like a holding circuit to maintain energization of the motor until the manual control switch is closed, or the door completes its movement, or the movement is obstructed. In any such case, the mechanism opens the holding circuit and movement terminates.

If there is a stoppage for any reason, severe damage may be done either to the mechanism or to the motor or perhaps to the body of a person subjected to pressure by the movement of the door, unless the motor is de-energized under these conditions.

Accordingly, I have provided a drive, associated switches and switch actuators so organized that regardless of the direction of rotation of the shaft the circuit will remain closed as long as the shaft is in rotation but will be opened to de-energize the motor if rotation of the shaft is arrested, even momentarily.

A yoke through which the shaft passes carries at least one switch, if only one direction of movement is involved, or two switches if the shaft is reversible. These switches are connected in series. Both switches are normally closed to actuate the stepping relay to a position in which the motor is de-energized. At least one will be held open during normal shaft rotation by the arm of a member frictionally engaged with the shaft. However, if the shaft rotation is obstructed, a clutch slips. The switches are mounted on a yoke which rides on the eccentric hub of the driving pulley so that the normally open switch will be closed momentarily under these conditions by eccentric displacement of the yoke on which the switches are mounted. This will step the relay to de-energize the motor.

In the drawings:

FIG. 1 is a diagrammatic view partially in elevation and partially in axial section through a shaft driving arrangement embodying the invention.

FIG. 2 is a greatly enlarged detail view taken in section on the line 2—2 of FIG. 1.

FIG. 3 is a view similar to FIG. 2 showing the parts in a different position which they assume if the shaft stops rotating.

FIG. 4 is a view of the switch mounting and operating mechanism in perspective, with the frictionally driven part shown in a relatively separated position.

FIG. 5 is a circuit diagram.

While the invention is by no means limited to a door operator, I have selected a door operator to exemplify the invention. The screw shaft **10** is driven from pulley **12** through a slip clutch which includes friction disk **14**. A belt **16** connects the pulley **12** with the armature shaft

18 of an electric motor **20**. A compression spring **22** is seated against nut **24**. The spring **22** exerts pressure on the clutch element **26** which is keyed to the shaft **10** and bears against the friction disk **14**. Thus the shaft normally receives torque from pulley **12**.

An extension **28** projecting axially from the hub of pulley **12** is slightly eccentric with respect to the axis of shaft **10**. The yoke **30** has upper and lower arms **32** and **34** respectively embracing top and bottom peripheral portions of the eccentric hub extension **28**. The degree of preferred eccentricity of hub extension **28** is indicated by the lines **36** and **38** in FIG. 2, the line **36** being at the level of the axis of the hub extension **28** and the line **38** being at the level of the axis of shaft **10**.

The yoke **30** is confined within a casing **40** which encloses switches **42** and **44**, respectively mounted on the yoke arms **32** and **34**. The contacts **46** and **48** of the normally closed switches are respectively mounted on arms **50** and **52** in the path of the end portions of switch actuators **54** and **56**, respectively. These actuators are guided for reciprocation in the terminal portions **58** and **60** of the yoke. Their respective inner ends **61** are spaced to receive the arm **62** of a split ring **64** embracing the shaft **10** and frictionally driven therefrom.

The motor **20** is reversible. As shown in FIG. 5, it receives the full voltage of the line **66**. A transformer at **68** reduces line voltage for control circuit purposes.

The control switch **70** may be operated manually or electrically or by radio. When closed, it energizes solenoid **72**. The resulting movement of its armature **74** causes one step of rotation of the ratchet **76** of the stepping relay. The shaft **78** advances the rotary relay contact **80** and the rotary relay contact **82** in steps of 45°. As clearly shown in FIG. 5, each of the rotors **80** and **82** has diametrical conductors **84** crossing at right angles. Their intervening position is indicated by the broken lines **85**. When lines **85** register with fixed contacts **86** and **88**, there is no electrical connection between the fixed contacts. A one tooth advance of the ratchet **76** will alternately close and open the circuits through the respective switch rotors **80** and **82**. Thus the assembly may be considered, in one sense, to function like a holding relay because, after the circuit is once established, it remains established until the solenoid **72** is next energized, whereupon the circuits are promptly broken until further energization of the solenoid **72** occurs.

The switch rotor **80** controls the low voltage circuit while switch **82** controls the energization of the operating motor **20** at line voltage.

As long as shaft **10** is in operation in either direction, friction between it and the split ring **64** causes arm **62** to displace one or the other of the switch actuators **54** or **56** and thereby to open one or the other of the switches **42** or **44**.

In case of any stoppage of shaft **10**, the friction drive through disk **14** will permit the motor **20** to continue to operate. The slight eccentricity of the hub extension **28** of pulley **12** assures that the entire yoke **30** will have vibratory movement with respect to the shaft if the shaft is stationary while the hub extension **28** continues to revolve. If this condition were to persist for any appreciable length of time, the friction clutch would be destroyed. However, if the shaft **10** stops while the hub extension **28** continues to be rotated by the motor **20**, acting through bent **16** on pulley **12**, the resulting vibratory movement of the yoke **30** will assure that the parts will assume the position shown in FIG. 3 in which the two switches **42** and **44** are both closed.

There will be a tendency for the parts to assume the position shown in FIG. 3 even without the eccentricity of the hub extension upon which the yoke is mounted. How-

ever, the vibration resulting from the eccentric mounting assures that the parts will function positively to de-energize the motor immediately upon cessation of rotation of shaft **10**.

When the two switches **42** and **44** are both closed as above described and shown in FIG. 3, a circuit will be established from ground **96** through conductor **98** and switch contacts **88** and **86** to the solenoid **72** and thence back to the secondary of transformer **68**. The resulting energization of the solenoid **72** will advance the stepping relay one step (45°) thus registering the non-conductive areas **85** of the respective rotors **80** and **82** with their respective fixed contacts. This immediately stops the motor **20** and de-energizes the low voltage control circuits. The closing of switch **70** will again advance the stepping relay ratchet **76** to rotate the rotors **80** and **82** for another 45° thereby setting up the low voltage circuits of the safety switch mechanism and at the same time energizing the motor **20**. In the particular device, the reversing switch at **100** (which is conventional in such devices) will, in the instant structure, cause shaft **10** to operate in a reverse direction from that in which it last operated.

There is a limit switch which is not here involved but will be referred to briefly. The bar **102** moves along screw **6** and in its path are spring contacts **104** and **106** shown in FIG. 5. Engagement of the bar **102** across spring contacts **104** and **106** will have the same effect as the functioning of the safety switch as above described in that it will connect the ground **108** through line **110** and line **98** to the fixed contact **88** of rotor **80**, current being conducted through the conductor **84** to the other fixed contact **86** and thence through the solenoid **72** with return through condductor **112** to the secondary of transformer **68**. The resulting energization of solenoid **72** of the stepping relay will advance the relay 45°, thereby stopping motor **20** and de-energizing the entire control circuit.

The starting of motor **20** and the energizing of the control circuit can always be effected by the switch **70**. The de-energization of the motor **20** and the control circuit can be accomplished either through the safety switches **42** and **44** as above described or by further manipulation of the switch **70** as above described or by the engagement of moving limit switch contact **102** with spring contacts **104** and **106** as above described.

I claim:

1. The combination of a motor, a driven shaft, means for communicating motion from the motor to the driven shaft, a rotor having a slip clutch connection with the shaft, a safety switch mechanism including relatively movable parts one of which is connected with the rotor and another of which is connected with said shaft, and means whereby relative movement between said parts de-energizes the motor in the event of slippage of said clutch, said last means including:

a mounting having means supporting the mounting for oscillation,

complementary means respectively mounted on the shaft and the rotor for effecting oscillation of the mounting upon the occurrence of movement in the slip clutch connection between the shaft and the rotor,

a switch on the mounting including switch contacts,

a switch actuator constituting means for displacing one of said contacts with respect to the other, said actuator being provided with a friction clutch driving connection with said shaft separate from the slip clutch connection first mentioned,

a motor energizing and de-energizing switch,

means for electrically operating said last switch to de-energize said motor,

means for electrically connecting said last mentioned means in circuit with the aforesaid contacts of the switch on said mounting,

the circuit through said contacts holding the motor energizing and de-energizing switch in motor energizing position by the friction clutch actuation of the switch actuator from the shaft during normal rotation of the shaft, the said mounting being stationary,

the motor energizing and de-energizing switch being operated to motor de-energizing position upon the occurrence of oscillation of the mounting consequent upon relative movement between said rotor and said shaft.

2. The combination of a motor, a driven shaft, a rotor having means for driving it from the motor and having slip clutch connection with the shaft for normally operating the shaft from the motor, an eccentric connected with the rotor, a yoke riding on the eccentric to receive motion therefrom, a switch mounted on the yoke and having normally closed contacts, a motor controlling circuit in which said switch is connected, an arm having friction drive connection with the shaft to receive motion therefrom tending to rotate the arm with the shaft, means for opening one of the contacts of the switch with respect to the other of said normally closed contacts and constituting an actuator comprising means for receiving motion from said arm when such motion is imparted frictionally to the arm from said shaft, whereby the switch tends to be held open during shaft rotation, said eccentric and yoke constituting means effective during continued operation of the eccentric for bringing about the closing of the said switch contacts of said switch when shaft motion is arrested.

3. The combination of a driven shaft and electrically controlled reversible means for the rotation thereof, said means including a driving rotor having slip clutch connection with the shaft and having an eccentric portion, switch means controlling the energization and de-energization of said electrically controlled means and including switch contact elements at opposite sides of the shaft and oppositely extending actuators therefor, an arm having frictionally driven connection with the shaft and disposed between said actuators whereby said arm selectively operates one of said actuators from said shaft according to the direction of rotation of the shaft, relatively fixed contacts with which the respective contact elements cooperate and from which the said one element is displaced, and means for energizing and de-energizing said electrical means, said energizing and de-energizing means including a circuit controlled by the actuator-effected movement of said opposed switch elements, and a mechanism engaged by the eccentric portion of said rotor for effecting bodily movement of said contacts in a direction to engage one of said switch elements which has been displaced by its respective actuator at a time when the movement of the shaft is arrested.

4. A combination according to claim **3** in which the respective fixed contacts and switch contact elements are mounted on a yoke having arms at opposite sides of the shaft and said yoke has bearing contact on an eccentric hub with which the driving rotor is provided and which constitutes the eccentric portion of said rotor aforesaid.

5. The combination of a screw shaft and a reversible motor, a stepping relay including a rotary switch member having alternate contact elements and insulated elements, contact means controlling the energization of the motor and respectively positioned at the periphery of the rotor to engage alternately during rotor rotation with the contact elements and insulated elements of said rotor, electrical means for the stepped advance of said rotor, a driving member operatively connected to receive motion from the motor and having a slip clutch connecting it with said shaft, said member having an eccentric hub, a yoke having guide means for positioning the yoke, the yoke including arms engaged with the eccentric hub,

switches controlling the stepping relay and having relatively fixed contacts mounted on the yoke and having cooperative movable contacts normally closed in engagement with the respective fixed contacts, switch opening actuators engageable with the respective movable contacts and disposed generally oppositely to each other, and an arm intervening between said actuators and having a split collar portion bearing upon the shaft, said arm tending to be rotated with said collar in the direction of rotation of the shaft and to push one of the actuators to tend to open the movable contact engaged thereby, the eccentric tending to close periodically a relatively fixed contact with a movable contact held open

if said shaft comes to rest during continued operation of the motor, thereby de-energizing the motor.

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