Sept. 15, 1970 W. H. ANGLE 3,529,104

LIMIT SWITCH OPERATING MECHANISM FOR ACTUATORS

Filed April 19, 1968 2 Sheets-Sheet 1

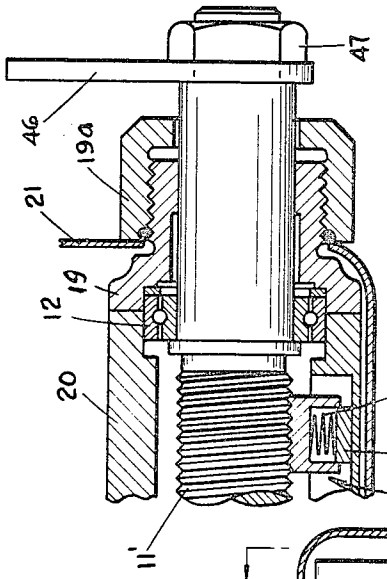


FIG. 5

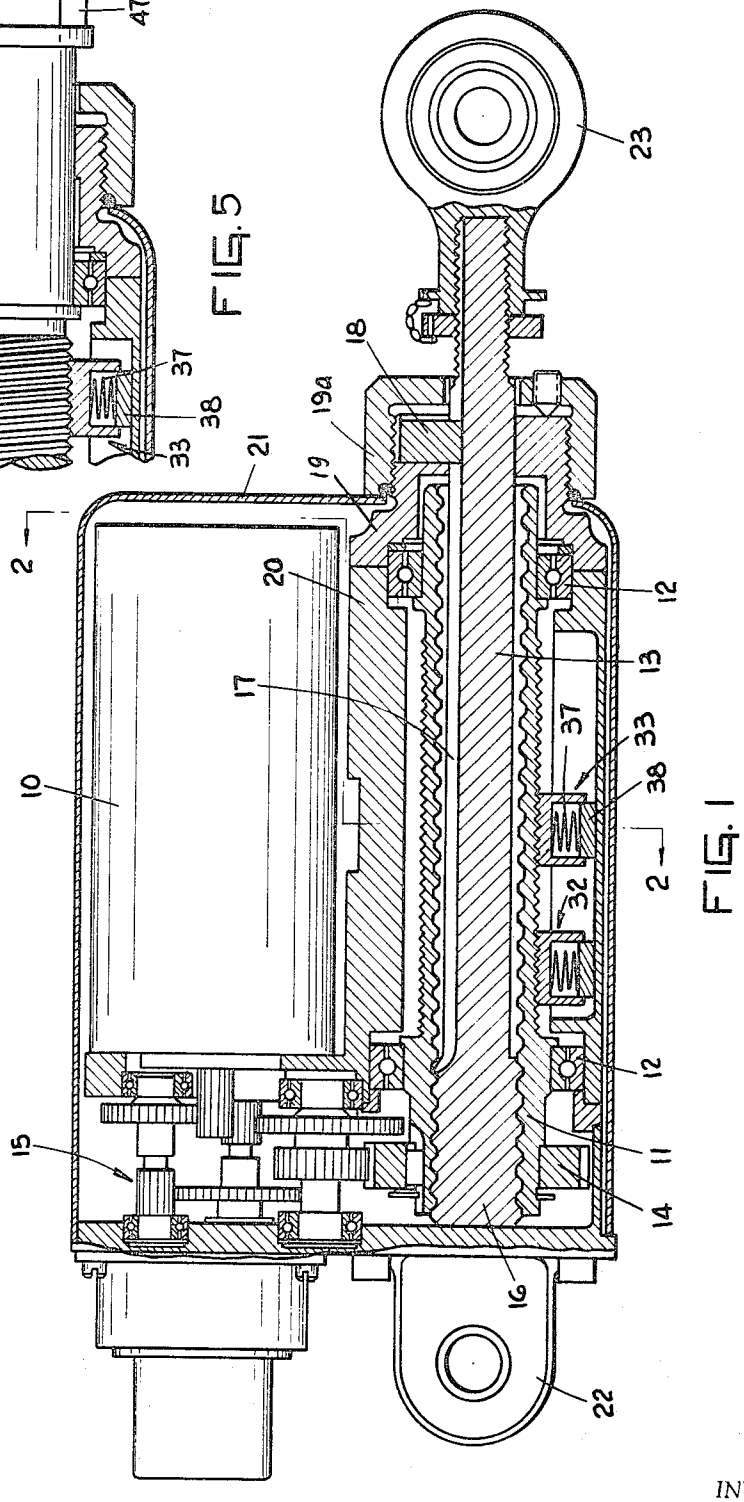


FIG. 1

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LIMIT SWITCH OPERATING MECHANISM FOR ACTUATORS

Filed April 19, 1968 2 Sheets-Sheet 2

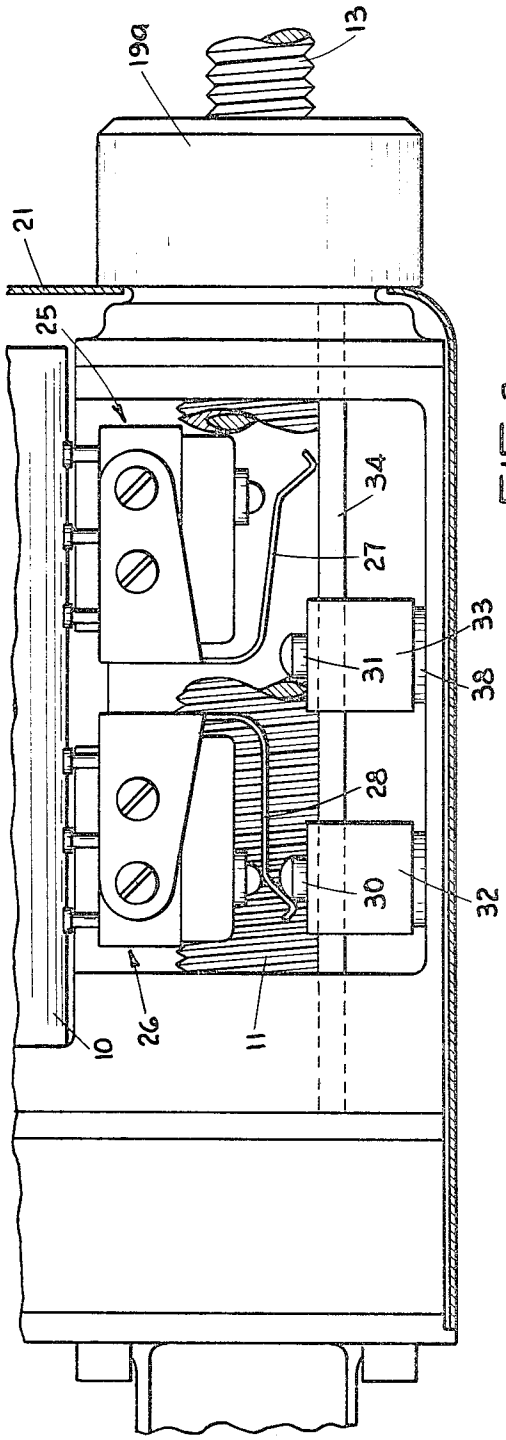


FIG. 3

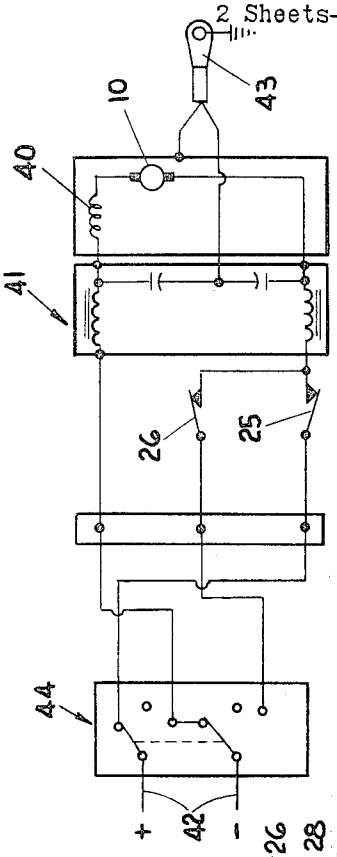


FIG. 6

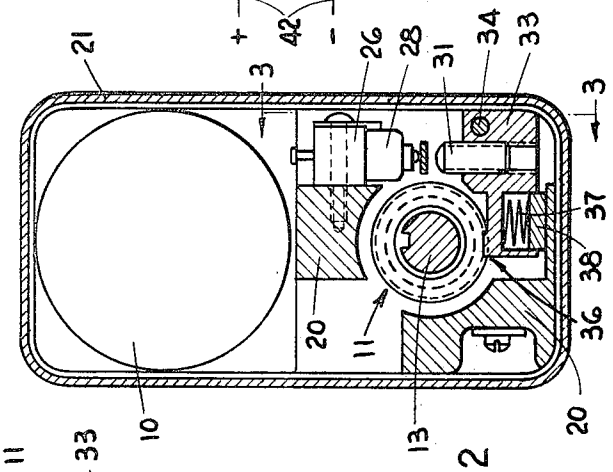


FIG. 2

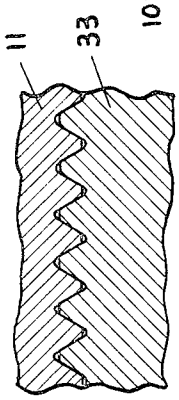


FIG. 4

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LIMIT SWITCH OPERATING MECHANISM FOR ACTUATORS

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Int. Cl. H01n 3/16
U.S. Cl. 200—47 8 Claims

ABSTRACT OF THE DISCLOSURE

A pair of sliders have threaded rack portions normally biased into meshing engagement with an external thread on the rotatable drive screw of a linear or rotary actuator. Rotation of the drive screw in one or the other direction, by the actuator drive motor, results in the simultaneous, linear displacement of both sliders for actuation of limit switches, thereby to limit the actuator to a predetermined operating range.

Power actuators are used to drive an external member back and forth within a desired operating range, said actuators comprising a drive screw coupled to an electric motor through a speed-reducing gearing system. Various arrangements have heretofore been proposed to limit the operation of the actuator to a predetermined range, thereby to avoid possible damage to the actuator and/or the external member coupled thereto. In general, the prior arrangements require additional gearing or other mechanical mechanisms to obtain proper travel ratios between the actuator drive screw and member which couples the actuator to the external member being driven thereby, thereby adding materially to the cost of the actuator. Furthermore, the prior arrangements are not conveniently adjustable for the purpose of changing the operating range of the actuator or for setting the high and low limits of such operating range within close tolerances.

In accordance with the invention, the arrangement for defining the operating range of a power actuator is of simple construction, includes a minimum number of parts, is quickly and easily adjustable, and is so constructed as to minimize maladjustment or damage in the event the associated limit switches fail to open the circuit of the actuator drive motor.

The drive screw of the actuator has an external thread formed thereon. A pair of spring-biased sliders are slidable along a guide rod disposed parallel to the drive screw, each slider including a toothed rack portion in mesh with the said external thread. Each slider carries an adjustable operating pin positioned for engagement with the actuating lever of an associated switch connected in the circuit of the actuator drive motor. The sliders are independently adjustable along the guide rod, thereby to effect operation of one or the other of the switches in response to a predetermined number of revolutions of the drive screw, thereby effecting a predetermined displacement of an external member coupled thereto or the predetermined displacement of a linear translation screw having an external member connected thereto.

An object of the invention is the provision of an improved arrangement for defining the operating limits of a power actuator.

An object of the invention is the provision of a mechanism for operating limit switches incorporated in a power actuator having a drive screw, which mechanism comprises an external thread formed on the drive screw, a pair of sliders carying switch-operating pins and having rack portions in mesh with the said external thread, means mounting the sliders for movement parallel to the drive screw upon rotation thereof, and means for adjusting the spacing between the sliders.

An object of the invention is the provision of an improved arrangement for operating limit switches incorporated in a linear power actuator of the type having a translating screw provided with an externally-threaded portion in mesh with an internal thread formed in a drive screw, which arrangement comprises an external thread formed on the drive screw, a pair of switch-operating sliders having rack portions normally in mesh with the external thread of the drive screw, and means mounting the sliders for movement parallel to the axis of the drive screw.

These, and other objects and advantages will be apparent from the following detailed description of a preferred embodiment of the invention, taken in conjunction with the drawings, in which:

FIG. 1 is a longitudinal sectional view through the operating parts of a linear actuator embodying the novel features of this invention;

FIG. 2 is a transverse sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary elevational view taken along the plane 3—3 of FIG. 2 and drawn to an enlarged scale;

FIG. 4 is a fragmentary cross-sectional view drawn to an enlarged scale to show the configuration of the teeth formed on the sliders and on the external surface of the drive screw;

FIG. 5 is a fragmentary, longitudinal sectional view corresponding generally to FIG. 1 and showing a rotary actuator; and

FIG. 6 is a circuit diagram of the actuator.

In FIGS. 1–3, the invention is shown incorporated in a linear power actuator comprising a reversible electric motor **10**, a drive screw **11** mounted for rotation in bearings **12**, and a translating screw **13**. The drive screw has secured thereto a gear **14** which is coupled to the motor shaft through a speed-reducing gearing system generally identified by the numeral **15**. In accordance with conventional practice, the drive screw has an internal thread running the full length thereof, which thread meshes with an externally threaded portion **16** of the translating screw. A longitudinal keyway **17** is formed in the translating screw for receiving a key **18** which is retained in fixed position in an end cap **19**, which is suitably fastened, as by screws, to a housing assembly **20**. A cover retaining nut **19***a* is threaded onto the end cap **19**. The operating parts of the actuator are enclosed within a cover **21**. Upon energization of the motor, the drive screw rotates, thereby resulting in a forward or back linear displacement of the translating screw, depending upon the direction of motor rotation. With the end coupling member **22** of the actuator secured to a support member, the linear displacement of the translating screw effects corresponding movement of a member or part connected to the coupling member **23**, the latter member being threaded onto and fixed to the projecting end portion of the translating screw.

It is desirable to limit the back and forth displacement of the translating screw to a predetermined operating range. In accordance with the invention, the arrangement for defining such operating range comprises a pair of microswitches **25** and **26** mounted in fixed position and provided with operating levers **27** and **28**, respectively. Each such lever has a free end extending into the path of travel of actuating pins **30** and **31** carried by the respective sliders **32** and **33**, which sliders are slidable along a guide rod **34** spaced from and parallel to the drive screw **11**. Referring specifically to FIG. 2, the slider **33** comprises a generally rectangular, metal block provided with a clearance hole for the guide rod **34**. A por-

tion of the block extends under the drive screw **11** and includes an integral tip **36** having a plurality of teeth formed thereon to constitute a rack. A coiled spring **37** is confined within a circular bore, formed in the slider, by means of a loose plug **38** resting and slidable upon a flat portion of the housing assembly **20**. Thus, the rack portion of the slider is spring-biased into engagement with the external thread formed on the drive screw **11**. The switch-actuating pin **31** comprises a set screw threaded into a hole formed is the slider, said screw preferably having a hexagonal socket and a rounded tip. The plug **38** acts as a sliding pad between the housing **20** and the spring functions as a wear and misalignment compensating device. The other slider is of similar construction.

It will now be apparent that the drive screw upon rotation performs two functions; namely, imparting a back and forth displacement to the translating screw and imparting a simultaneous movement to the two sliders along the guide rod. The sliders are independently adjustable to effect operation of the limit switches upon predetermined displacement of the translating screw in one or the other direction. More specifically, the rack portion of the slider can be disengaged from the drive screw upon compression of the coiled spring by means of a suitable tool, whereby the slider may be moved to a desired position along the guide rod. A finer adjustment is then obtained by turning the set screw in or out, as required. In any event, the travel ratio between the sliders and the translating screw remains fixed, as determined by the number of teeth per inch on the internal and external threads of the drive screw. Thus, a given linear displacement of the translating screw corresponds to a given number of revolutions of the drive screw. A relatively fine thread of the order of 56 teeth per inch is formed on the external surface of the drive screw and on the rack portions of the sliders, thereby to provide a relatively small movement of the sliders in correspondence with a relatively large displacement of the translating screw.

As shown in the enlarged fragmentary cross-sectional view of FIG. 4, the roots of the teeth formed on the drive screw **11** and the slider **33** are rounded, slightly, and the peripheral surfaces of the teeth are flat, thereby to minimize the otherwise normal tendency of the slider to rotate about the guide rod. Furthermore, in the event a limit switch fails to open the circuit to the motor, the described tooth configuration, together with the action of the coiled spring, permits the slider to ratchet freely in and out of engagement with the drive screw without causing mechanical damage to the mechanism. The use of two independently adjustable sliders affords maximum flexibility for adjustment of the travel limits of the translating screw. The spacing between the sliders determines the number of drive screw revolutions required to actuate the switches. By varying such spacing, it is possible to obtain any travel settings from that approaching zero up to the limitations imposed by the physical size of a particular design.

The limit switches **25** and **26** are of the normally closed type as shown in the circuit diagram of FIG. 6. The drive motor **10** is of the permanent magnet type provided with an electromagnetic brake having an operating solenoid **40**. It will be apparent, however, that the motor may be of any reversible type and power rating consistent with the application for which the actuator is designed. A radio interference filter **41** is interposed in the motor circuit, which filter, together with the motor housing, is grounded through a connection terminal **43**. The motor control switch **44** is of the double-pole, three-position type having a center "off" position. Energization of the motor for rotation in one or the other direction is effected upon closure of the control switch to one or the other operating positions, and the motor circuit is opened by one or the other of the limit switches **25**, **26** upon displacement of the translating screw to one or the other extreme limit of the predetermined operating range.

The described arrangement for effecting operation of the limit switches is not limited for use with a linear actuator as hereinbefore described. The pertinent parts of a rotary actuator are shown in the fragmentary longitudinal sectional view of FIG. 5. In this case, the drive screw **11'** is provided with a single thread; namely, the external thread to which the rack portions of the two sliders are coupled, only one slider **33** being shown in this particular view. The drive screw includes a non-threaded portion projecting through the opening of the end cap **19** and having an operating arm **46** secured thereto as by the nut **47**. Upon energization of the actuator drive motor, the two sliders move simultaneously in one or the other direction and the operating arm **46** imparts an angular displacement to an external member which may be coupled thereto. The rotation of the arm **46** is limited to a predetermined angular operating range as determined by the spacing between the two sliders.

It is believed that the advantages and improved results of the invention will be apparent from the foregoing description of a preferred embodiment of the invention. It will be apparent that various changes may be made without departing from the spirit and scope of the invention as sought to be defined in the following claims.

I claim:

1. A power actuator comprising a drive screw rotatable by an electric motor, an external thread formed on the drive screw, a pair of switches mounted in fixed positions relative to the drive screw and connected in the motor circuit, a pair of sliders, each slider having a toothed rack portion, spring means carried by each slider urging the rack portion of each slider in meshing engagement with the external thread, means mounting the sliders for movement parallel to the axis of the drive screw, and switch-operating elements carried by the sliders, said elements effecting operation of one or the other of the switches upon rotation of the drive screw in one or the other direction.

2. An actuator as set forth in claim **1**, wherein the means mounting the sliders comprises a guide rod passing through clearance holes formed in the sliders, and wherein the switch-operating elements are projecting pins threaded into the sliders.

3. A linear power actuator comprising a drive screw having an internal thread and rotatable by an electric motor, a translating screw having an external thread in mesh with the internal thread of the drive screw, an external thread formed on the drive screw, a pair of switches mounted in fixed position adjacent the drive screw in circuit with the motor, a guide rod spaced from and parallel to the drive screw, a pair of sliders mounted for sliding movement along the guide rod, each slider having a rack portion, spring means carried by each slider urging the rack portion of each slider in meshing engagement with the external thread, and a switch-operating element carried by each slider, whereby rotation of the drive screw causes simultaneous movement of the sliders along the guide rod to effect actuation of the switches.

4. An actuator as set forth in claim **3**, wherein each switch-operating element is a projecting pin threaded into its associated slider, and wherein the switches include actuating levers having portions lying in the path of travel of the pins.

5. A mechanism for operating spaced electrical switches mounted in fixed positions comprising a rotatable screw having an external thread, a pair of sliders mounted for movement parallel to the axis of the screw, each slider including a rack portion having teeth, spring means carried by each slider urging the rack portion of each slider in mesh with the said thread, and switch-operating elements carried by the sliders and effecting operation of one or the other of the switches upon rotation of the screw in one or the other direction.

6. A power actuator comprising a drive screw rotatable by an electric motor, an external thread formed on the

drive screw, a pair of switches mounted in fixed positions relative to the drive screw and connected in the motor circuit, a pair of sliders, each slider having a toothed rack portion in mesh with the said external thread, a bore formed in each slider, a coiled spring disposed within the bore, a plug slidable within the bore and engaged by an end of the spring, a flat surface spaced from the slider and along which the plug is slidable upon rotation of the drive screw, means mounting the sliders for movement parallel to the axis of the drive screw, and switch-operating elements carried by the sliders, said elements effecting operation of one or the other of the switches upon rotation of the drive screw in one or the other direction.

7. A linear power actuator comprising a drive screw having an internal thread and rotatable by an electric motor, a translating screw having an external thread in mesh with the internal thread of the drive screw, an external thread formed on the drive screw, a pair of switches mounted in fixed position adjacent the drive screw in circuit with the motor, a guide rod spaced from and parallel to the drive screw, a pair of sliders mounted for sliding movement along the guide rod, each slider having a rack portion in mesh with the external thread of the drive screw, a bore in each slider, a spring disposed within each bore, a plug slidable within each bore and engaged by an end of the associated spring, a flat surface adjacent the sliders along which the plug of each slider is slidable upon rotation of the drive screw, the springs of the sliders being compressed and applying a biasing force retaining the rack portions of the sliders in mesh with the external thread of the drive screw, and a switch-operating

element carried by each slider, whereby rotation of the drive screw causes simultaneous movement of the sliders along the guide rod to effect actuation of the switches.

8. A mechanism for operating spaced electrical switches mounted in fixed positions comprising a rotatable screw having an external thread, a pair of sliders mounted for movement parallel to the axis of the screw, each slider including a rack portion having teeth, a bore in each slider, a spring in each bore, a plug slidably positioned in each bore and engaged by an end of its associated spring, means providing a flat surface adjacent the sliders, the plugs being slidable along the surface, and switch-operating elements carried by the sliders and effecting operation of one or the other of the switches upon rotation of the screw in one or the other direction.

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