Aug. 8, 1961 C. F. SCHUNEMANN 2,995,042

SWITCH ACTUATOR

Filed March 3, 1958 3 Sheets-Sheet 1

Fig. 2

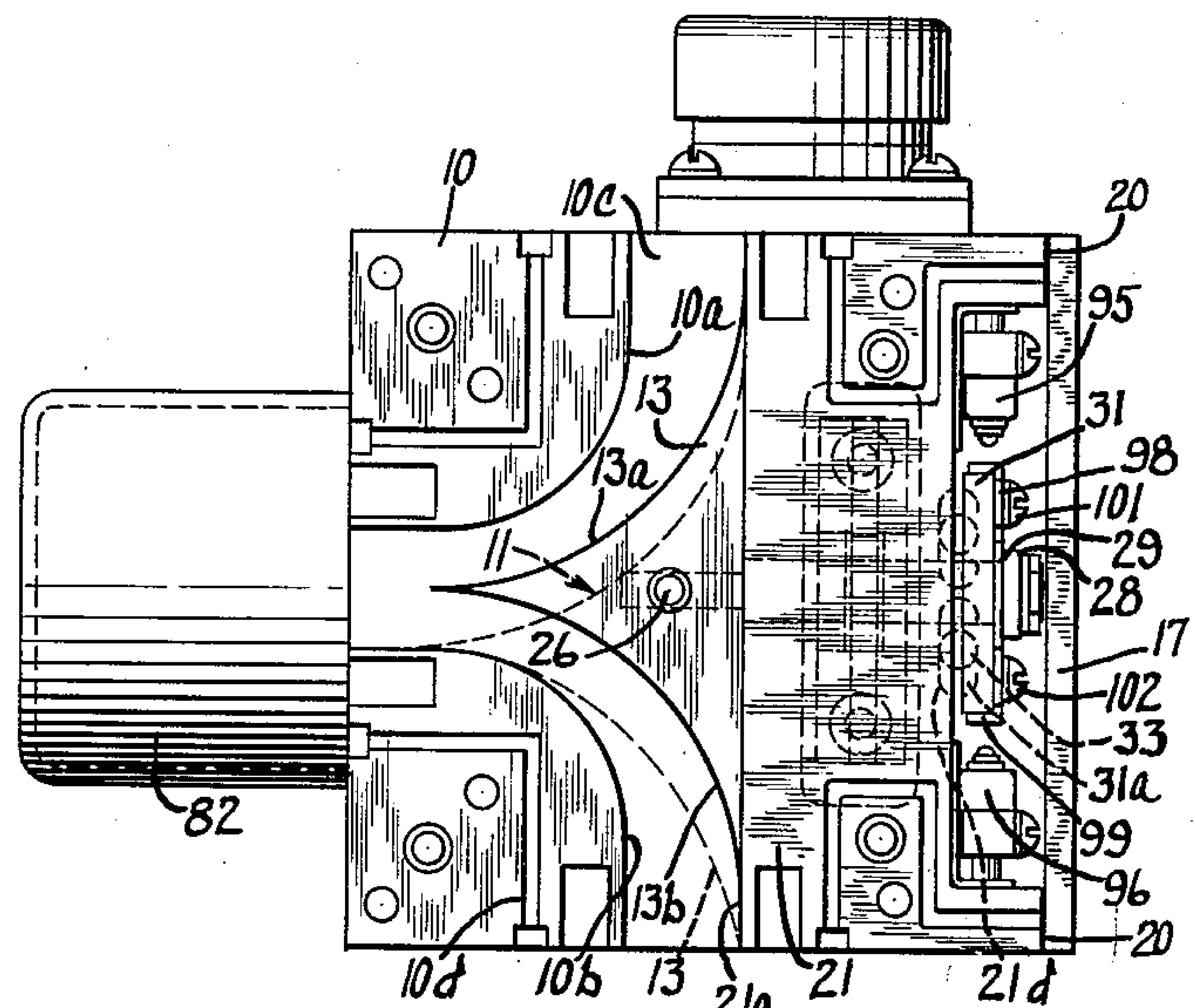
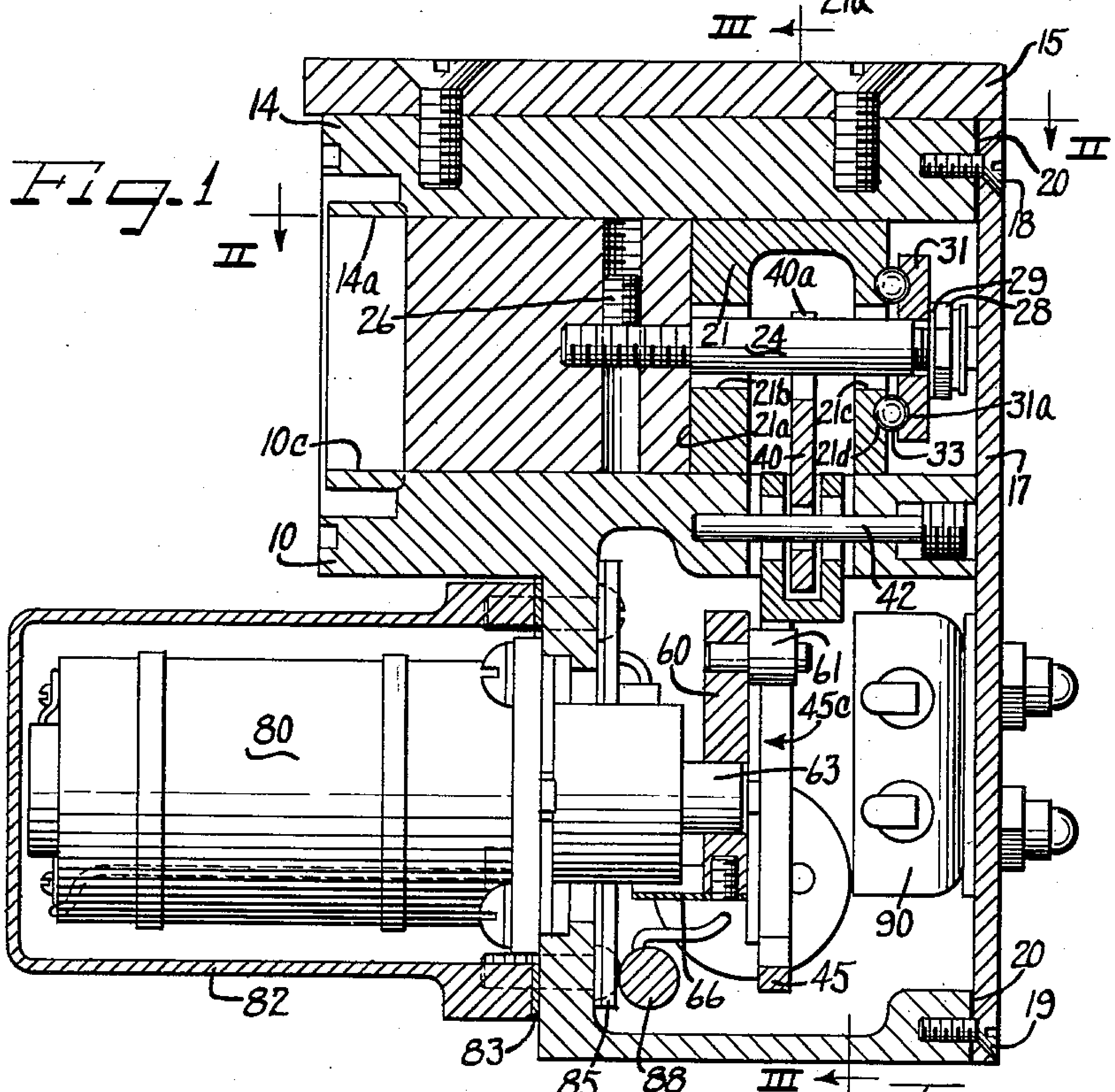


Fig. 1



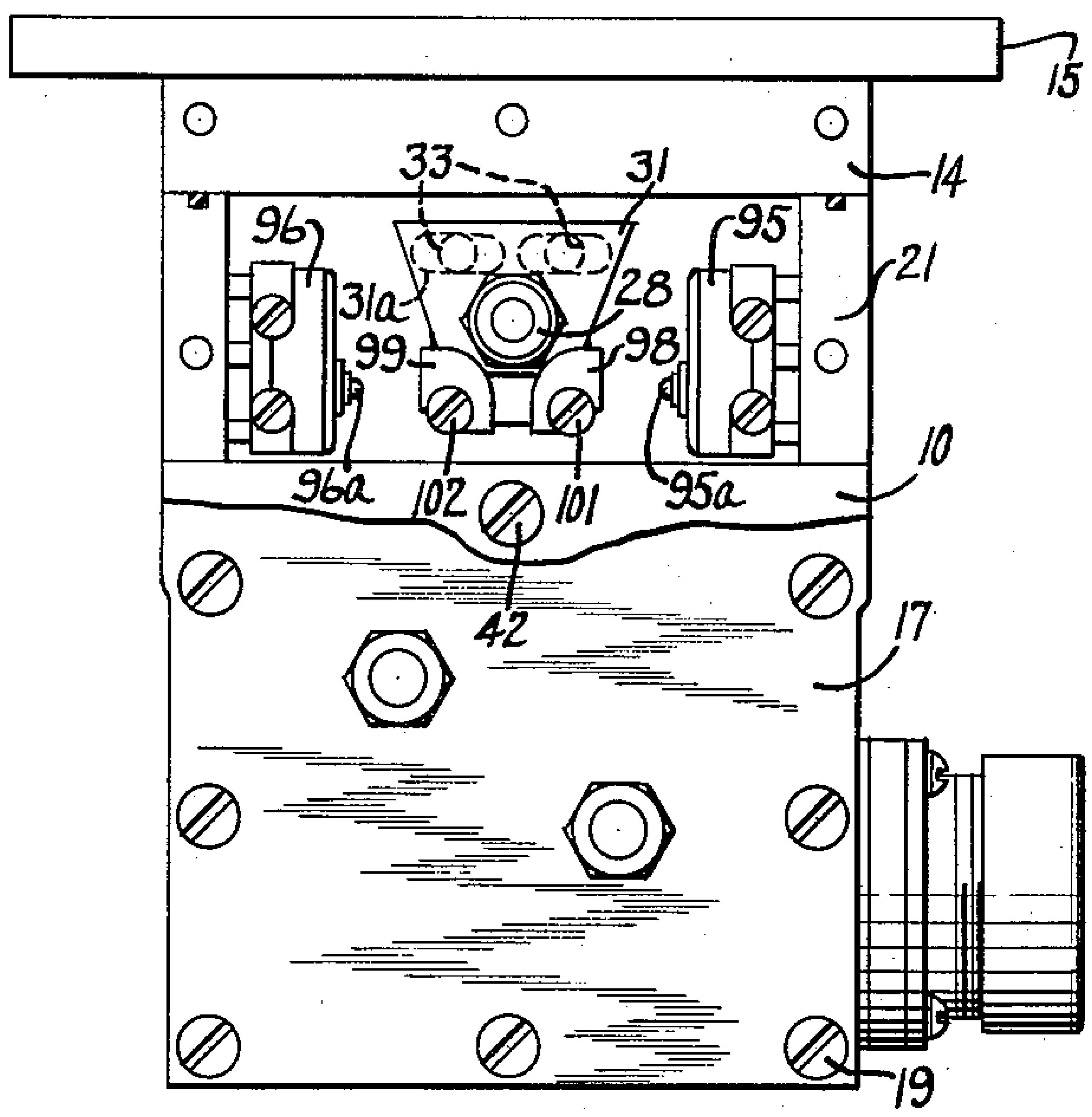
Inventor
Carl F. Schunemann

by Hill, Sherman, Meroni, Gross & Simpson Attys

SWITCH ACTUATOR

Filed March 3, 1958 3 Sheets-Sheet 2

Fig-4



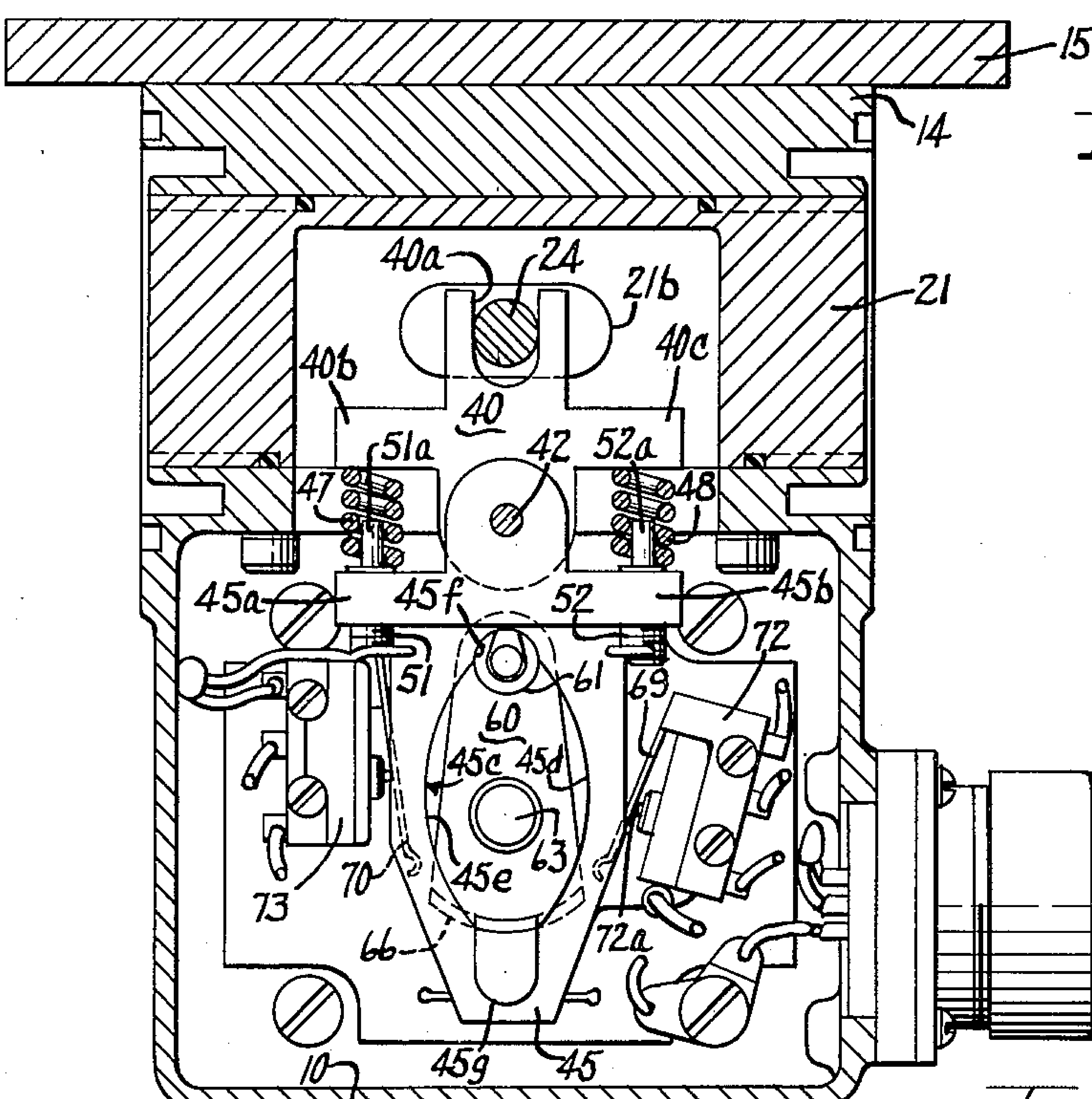


Fig-3

Inventor
Carl F. Schunemann

by Hill, Sherman, Meroni, Gross & Simpson Attys

Aug. 8, 1961 C. F. SCHUNEMANN 2,995,042

SWITCH ACTUATOR

Filed March 3, 1958 3 Sheets-Sheet 3

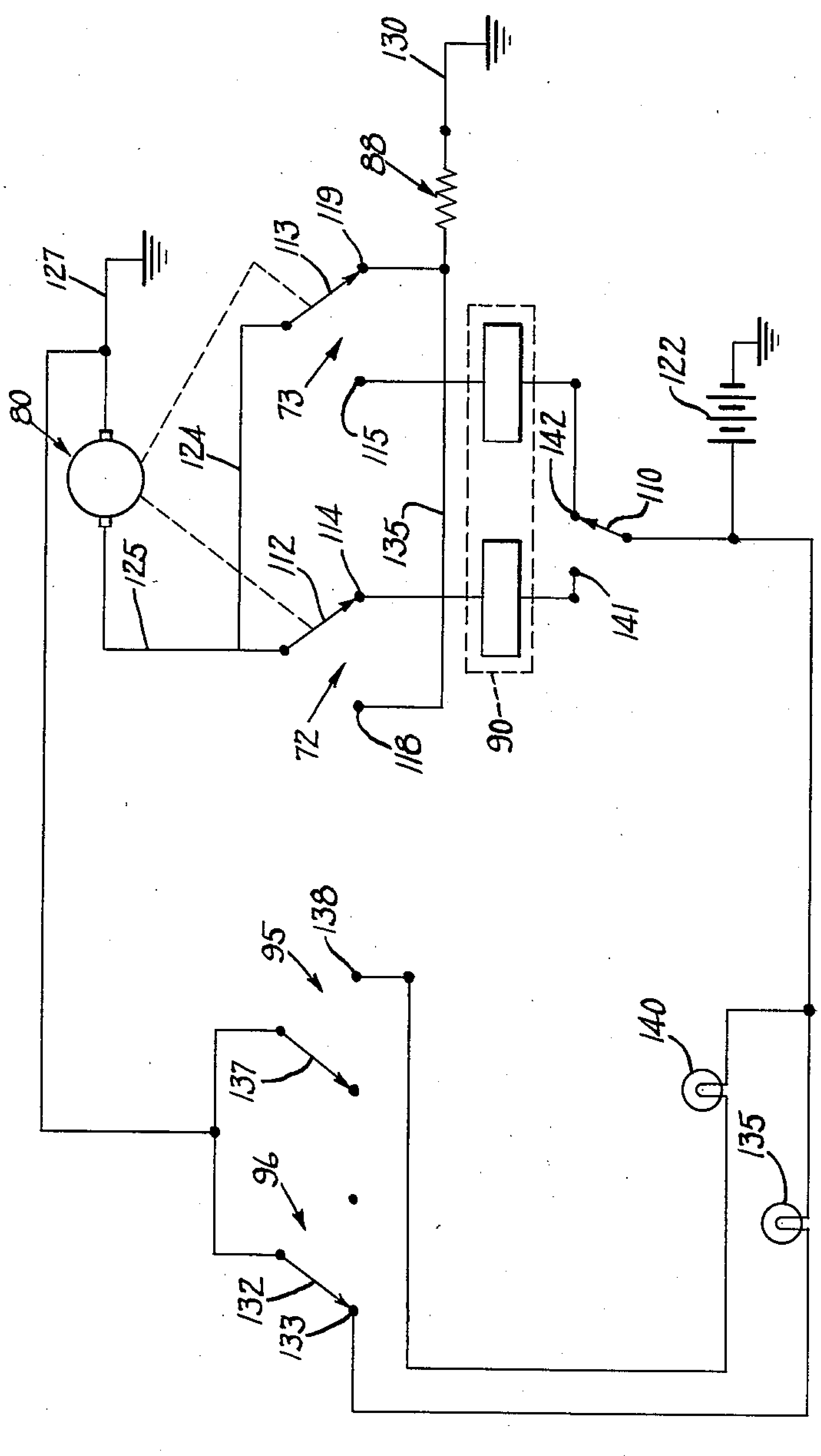


Fig. 5

Inventor
Carl F. Schunemann
by Hill, Sherman, Meroni, Gross & Simpson Attys

United States Patent Office

2,995,042

Patented Aug. 8, 1961

2,995,042

SWITCH ACTUATOR

Carl F. Schunemann, Euclid, Ohio, assignor to Thompson Ramo Wooldridge Inc., a corporation of Ohio

Filed Mar. 3, 1958, Ser. No. 718,734

5 Claims. (Cl. 74—45)

This invention relates to a switching assembly for interconnecting high frequency transmission structures and to a switch actuating mechanism for selectively moving a switch element into a plurality of switching positions.

It is an important object of the present invention to provide a switch actuating system wherein the actuating motor can be brought up to speed before actuation of the switch element is initiated.

Another object of the invention is to provide an actuating system wherein the actuating motor can be stopped after the switch element has been moved to a desired switching position.

A further object of the invention is to provide a novel and improved shuttle type waveguide switch.

Still another object of the invention is to provide a waveguide switch wherein a switch element is spring urged into its switching positions.

Yet another object of the invention is to provide a waveguide switch having means for providing a visual indication of the condition of the switch.

Other objects, features and advantages of the present invention will be apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a longitudinal sectional view of a shuttle type waveguide switch in accordance with the present invention;

FIGURE 2 is a horizontal sectional view taken generally along the line II—II of FIGURE 1, and showing parts in top plan;

FIGURE 3 is a vertical sectional view taken generally along the line III—III of FIGURE 1;

FIGURE 4 is a side elevational view of the structure of FIGURE 1 with a portion of the housing broken away to show certain parts in elevation; and

FIGURE 5 is a schematic electric circuit diagram of an indexing arrangement for the switch of FIGURE 1.

As shown on the drawings:

The illustrated embodiment comprises a shuttle type waveguide switch wherein a housing body part **10** has a pair of curved wall portions **10***a* and **10***b* adapted to define waveguide channels such as indicated at **11** in cooperation with curved wall portions **13***a* and **13***b* of a shuttle type switch element **13**. The bottom wall of the channel **11** is defined by a flat surface **10***c* on which the switch element **13** slides, and a top wall of the channel **11** is defined by a surface **14***a* of a plate **14** which is suitably sealed to the housing body part **10**, as by means of a sealant in sealing passages such as indicated at **10***d* in FIGURE 2. A mounting plate for the housing is indicated at **15**. It will be understood that the exact orientation of the switch assembly depends on field conditions, so that the orientation of the switch assembly illustrated in the drawings is purely arbitrary. The name plate is normally affixed to the housing in such an orientation that FIGURE 4 would constitute a top plan view of the assembly. For purposes of the present description, FIGURE 4 is taken as a side elevational view. The housing is enclosed by means of a plate **17** secured to plate **14** by means of screws **18** and gasket **20** and secured to the body part **10** by means of screws **19**.

For guiding the reciprocating movement of shuttle switch element, a guide member **21** provides a planar guiding surface **21***a* at right angles to the surface **10***c* of the body part. The guide member **21** has a pair of elongated slots **21***b* and **21***c* accommodating reciprocating movement of a pin **24** which is secured to the shuttle switch element **13**. A set screw **26** retains the pin **24** in engagement with the element **13** and a lock nut **28** and preloaded tension spring washer **29** act on a ball guide **31** to retain the shuttle element **13** snugly against the wall surface **21***a* of guide member **21**. To reduce friction, balls such as indicated at **33** are interposed between the ball guide **31** and guide member **21**, and these balls **33** ride in elongated ball races such as indicated at **21***d* and **31***a* in FIGURE 2. Lock nut **28** is adjusted to preload spring washer **29** to 8.5±0.5 pound loading.

For shifting the shuttle element **13** between its switching positions, a shutle lever **40** is provided having a slot **40***a* receiving pin **24** as seen in FIGURE 3 and mounted on a lever shaft **42** for rocking movement in respective opposite directions. The slot **40***a* has a lost motion connection with the pin **24** to accommodate linear movement of pin **24** during arcuate movement of shuttle lever **40** about shaft **42**. The lever **40** has arms **40***b* and **40***c* which are coupled to arms **45***a* and **45***b* of a rocking lever **45** also mounted on the lever shaft **42**. Compression springs **47** and **48** are interposed between the respective arms to that rocking movement of rocking lever **45** tends to compress one of the springs to urge the shuttle lever **40** to rock in the same direction. Adjustment screws **51** and **52** have body portions which are externally threaded over their entire length and are received in threaded holes in arm portions **45***a* and **45***b*. The body portions have reduced elongated end portions **51***a* and **52***a* extending within the springs **47** and **48** and the shoulders at the junctions between the ends of the body portions **51** and **52** and the end portions **51***a* and **52***a* are of diameter to engage the lower ends of springs **47** and **48** so that longitudinal adjustment of the screws **51** and **52** in the holes in the arm portions **45***a* and **45***b* adjusts the preloading of the springs **47** and **48**. For example, screws **51** and **52** may be adjusted to load the shuttle 10.5 pounds±4.5 pounds against the corner blocks **10***a* and **10***b* with levers **40** and **45** in their respective extreme positions.

The rocking lever **45** is driven by means of a crank **60** having a roller **61** cooperating with an internal cam surface **45***c* of rocking lever **45**. In the illustrated embodiment, the crank **60** is mounted on a shaft **63** for continuous rotation in a given direction to rock lever **45** first in one direction and then in the opposite direction. The lever **45** is rocked in the counterclockwise direction by engagement of roller **61** with arcuate cam surface portion **45***d* and is rocked in the clockwise direction by engagement of the roller **61** with the arcuate cam surface portion **45***e*. The arcuate cam surface portions **45***d* and **45***e* may have a radius of curvature equal to the distance from the center of shaft **63** to the outer surface of **61** so that the lever **45** will be substantially stationary as roller **61** travels along the arcuate surface portions. Between the arcuate surface portions **45***d* and **45***e*, the roller **61** engages in groove portions **45***f* and **45***g*.

The crank **60** may have secured thereto at the end thereof opposite that carrying roller **61** a curved plate **66** for actuating arms **69** and **70** of switches **72** and **73**. It will be observed that with roller **61** engaging arcuate cam surface portions **45***d* to rock lever **45** to its extreme counterclockwise position, curved plate **66** will engage arm **70** to depress an actuating button of switch **73**. An energizing circuit for motor **80** driving shaft **63** is controlled by switch **73** so that when switch **73** is actuated by curved plate **66**, the energizing circuit is opened to deenergize motor **80**. At the same time, actuation of switch **73** may complete a dynamic braking circuit for the motor 80 to cause the motor to come to a stop more rapidly. In this way, the motor 80 is stopped while curved plate 66 still engages arm 70.

When motor 80 is energized through a second energizing circuit under the control of switch 72, crank 60 is turned in the clockwise direction until curved plate 66 engages actuating arm 69 of switch 72 to depress actuating button 72*a* thereof and open the second energizing circuit for the motor 80 and connect a second dynamic braking circuit with said motor to bring the motor to a stop while curved switch actuating plate 66 is still in engagement with arm 69.

It will be apparent from FIGURE 3 that, with the crank 60 in one stop position and with the motor stopped, when the motor is energized to move the shuttle switch element 30 to its opposite switching position, the motor 80 will have a relatively light load during the time when the roller 61 continues to travel along the arcuate cam surface portion 45*d* and until the time that crank 60 begins to move rocking lever 45 past its central position in the clockwise direction. Similarly, with the shuttle switch element in its opposite position from that shown in dotted outline in FIGURE 2, and with the motor stopped, the motor will be enabled to start with a relatively light load while the roller 61 travels along arcuate cam surface portion 45*e* and until the crank 60 moves lever 45 past its central position in the counterclockwise direction. Further, after the motor has been deenergized by engagement of the curved plate 66 with one of the arms 69 or 70, the motor has the angular range for overtravel corresponding to the angle subtended by the curved plate 66. The roller 61 rides on the arcuate cam surface portion 45*d* or 45*e* during this overtravel deceleration period locking the shuttle switch element 13 in the selected switching position and providing for lost motion between crank 60 and lever 45. In other words, the motor 80 need not be stopped at the moment that switch shuttle element 13 reaches the selected switching position. Further, during the time that the motor is being brought to a stop, crank 60 and lever 45 are interlocked in such a way as to positively compress one of the springs 47 or 48 to urge the shuttle switch element 13 into the selected switching position.

The roller 61 on crank or drive transmission element 60 and the internal cam surface 45*c* of rocking lever or drive transmission element 45 comprise interengaging means arranged to move the rocking lever 45 from one extreme position to the other as the crank 60 is rotated in a given direction. It will be observed that the roller 61 while riding on the cam surface 45*d* locks the rocking lever 45 in its extreme counterclockwise position and while riding on the cam surface 45*e* locks lever 45 in its extreme clockwise position. Crank 60 is free to rotate without actuating the rocking lever 45 as long as roller 61 rides on cam surface 45*d* or 45*e*.

It will be understood that the motor 80 may be enclosed in a suitable housing 82 which is effectively sealed to the housing body part 10 for example by means of a gasket 83. A suitable printed circuit indicated at 85 may be connected with the motor circuit and with the switches 72 and 73 to control operation of the motor. A resistor 88 may be included in the dynamic braking circuits for the motor previously mentioned and radio frequency noise filters may be housed in a casing 90 indicated in FIGURE 1.

Indicator lamps may be associated with the housing for the switch and visible from the exterior thereof to indicate the position of switch shuttle element 13. Switches 95 and 96 indicated in FIGURE 4 may control these lamps and may have actuating buttons 95*a* and 96*a* which are adapted to be actuated by adjustable trip members 98 and 99 angularly adjustably secured by fastening means 101 and 102 to ball guide member 31. The trips 98 and 99 are adjusted so that switches 95 and 96 are actuated in the respective positions of switch element 13.

It will be understood that suitable waveguide terminal fixtures may be secured to the housing at the respective ends of the waveguide channel 11, for example, to accommodate the connection of waveguides with the switch assembly of the present invention.

A suitable electric circuit for the switch of FIGURES 1 to 4 is illustrated in FIGURE 5 and corresponding reference numerals have been utilized to designate generally corresponding parts. In the illustrated circuit, the motor 80 is illustrated as comprising a D.C. motor having a pair of energizing circuits which are selectively energized by means of a switch 110. The switches 72 and 73 of FIGURE 3 controlling the respective energizing circuits for the motor 80 are illustrated as comprising switch arms 112 and 113 which are normally in engagement with contacts 114 and 115, but which are moved into engagement with contacts 118 and 119 when the corresponding switch actuating arms 69 and 70 are engaged by curved plate 66.

With switch arm 110 in the position illustrated, an energizing circuit would normally extend from battery 122 through contact 110, contact 115, switch arm 113 (when deactuated), lines 124 and 125 to the positive terminal of the motor, the negative terminal of the motor being grounded by means of line 127 to provide a return path to the battery 122. It will be understood that when the motor 80 is energized by means of the energizing circuit just described, crank 60 will be turned until curved plate 66 engages actuating arm 70 of switch 73 to shift arm 113 into engagement with contact 119 as shown in FIGURE 5. At this time, the energizing circuit for motor 80 is interrupted. Further, the motor is connected with a dynamic braking circuit comprising resistor 88 and lead 130 leading to ground to shunt resistor 88 across the motor 80.

In the position of switch element 13 shown in FIGURE 2 in dotted outline, switch 96 will be actuated to move arm 132 into engagement with contact 133 to complete an energizing circuit for lamp 135 to indicate the position of switch shuttle element 13.

If switch arm 110 is moved to its opposite position to select the other switching position, a second energizing circuit for motor 80 is completed extending from battery 122 through contact 110, contact 114, switch arm 112, line 125, and motor 80 to ground line 127. When curved plate 66 engages actuating arm 69 of switch 72, switch arm 112 makes contact with contact 118 to open the second energizing circuit for the motor and to connect the motor in a second dynamic braking circuit including lead 135 and resistor 88.

In this position of switch shuttle 13, switch 95 is actuated to move switch arm 137 into engagement with contact 138 and thus light lamp 140 indicating the opposite position of the switch.

Summary of operation

In order to actuate the switch mechanism of the illustrated embodiment to move shuttle switch element 13 to its opposite switching position from that shown in dotted outline in FIGURE 2, voltage is supplied to contact 141 in FIGURE 5 in any suitable manner as by shifting switch arm 110 to its left hand position. Motor 80 is then energized to rotate crank 60, FIGURE 3, in a clockwise direction. During starting of the motor, roller 61 on crank arm 60 rides on constant radius arcuate cam surface portion 45*d* and encounters relatively little resistance to movement. The roller 61 then rides into recess 45*g* and rocks lever 45 in the clockwise direction compressing spring 47 and releasing the compression of spring 48. This causes shuttle lever 40 to rock in the clockwise direction about shaft 42 moving pin 24, FIGURES 1 and 3, to the right as seen in FIGURE 3 to move switch element 13, FIGURE 2, to its opposite switching position. After switch element 13 has reached its switching position, motor 80 continues to be energized until curved actuating plate 6*b* engages switch actuating arm 69 of switch 72 causing switch arm 112, FIGURE 5, to disengage contact 114 and engage contact 118. Engagement of contact 118 connects a dynamic braking circuit including resistor 88 across the motor 80 to cause the motor to come to a stop while curved actuating plate 66 is still in engagement with arm 70. Switch 73 is deactuated when curved plate 66 moves out of engagement with actuating arm 70, causing switch arm 113, FIGURE 5, to move into engagement with contact 115. Thus, when switch element 13 has reached its opposite switching position, it may be returned to the switching position shown in dotted outline in FIGURE 2 by applying voltage to contacs 142 in FIGURE 5. The illustrated actuating mechanism thus accommodates lost motion between the motor drive shaft and the switch element at the time the motor is being started up, and also provides lost motion between the motor shaft and the switch element after the switch element has reached its switching position to accommodate stopping of the motor after the switch element has reached its selected switching position. Crank 60 locks the switch element in its selected switching position after deenergization of the motor, and resilient means in the form of spring 47 or 48 is provided for resiliently urging the switch element into its selected switching position.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. A switch assembly comprising a switch element movable between a first switching position and a second switching position, rocking lever means mounted on a fixed axis for rocking movement between a first angular position and a second angular position to move said switch element from said first switching position thereof to said second switching position thereof, said rocking lever means having an internal cam surface including opposite constant radius arcuate cam surface portions, rocking lever drive means mounted for rotary movement about an axis within the perimeter of said internal cam surface and engageable with said cam surface to rock said rocking lever means between said first and second angular positions thereof, and said constant radius cam surface portion accommodating angular movement of said drive means while said rocking lever means is stationary in said first and second angular positions thereof.

2. A switch assembly comprising a switch element mounted for reciprocation between first and second switching positions, shuttle lever means having a lost motion coupling with said switch element and mounted for rocking movement to shift said switch element between said first and second switching positions, said shuttle lever means having arm means projecting at either side thereof, rocking lever means mounted for rocking movement and having arm means projecting at either side thereof and opposing the respective arm means of said shuttle lever means, compression spring means interposed between the respective arm means of said shuttle lever means and said locking lever means to tend to cause the shuttle lever means to follow rocking movements of said rocking lever means, said rocking lever means having an internal cam surface operatively connected therewith, rocking lever drive means mounted for rotary movement about an axis within the perimeter of said internal cam surface and engageable with said cam surface to rock said rocking lever means in respective opposite directions, said cam surface accommodating angular movement of said drive means with said rocking lever means in opposite extreme angular positions, and means for rotating said rocking lever drive means to shift said switch element betwen its first and second switching positions.

3. A switch assembly comprising a switch element mounted for reciprocation between first and second switching positions, shuttle lever means having a lost motion coupling with said switch element and mounted for rocking movement to shift said switch element between said first and second switching positions, said shuttle lever means having arm means projecting at either side thereof, rocking lever means mounted for rocking movement and having arm means projecting at either side thereof and opposing the respective arm means of said shuttle lever means, compression spring means interposed between the respective arm means of said shuttle lever means and said locking lever means to tend to cause the shuttle lever means to follow rocking movements of said rocking lever means, said rocking lever means having an internal cam surface operatively connected therewith, rocking lever drive means mounted for rotary movement about an axis within the perimeter of said internal cam surface and engageable with said cam surface to rock said rocking lever means in respective opposite directions, said cam surface accommodating angular movement of said drive means with said rocking lever means in opposite extreme angular positions, means for rotating said rocking lever drive means to shift said switch element between its first and second switching positions, said rocking lever drive means carrying a curved plate of substantial arcuate extent, and switch means for deenergizing said drive means and engageable with said curved plate as said rocking lever means reaches one of said opposite extreme angular positions to initiate deceleration of said drive means, and said curved plate having sufficient arcuate extent to maintain engagement with said switch means until said drive means has come to a stop with said rocking lever means in said one extreme angular position.

4. A switch assembly comprising a switch element mounted for reciprocation between first and second switching positions, shuttle lever means having a lost motion coupling with said switch element and mounted for rocking movement to shift said switch element between said first and second switching positions, said shuttle lever means having arm means projecting at either side thereof, rocking lever means mounted for rocking movement and having arm means projecting at either side thereof and opposing the respective arm means of said shuttle lever means, compression spring means interposed between the respective arm means of said shuttle lever means and said locking lever means to tend to cause the shuttle lever means to follow rocking movements of said rocking lever means, said rocking lever means having an internal cam surface operatively connected therewith, rocking lever drive means mounted for rotary movement about an axis within the perimeter of said internal cam surface and engageable with said cam surface to rock said rocking lever means in respective opposite directions, said cam surface accommodating angular movement of said drive means with said rocking lever means in opposite extreme angular positions, means for rotating said rocking lever drive means to shift said switch element between its first and second switching positions, a first housing part housing said rocking lever means and having a shaft pivotally mounting said rocking lever means in depending relation therefrom and pivotally mounting said shuttle lever means in upwardly extending relation therefrom, and second housing means having a downwardly opening slot for receiving said shuttle lever means and accommodating coupling of the shuttle lever means with said switch element.

5. In a switch assembly; a switch element; a switching member coupled to said element and movable between first and second positions to move said switch element between first and second switching positions; a drive member mounted for rotation about a fixed axis; a drive motor coupled to said drive member; interengaging cam means on said members including a cam element on one member and cam surface means on the other for interengagement to move said switching member between said first and second positions when said drive member is

rotated about said fixed axis by said drive motor between first and second stop positions; said cam surface means being concentric to said fixed axis for a continuous angular distance along said cam surface means which includes the point of engagement of said cam element with said cam surface means when said drive member is in its first stop position and in a substantial number of successively offset first angular positions beyond its first stop position through which said drive member is accelerated in movement thereof by said drive motor to said second stop position, and which includes the point of engagement of said cam element with said cam surface means when said drive member is in its second stop position and in a substantial number of successively offset second angular positions beyond its second stop position through which said drive member is accelerated in movement thereof by said drive motor to said first stop position; means for energizing said drive motor to accelerate said drive member from any one of its stop positions and to rotate said drive member through the successively offset angular positions therebeyond during which said cam element engages said concentric cam surface means and said switching member and switch element remain stationary, and thereafter to drive said switching member through the medium of said drive member and said interengaging cam means from one of its first and second positions to the other to correspondingly drive said switch element from one of its switching positions to the other; and means coupled to said drive motor for bringing said drive member to rest at the one of its first and second stop positions toward which it is being driven by said drive motor.

References Cited in the file of this patent

UNITED STATES PATENTS

865,999	Coombs	Sept. 17, 1907
874,289	Bemus	Dec. 17, 1907
1,563,305	Ambler	Nov. 24, 1925
1,609,292	Burch	Dec. 7, 1926
1,791,819	Kull et al.	Feb. 10, 1931
1,814,608	Schuh et al.	July 14, 1931
2,229,545	Beckstrom	Jan. 21, 1941
2,661,404	Wasserman	Dec. 1, 1953
2,696,568	Jepson	Dec. 7, 1954
2,813,937	Diebold	Nov. 19, 1957
2,827,613	Robison et al.	Mar. 18, 1958

FOREIGN PATENTS

363,855	Great Britain	Dec. 31, 1931