Aug. 8, 1961 C. F. SCHUNEMANN ET AL 2,995,716

WAVE GUIDE SWITCH AND ACTUATOR THEREFOR

Filed Nov. 21, 1955 3 Sheets-Sheet 1

Fig-1

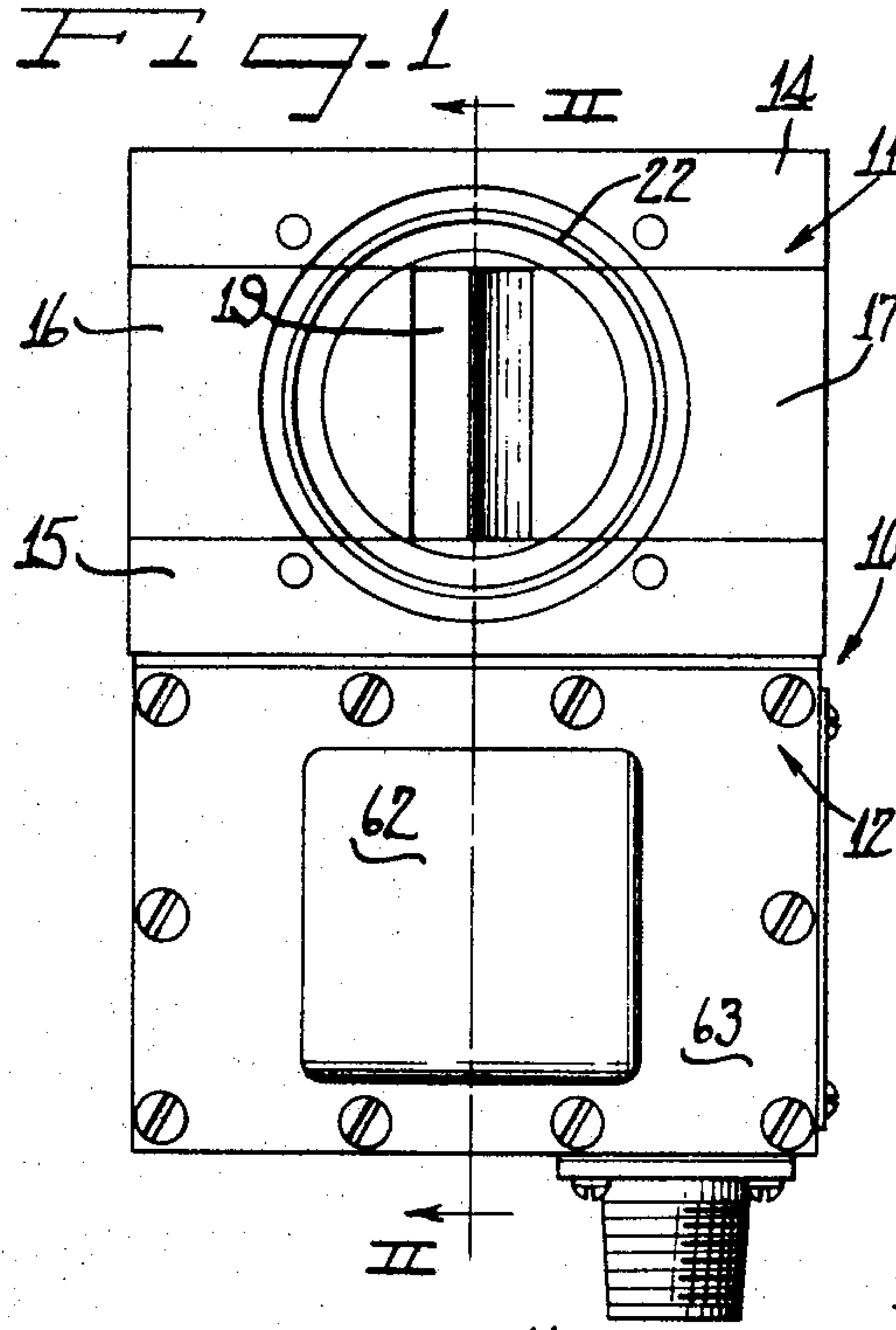


Fig-3

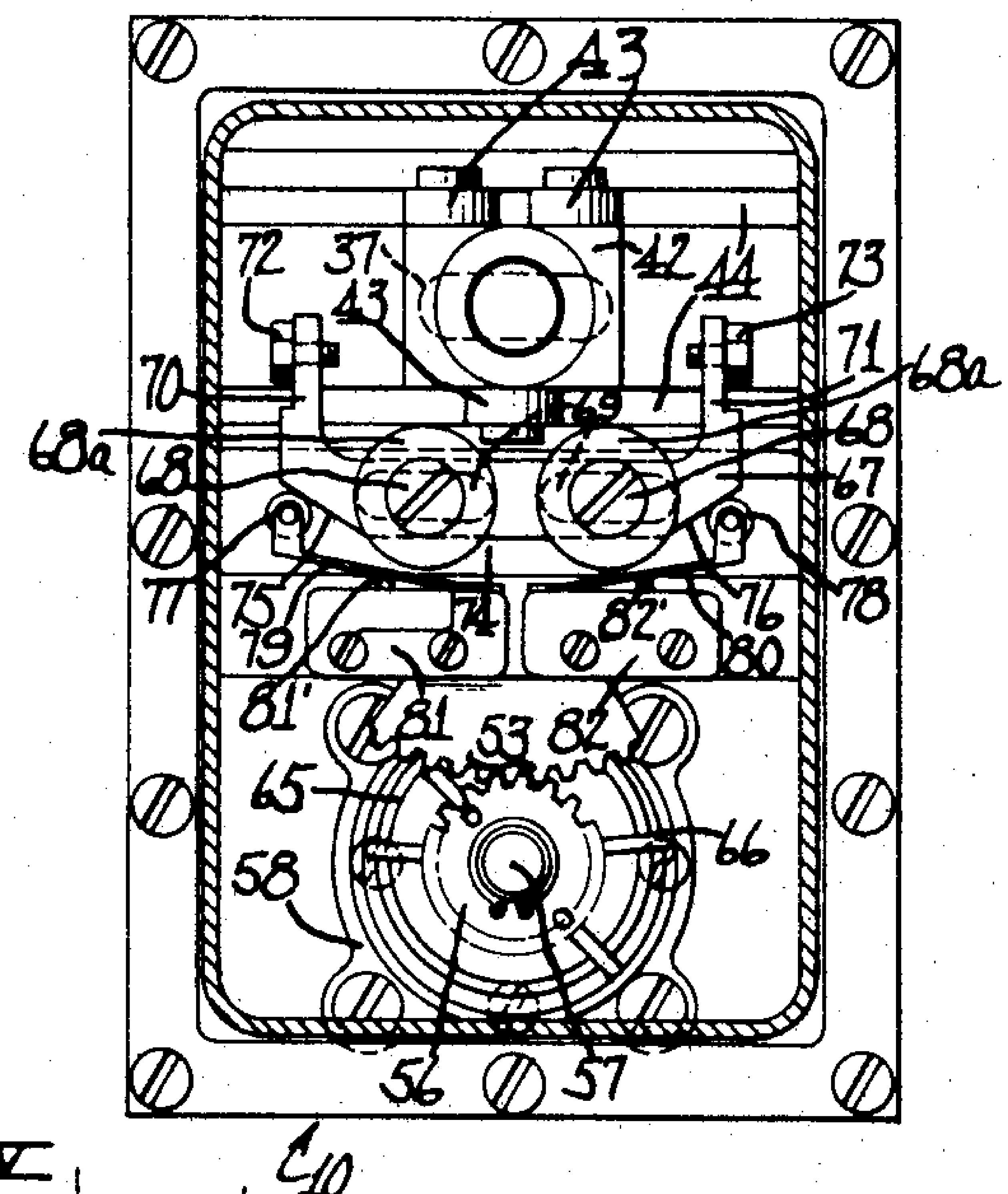
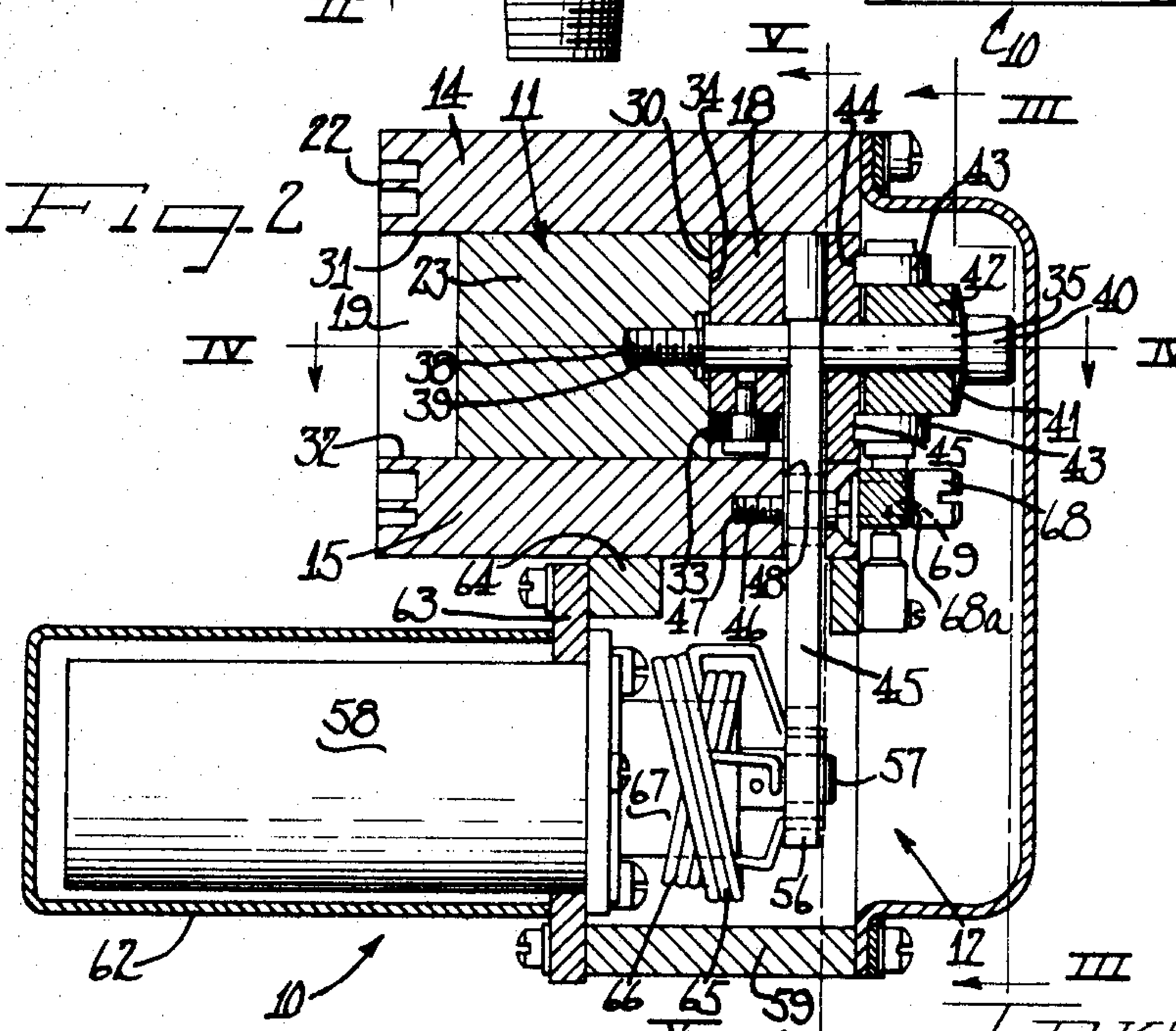


Fig-2



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WAVE GUIDE SWITCH AND ACTUATOR THEREFOR

Filed Nov. 21, 1955 3 Sheets-Sheet 2

Fig-4

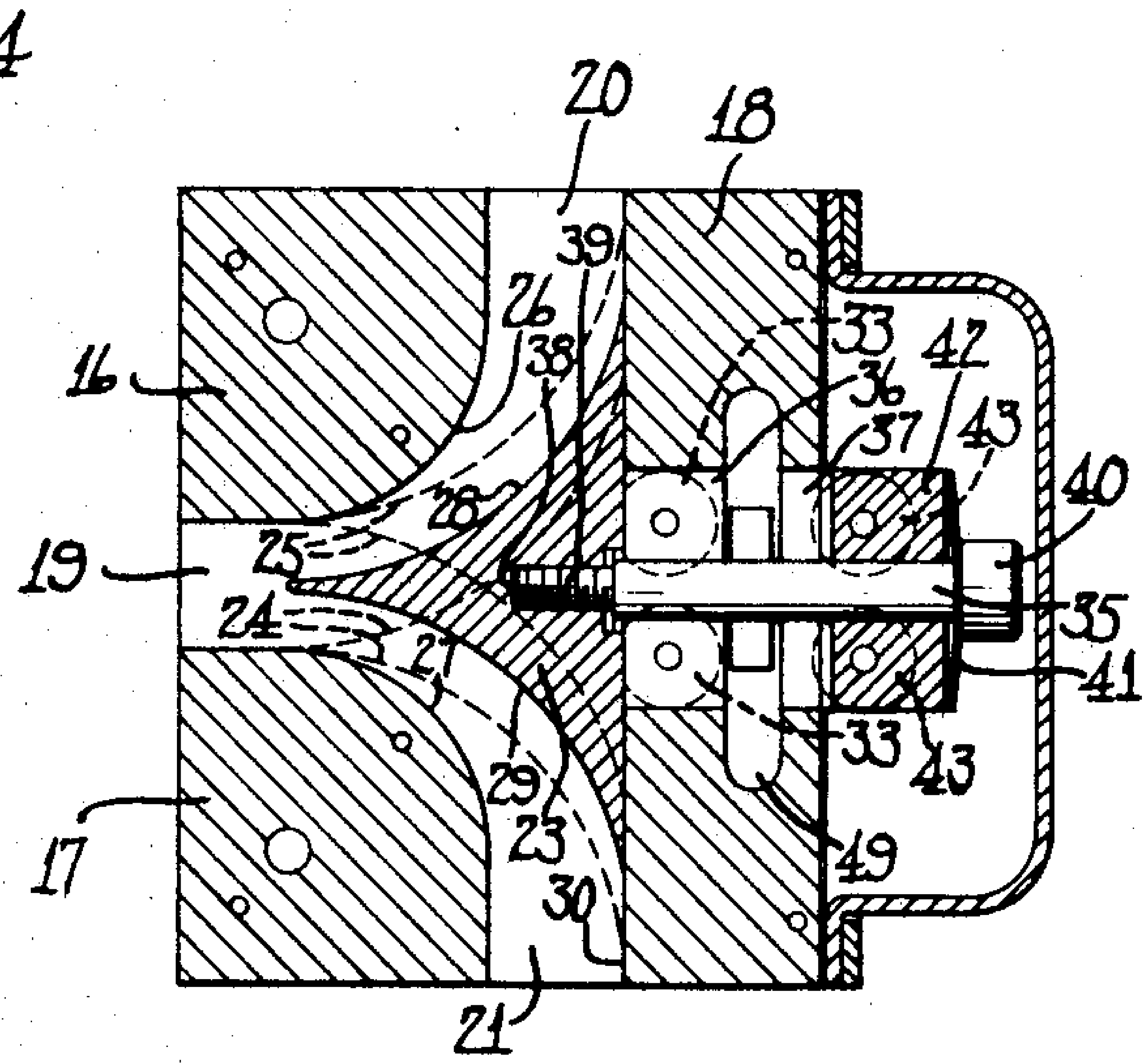

Fig-5

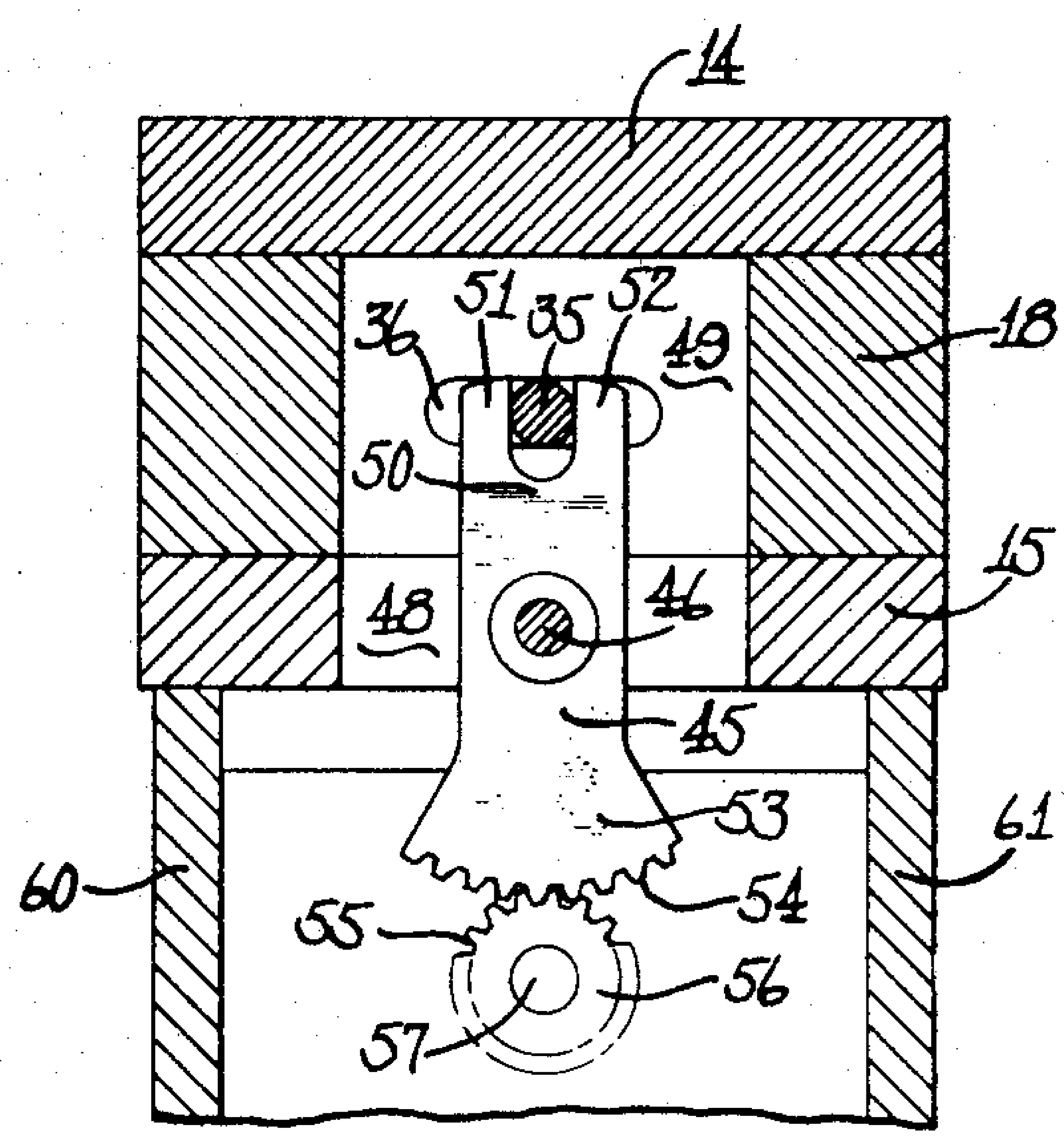

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Fig-6

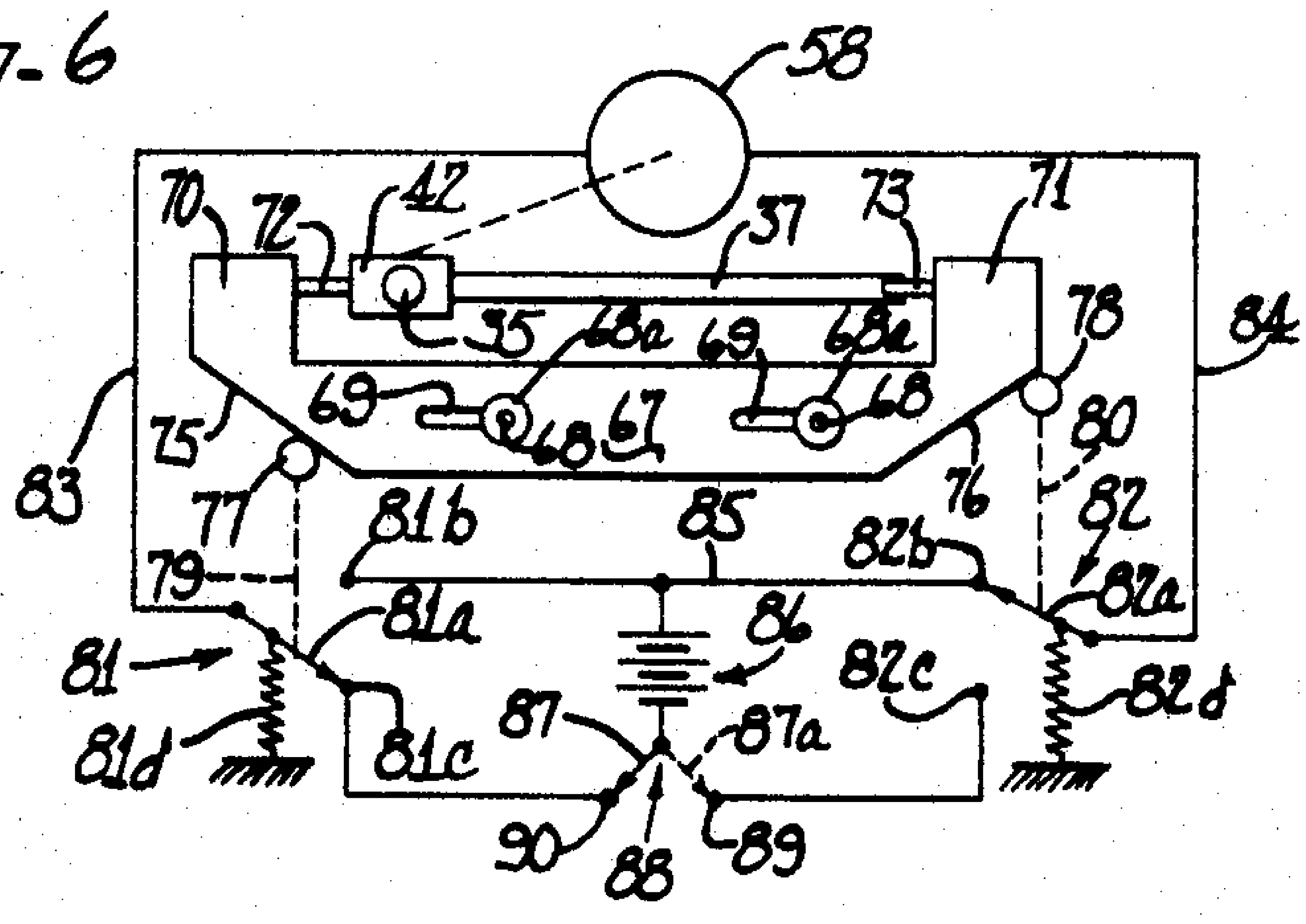


Fig-7

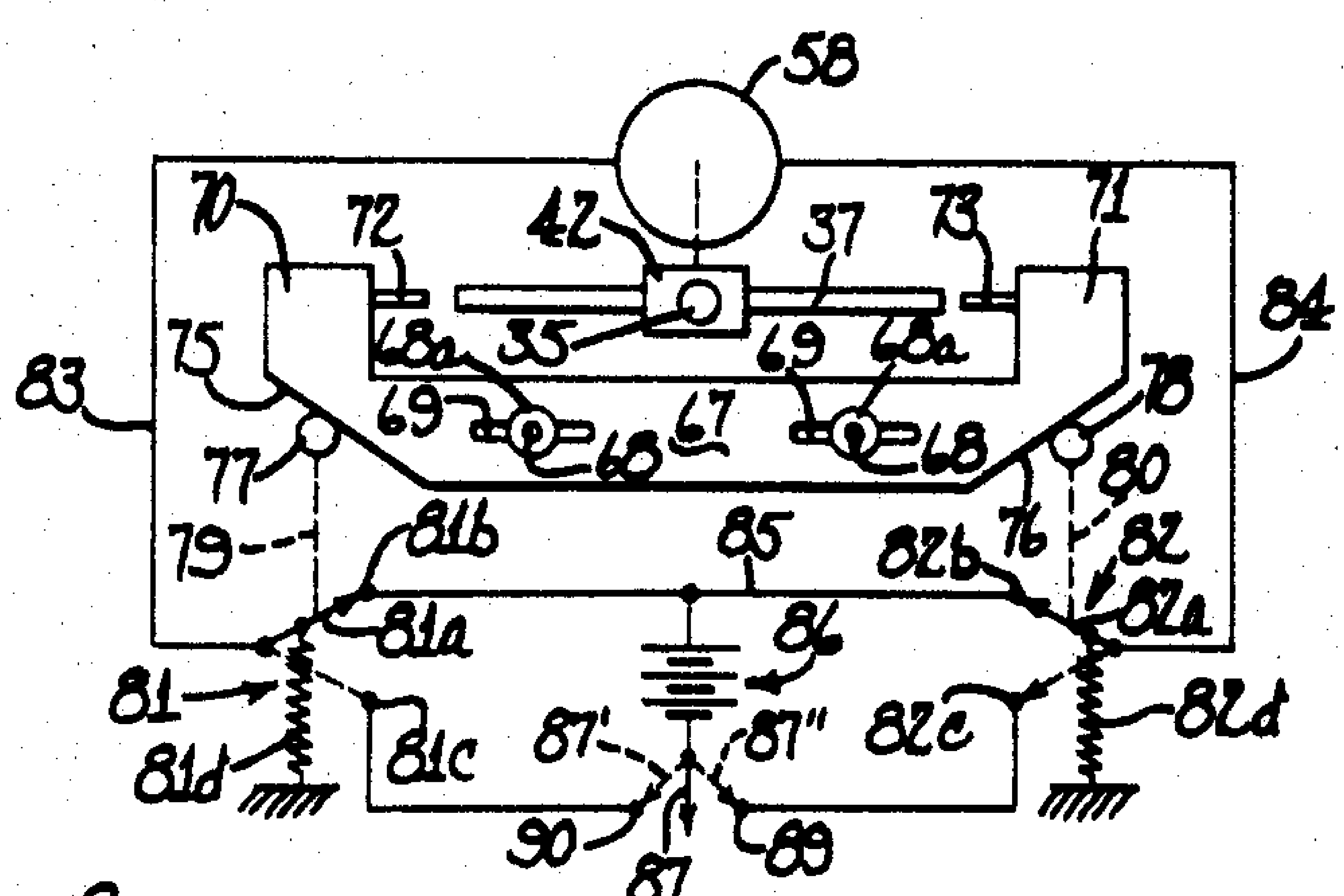
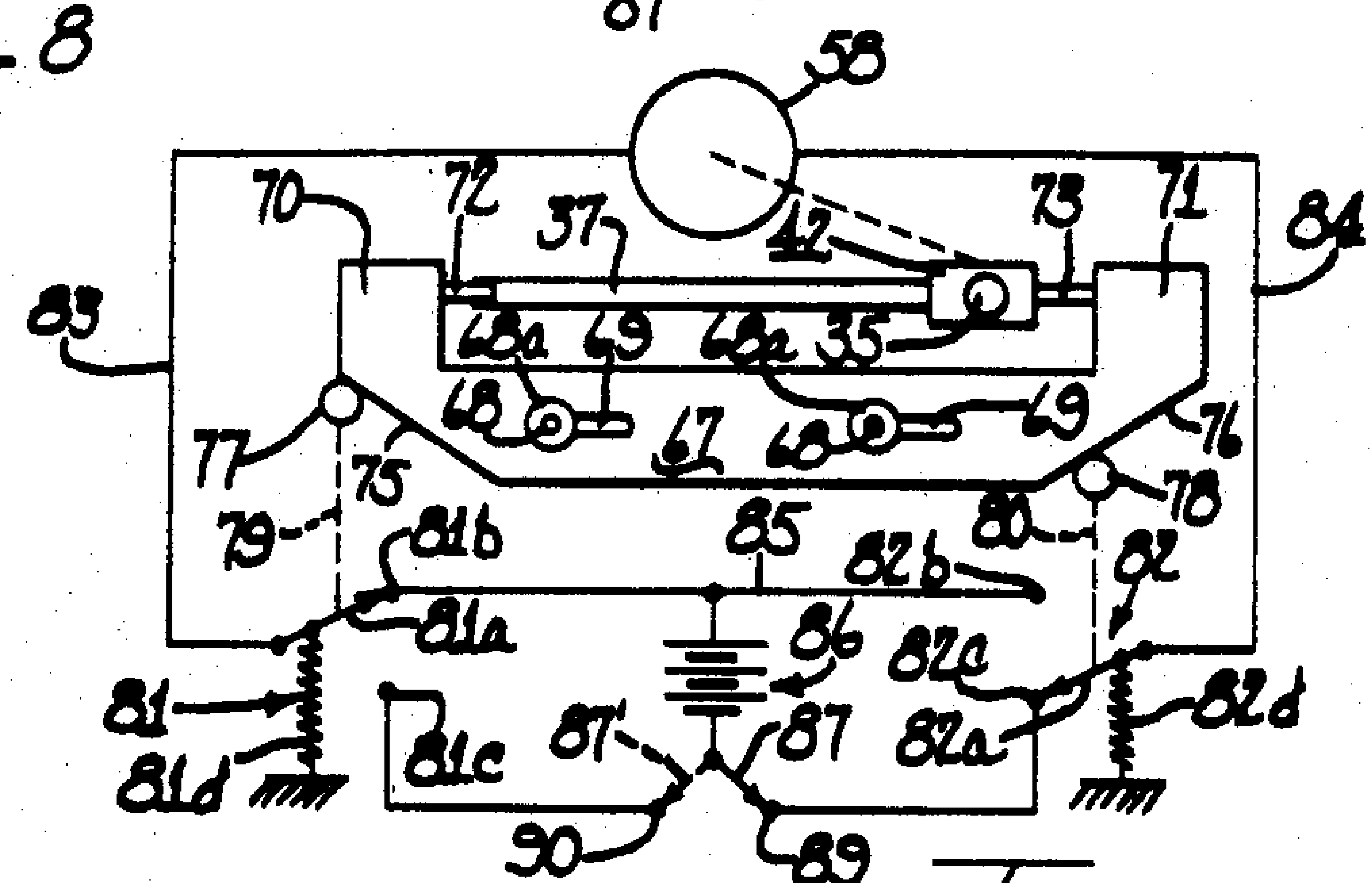


Fig-8



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WAVE GUIDE SWITCH AND ACTUATOR THEREFOR

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8 Claims. (Cl. 333—7)

The present invention relates to a wave guide switch assembly and actuator therefor and more particularly relates to a wave guide switch assembly having a self-contained actuator mechanism and system for controllably actuating the switch between its respective positions to properly direct transmitted energy passing through the wave guide into the appropriate switch channels therefor.

It is an important object and feature of this invention to provide a new and improved wave guide switch mechanism of the T type for controllably switching a first wave guide channel into selective communication with either channel of a pair of wave guide channels. The switch is effective not only to so interconnect the first channel with either channel of the other pair of channels but to be efficiently operative through a wide range of frequencies.

For these purposes, the switch mechanism is provided with a housing assembly with at least three channels therein in a T relation to each other and a sliding shuttle member whereby the leg of the T may be placed into communication with either of the arms of the T. To provide for a wide range of frequencies through which the switch will be efficiently operative, at the junction of the arms and legs, the housing is arcuately shaped to provide a pair of convex faces while the shuttle projects into the leg channel and is provided with a pair of concave faces.

The shuttle is moved, in accordance with the principles of this invention, between its two opposed positions, by an actuator mechanism including a pivotal fork or lever having a bifurcated end receiving a pin projecting from the shuttle, and a motor mechanism effective to oscillate or pivot the lever reversibly to selectively actuate the switch.

In accordance with the principles of this invention the actuator motor drive for the lever and the shuttle includes a pair of oppositely biased springs which preload the shuttle at either of its extreme positions whereby such deleterious effects as cross talk or the like are limited.

Still another feature of this invention is the inclusion in the actuator mechanism and control system of a switching system which is effective to cause only momentary energization of the reversible motor and to thereafter short the motor for dynamic braking of movement of the shuttle at the end of which movement of the shuttle the switch system is effective to prepare the circuit for energization of the reversible motor in an opposite direction. This feature of the invention is effected through the utilization of a slide bar which is moved slightly at the end of the movement of the shuttle and which is effective to operate a pair of switches such as normally closed single pole double throw microswitches.

It is, therefore, evident that another important object and feature of the present invention is to provide a new and improved switch actuator mechanism and control system.

Still other objects, features and advantages will become readily apparent from the following detailed description of the present invention and an embodiment thereof, from the claims, and from the accompanying drawings in which each and every detail illustrated and shown is fully and completely disclosed as a part of this specification, in which like reference numerals refer to like parts, and in which:

2

FIGURE 1 is an elevational view of a switch control mechanism and system and actuator therefor embodying the principles of this invention;

FIGURE 2 is a sectional view of the unit of FIGURE 1 and is viewed as taken substantially along the line II—II of FIGURE 1;

FIGURE 3 is a sectional view taken as viewed substantially along the line III—III of FIGURE 2;

FIGURE 4 is a sectional view taken as viewed substantially along the line IV—IV of FIGURE 2;

FIGURE 5 is a sectional view taken as viewed substantially along the line V—V of FIGURE 2; and

FIGURES 6, 7 and 8 are schematic illustrations of the system of the actuator illustrating different conditions thereof.

As shown on the drawings:

A wave guide switch and actuator embodying the principles of this invention may be a self-contained integral structure such as the assembly **10** wherein a wave guide switch **11** is assembled with an actuator **12** which controllably reversibly actuates the switch **11** for controlled communication between a first wave guide passage and either wave guide passages of a pair thereof.

The switch **11** forming the embodiment of the invention illustrated and described here is formed by a pair of plates **14** and **15** secured in spaced parallel arrangement by a pair of blocks **16** and **17** and a mounting block **18** which is also secured to the plates **14** and **15** and disposed therebetween. Between the plates **14** and **15**, the blocks **16**, **17** and **18** form T-shaped channel including a leg channel **19** between the blocks **16** and **17** and a pair of arm channels **20** and **21** respectively between the blocks **16** and **18** and between the blocks **17** and **18**. Since the blocks are coextensive with the plates **14** and **15**, the outer face of the switch is formed with three sets of couplings **22** provided for mounting and securing of wave guides to the switch assembly **11**.

Thus, a plurality of wave guides may be connected with the switch in such a manner that the leg and each of the arm channels **19**, **20** and **21** within the switch may individually be in communication with a wave guide. For example, the leg channel **19** may be coupled to a radar receiving and detection system while each of the channels **20** and **21** may be connected to radar antenna assemblies respectively differing from each other. In such an arrangement it is desirable to be able to switch the receiver and detector to either of the antennas respectively connected through wave guides coupled to the arm channels **20** and **21**.

To this end, the switch is provided with a laterally shiftable switching shuttle block **23** controllably movable between positions defining continuity and communication between the channels **19** and **20** closing off the channel **21**, as illustrated by the dashed shuttle block outline **24**, and a position for continuity and communication between the channels **19** and **21** closing off the channel **20** as illustrated by the dashed shuttle block outline **25** (FIG. 4). Thus, when the shuttle block is in the position indicated by the dash line **24**, there is continuous wave guide communication between the channels **19** and **20** and lateral movement of the shuttle block **23** to a position where it closes against the block **16** will close off the arm channel **20** and provide continuous wave guide communication between the leg channel **19** and the leg channel **21**.

In order that the switch may have maximum utility and versatility and be useful at a relatively high efficiency level of operation through a wide range of frequencies, the inner corners of the blocks **16** and **17** are arcuately configurated as at 26 and 27, respectively, and formed with convex faces, respectively. At the same time, the channel defining faces 28 and 29 of the shuttle 23 are also arcuately formed and open concavely into the switch channels in such a manner that the arcuate face 28 is more or less concentric with the convex face 26 on the block 16 when the shuttle is in the position 24 defining continuity between the channels 19 and 20, and the face 29 is more or less concentric with the face 27 of the block 17 when the shuttle 23 is in a position defining continuity and communication between the channels 19 and 21. These arcuate faces 28 and 29 on the shuttle block 23 cause the shuttle block to be more or less isometrically triangular in plan configuration or in cross section such as viewed in FIGURE 4. Further, the thickness of the shuttle 23 is substantially equal to the thickness of the blocks 16, 17 and 18 but is just slightly smaller than those blocks whereby it may be laterally slidingly moved along the inner face 30 of the block 18 and between the inner faces 31 and 32 of the plates 14 and 15. Additionally, rollers 33 journalled in the block 18 engage the back sliding face 34 of the shuttle 23 to facilitate movement of the shuttle 23 and substantially reduce friction between the faces 30 and 34 of the block 18 and shuttle 23, respectively.

Movement of the shuttle 23 between the switch positions 24 and 25 is effected by translational movement transmitted thereto through a pin 35 extending through slots 36 and 37 in the block 18 and threadably secured to the shuttle 23 as provided for by threaded recess 38 in the back of the shuttle 23 and a threaded end 39 on the inner end of the pin 35. At the outer end of the pin 35 a head 40 thereon bears against a resilient spring ring 41 which in turn resiliently bears against a block 42 journalling rollers 43 riding in tracks 44 on the back face of the block 18 whereby translational movement of the shuttle 23 is permitted with a minimum of friction or other mechanical drag or other sources of hysteresis, and the shuttle 23 is tightly held against the rolls 33 and the block 18 by action of the spring 41 acting against the head 40 on the pin 35 to urge the same resiliently as described.

Translational movement of the shuttle 23 between its switching positions 24 and 25 is effected by translational movement transmitted thereto through the pin 35 by a pivoted lever 45 journalled on a screw pin 46 threaded into the plate 15, as at 47 and extending through a slot 48 in the laterally central and rearward portion of the plate 15. This slot 48 mates with a slot 49 in the block 18 whereby pivotal movement of the lever 45 is accommodated. The lever 45 has a bifurcated end portion 50 with legs 51 and 52 receiving the pin 35 therebetween whereby pivotal movement of the lever 45 is transformed into lateral translational movement of the pin 35 and the shuttle 23 as well as the block 42.

At the opposite end of the lever 45 from the bifurcated end 50, the lever is provided with a gear-like portion 53 having teeth 54 in gear coupling connection with teeth 55 on a gear 56 secured to the shaft 57 of a motor 58 mounted on base plate 63 and this assembly is secured to the side plates 59, 60, 61 and 64.

The motor 58 is a reversible motor whereby reversibly energizing the same will effect reversing rotation of the gear 56 and reversing pivotal movement of the lever 45 whereby the shuttle 23 may be driven reversibly between its switch positions 24 and 25. The motor 58 is physically encased in a housing 62 to which it is secured and which housing 62 is in turn secured to the base plate 63. The side mounting plates 59, 60, and 61 as well as the bracket bar 64 are secured to the plate 15 of the switch mechanism whereby the assembly is unified as an integral switch and actuator 10.

To avoid cross talk and other similar disturbances and to prevent any intercommunication between the channel 21 and the channel 20, a pair of preloading spring elements 65 and 66 are mounted on the output end 67 of the motor 58 and connected to the gear 56. These oppositely biased loading springs 65 and 66 are so connected into the actuator 12 and particularly to the motor 58 and gear 56 that when the shuttle 23 is in the switch position 24, the spring 65 resiliently and positively biases the shuttle tightly against the block 17, while when the shuttle 23 is in the switch position 25, the spring 66 resiliently and positively biases the shuttle against the block 16. With these springs positively preloading the shuttle as described, the closed off arm channels of the switch are positively closed off, respectively, thereby preventing any intercommunication between the arm channels 20 and 21 when the switch is in either of its switch positions and any possibilities of garbled cross talk feeding into the channel 19 is positively prevented. Also, should the switch be used to transmit energy from the channel 19 into either the channel 20 or 21, then the springs 65 and 66 will so bias the shuttle that the wave guide channel 19 will not be loaded by feeding into both the channels 20 and 21 simultaneously.

For purposes hereinafter described in detail in conjunction with the operating characteristics and electrical system of the actuator, a slide bar 67 is mounted on the back of the block 18 by a pair of screws 68 extending through slots 69 in the slide bar 67 and threaded into the block 18. The slide bar 67 is substantially U-shaped with the slot 69 being in the bight portion of the block and the arms 70 and 71 thereof extending upwardly to be laterally extensive with the block 42. Additionally, for purposes hereinafter described, each of the arms 70 and 71 of the slide bar 67 have adjusting screws 72 and 73 respectively threaded laterally inwardly therethrough toward the block 42 for engagement therewith as the block moves laterally between the switch positions for the shuttle 23.

The lower face 74 of the bight portion of the slide bar 67 is sloped upwardly at the lateral extremities thereof to provide a pair of slant faces 75 and 76 upon which rollers 77 and 78 ride. These rollers 77 and 78 are operative as cam followers on the slant faces 75 and 76 and are attached to resilient switch actuator arms 79 and 80, respectively resiliently urging the follower elements 77 and 78 against the slant faces 75 and 76 of the slide block 67. These switch actuating arms 79 and 80 are respectively attached to microswitches 81 and 82 and are positioned to actuate the switches upon movement of the slide bar 67 through following of the cam or slant faces 75 and 76. Each of the microswitches 81 and 82, as hereinafter described, are preferably single pole double throw switches which are biased in one direction, a normally closed direction and movable by depression of pins or buttons 81′ and 82′, respectively, to their alternate pole positions or open positions. The expressions "normally closed" and "open" utilized herein to describe positions for the single pole double throw microswitches 81 and 82 are utilized to describe those positions of the microswitches where the microswitch is closed in the direction in which it is biased, and closed in the position against the biasing of switches, respectively. That is, the "normally closed" position of the microswitches is the position in which the switch is closed in the direction in which it is biased, while the "open" position of the switches is the position in which the switch is closed against the normal biasing of the switches.

The significance of the foregoing difference between the "normally closed" and "open" positions of the switches 81 and 82 may be more readily gained in conjunction with the following detail description of the operating character of the actuator for the switch in conjunction with the schematic diagrams of FIGURES 6, 7 and 8 wherein the switches 81 and 82 are illustrated as having their switch arms 81*a* and 82*a*, respectively, biased towards terminals 81*b* and 82*b*, respectively, and away from terminals 81*c* and 82*c*, respectively. Thus, when free or "normally closed" switch arm 81*a* is in contact with the terminal 81*b* and the switch arm 82*a* is in contact with the terminal **82*b***. When "open" the switch arm **81*a*** is in contact with the terminal **81*c*** and the switch arm **82*a*** is in connection with the terminal **82*c***.

In FIGURES 6, 7 and 8 it is also shown that the reversible motor **58** is electrically connected through leads **83** and **84** to the switch arms **81*a*** and **82*a***, respectively. Further, the switch terminals **81*b*** and **82*b*** are connected together or shorted together through a lead **85** also connected to one end of a source of electrical energy indicated generally at **86**. The other end of the source of electrical energy is connected to the switch arm **87** of a single pole double throw switch **88** having a pair of throw terminals **89** and **90**, respectively connected to the terminals **82*c*** and **81*c*** of the microswitches **82** and **81**, respectively.

As the wave guide switch and actuator and control system therefor is illustrated in FIGURE 6, the shuttle block **23** is in a left hand position along with the block **42** and shuttle pin **35**. In such position, the block **42** has engaged the screw or pin **72** on the arm **70** of the slide bar **67** whereby the slide bar **67** has moved to the left by sliding the same with the pins **68** in the slot **69**, and as illustrated in FIGURES 6, 7 and 8 as well as in FIGURES 2 and 3, resilient spring rings **68*a*** hold the slide bar **67** against the block **18** resiliently. In this left hand position of the slide bar **67**, the switch **81** is open and the switch **82** is closed. That is, the switch arm **81*a*** is in connection with the terminal **81*c*** while the switch arm **82*a*** is in connection with the terminal **82*b*** by virtue of the followers **77** and **78** having ridden downwardly and upwardly, respectively, on the slant faces **75** and **76** of the slide bar **67**. At this time, the motor **58** is also de-energized since the circuit therefor is open and the switch arm **87** is in the position indicated by the dash line **87*a*** so that it is in connection with the terminal **89** on the switch **88**. To switch the wave guide switch to its right hand position, that is to move the shuttle **23**, the block **42** and the shuttle pin **35** to the right, the switch arm **87** of the switch **88** is thrown to a position in connection with the terminal **90** whereby the circuit for the motor **58** is closed through the switch **82** which is in its normally closed position, through the lead **84**, the motor **58**, the lead **83**, the switch **81** which is in its "open" position with the arm **81*a*** in contact with the terminal **81*c***, and the source of electric energy supply **86**. This energization of the motor **58** will move the shuttle members including the block **42** to the right. Upon disengagement of the block **42** from the pin **72** on the left arm **70** of the slide bar **67**, the slide bar **67** will remain in position held fixed by springs **68*a***. As the block **42** travels across to the right no change in circuitry occurs until the block **42** engages the pin **73** on the right arm **71** of the slide bar **67**. At that time, the slide bar **67** will be moved positively to the right thereby throwing the switch **81** to its normally closed position **81*a*** as shown in FIGURE 7.

With both of the switches in their normally closed position, the motor **58** is short circuited through the lead **85** and a dynamic braking of the motor takes place. The shuttle elements, however, are carried over to the right hand position by the momentum of the shuttle elements and the kinetic energy of the motor **58**. In FIGURE 7 it is clearly seen that the motor **58** is short circuited through the lead **83**, the switch **81**, the lead **85**, the switch **82**, and the lead **84** for dynamic braking when the shuttle **67** has so moved that the switches **81** and **82** have their arms **81*a*** and **82*a*** in the normally closed positions in engagement and electrical contact with the terminals **81*b*** and **82*b*** short circuited together through the lead **85**. At such time, the position of the switch arm **87** on the switch **88** is wholly immaterial, but it will be noted that the switch arm **87** will remain in its contact with the terminal **90** of the switch **88** as indicated at **87'** in FIGURE 7.

When the shuttle moves fully to its right-hand position, as illustrated in FIGURE 8, the block **42** during its last increment of movement, will engage the pin **73** to move the slide bar **67** fully to the right thereby causing the follower **78** to ride on the slant surface or cam surface **76** to operate through the follower arm **80** to move the switch **82** to its "open" position where the arm **82*a*** is in contact with the terminal **82*c***. This will prepare the circuit for reactuation and energization to move the wave guide switch to its left position.

Now, to move the switch to its left position the switch arm **87** is thrown from the position **87'** in engagement with the terminal **90** to the position shown therefor in FIGURE 8 where it is in engagement with the terminal **89** thereby closing the circuit for the motor **58** through the lead **83**, the switch arm **81*a***, the terminal **81*b***, the source of electrical energy supply **86**, the switch arm **87**, the terminal **89**, the terminal **82*c***, the switch arm **82*a***, and the lead **84**. Now the motor **58** will cause the shuttle elements including the shuttle pin **35** and block **42** to move toward the left. Upon disengagement of the block **42** from the pin **73** on the right arm **71** of the slide bar **67**, the slide bar **67** will remain in position held fixed by springs **68*a***. As the block **42** travels across to the left no change in circuitry occurs until the block **42** engages the pin **72** on the left arm **70** of the slide bar **67**. At that time, the slide bar **67** will be moved positively to the left thereby throwing the switch **82** to its **82*b*** position as shown in FIGURE 7, and the dynamic braking circuit is thereby set up. An instant later, as the slide bar **67** continues its positive movement to the left due to the momentum of the shuttle elements and the kinetic energy of the motor **58**, the switch **81** is moved to its **81*c*** position as is shown in FIGURE 6. The circuit will then be prepared for energization of the motor **58** to move the shuttle to the right when the arm **87** of the switch **88** is moved from the position **87''** to the position **87'**, or from the position shown for the arm in FIGURE 8 to the position shown for the arm in FIGURE 6.

From the foregoing it will be readily observed that there is provided by the principles of this invention a new and improved wave guide switch and actuator and control therefor and that numerous variations and modifications may be made without departing from the true spirit and scope of the novel concepts and principles of this invention. We, therefore, intend to cover all such modifications and variations as fall within the true spirit and scope of the novel concepts and principles of this invention.

We claim as our invention:

1. A wave guide switch and actuator comprising a housing having a leg channel and a pair of arm channels therein arranged in a T configuration, a shuttle block in said housing laterally movable between positions providing communications between said leg channel and each of said arm channels selectively, a pair of single pole double throw switches mounted on said housing, a slide bar laterally shiftably mounted on said housing, means interconnecting said slide bar and said switches whereby lateral shifting movement of said slide bar effects operation of said switches, means effective upon movement of said shuttle block to shift said slide bar, reversible motor means to drive said shuttle block reversibly to said positions selectively, and a control system including said switches to reversibly energize said motor means, said control system including means interconnecting switches to dynamically brake said motor means after initiation of movement of the shuttle block and prior to completion of movement thereof, and means connecting said switches to the motor means and effective to prepare the control system for energization of the motor means in one direction following completion of movement thereof in the other direction.

2. In a wave guide switch and actuator, motor means to drive the switch, and control means to reversibly energize the motor means, said control means comprising a dynamic braking circuit for connection with said motor

means, and means responsive to the switch reaching a position in advance of each switching position to connect said dynamic braking circuit with said motor means to automatically dynamically brake the motor means.

3. A wave guide switch and actuator comprising a housing having a leg channel and a pair of arm channels therein arranged in a T configuration, a shuttle block in said housing laterally movable between positions providing communication between said leg channel and each of said arm channels selectively, a pair of single pole double throw microswitches mounted on said housing, said microswitches being normally closed for connection with one of the throw positions thereof, a slide bar laterally shiftable mounted on said housing, microswitch operator means coupled to said slide bar, means interconnecting said slide bar, said shuttle block and said switches whereby lateral shifting movement of said shuttle block effects operation of the switches such that one of said switches is open prior to movement of the shuttle block, the other of said switches is open at the conclusion of movement of the shuttle block, and both of said switches are closed during movement of said shuttle block.

4. A wave guide switch and actuator comprising a housing having a leg channel and a pair of arm channels therein arranged in a T configuration, a shuttle block in said housing laterally movable between positions providing communication between said leg channel and each of said arm channels selectively, a pair of single pole double throw microswitches mounted on said housing, said microswitches being normally closed for connection with one of the throw positions thereof, a slide bar laterally shiftably mounted on said housing, microswitch operator means coupled to said slide bar, means interconnecting said slide bar, said shuttle block and said switches whereby lateral shifting movement of said shuttle block effects operation of the switches such that one of said switches is open prior to movement of the shuttle block, the other of said switches is open at the conclusion of movement of the shuttle block, and both of said switches are closed during movement of said shuttle block, and a control system including said switches to reversibly energize said motor means.

5. A switch comprising a switch member, means mounting said switch member for linear reciprocating movement between two switching positions, rotary driving means rotatable in respective opposite directions for moving said switch member between said switching positions, energizing circuit means for applying voltage of reversible polarity to said rotary driving means, switch contact means controlling energization of said driving means as it moves said switch member from each switching position to the other switching position, switch actuating means for actuating said switch contact means to deenergize said driving means upon movement of said switch actuating means from a first position to a second position, said switch actuating means being movable from said second position to a third position while maintaining said switch contact means in actuated condition and said driving means deenergized, means for coupling said driving means with said switch actuating means for moving said switch actuating means from said first position to said second position as said switch member approaches said other switching position for actuating said switch contact means to deenergize said driving means, the driving means having sufficient momentum to move said switch member to said other switching position and to move said switch actuating means to said third position, and means responsive to the switch actuating means reaching said third position for reversing the polarity of said energizing circuit means to produce rotation of the rotary driving means in the opposite direction when said driving means is next energized.

6. A switch comprising a switch member, means mounting said switch member for movement between two switching positions, rotary driving means rotatable in respective opposite directions for moving said switch member from one switching position to the other switching position and from said other switching position to said one switching position, energizing circuit means for applying voltage of reversible polarity to said rotary driving means, switch contact means controlling energization of said driving means as it moves said switch member toward said other switching position, switch actuating means for actuating said switch contact means upon movement of said actuating means from a first position to a second position, said switch actuating means being movable from said second position to a third position while maintaining said switch contact means in actuated condition, means for coupling said driving means with said switch actuating means for moving said switch actuating means from said first position to said second position as said switch member approaches said other switching position for actuating said switch contact means to deenergize said driving means, retarding means for said driving means operative to oppose the momentum of said driving means, the driving means when subjected to said retarding means still having sufficient momentum to move said switch member to said other switching position and to move said switch actuating means to said third position, means responsive to said switch actuating means reaching second position to actuate said retarding means, and means responsive to the switch actuating means reaching said third position for reversing the polarity of said energizing circuit means for said driving means to move said switch member toward said one position when said driving means is next energized.

7. A switch comprising a switch member, means mounting said switch member for linear reciprocating movement between two switching positions, reversible rotary driving means for rotational movement in opposite directions to move said switch member toward its respective switching positions, means providing a drive train for coupling said rotary driving means to said switch member, said drive train comprising means for translating rotary movement of said rotary driving means into linear movement of said switch member, bilateral resilient means interposed in said drive train having two sections one active in each of the respective opposite directions of rotation of said rotary drive means, and means responsive to the switch member reaching a position in advance of the switching position toward which it is being moved to deenergize said rotary driving means, the rotary driving means having sufficient momentum to thereafter move the switch member to the switching position and to itself move still further to resiliently tension the corresponding section of said resilient means for resiliently urging the switch member into its switching position.

8. A wave guide switch and actuator comprising a housing having a leg channel and a pair of arm channels therein arranged in a T configuration, a shuttle block in said housing laterally movable between positions providing communication between said leg channel and each of said arm channels selectively, a slide bar laterally shiftably mounted in said housing for movement from a first position through a second position to a third position as said shuttle block is moved from one switching position to a second switching position, reversible motor means for driving said shuttle block from its first position to said second position and from said second position to said first position, means for coupling said motor means with said slide bar when said shuttle block is still in advance of said second switching position thereof to drive said slide bar from its first position through its second position to its third position as said shuttle block moves to said second switching position, means responsive to the slide bar reaching said second position for substan-

tially diminishing the driving force exerted on said shuttle block by said motor means, and means responsive to the slide bar reaching said third position to condition said motor means for energization in the opposite direction.

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