Nov. 10, 1970 K. E. NEUMEIER 3,539,748

CENTER TAP POTENTIOMETER CENTER BIASED BY LINEARLY MOVABLE MICROSWITCH ACTUATING CONTROL RODS

Filed May 1, 1968 2 Sheets-Sheet 1

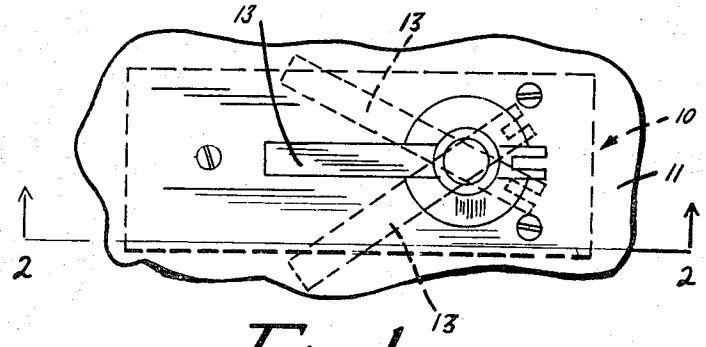


Fig. 1

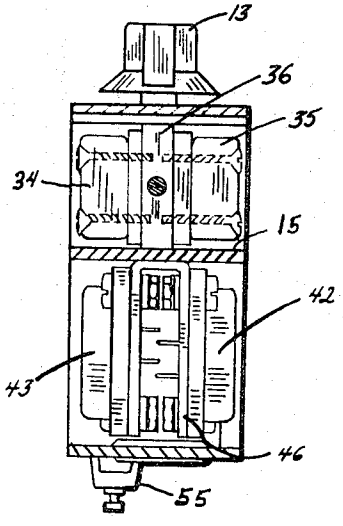


Fig. 3

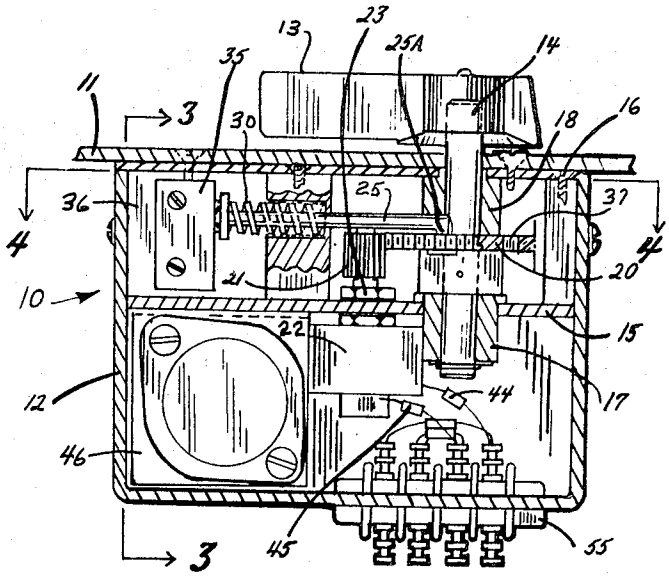


Fig. 2

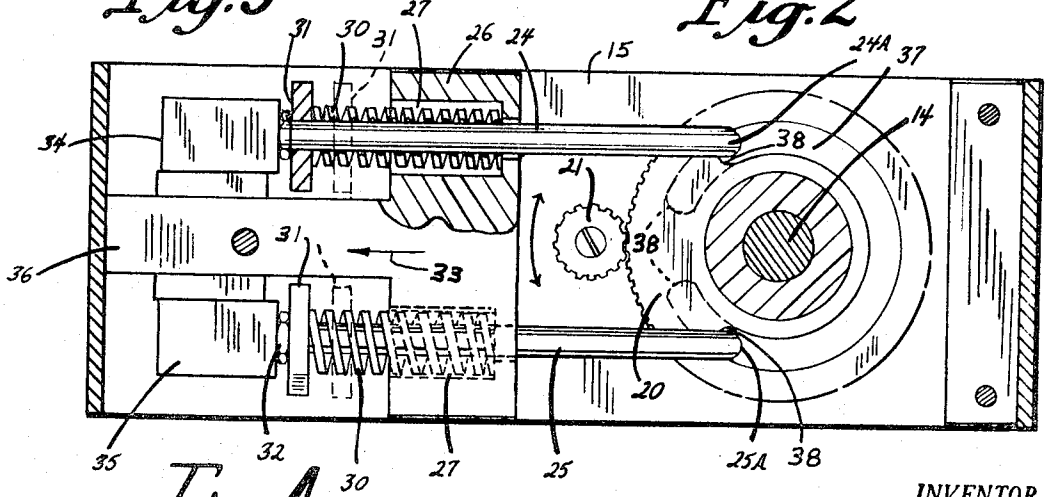


Fig. 4

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CENTER TAP POTENTIOMETER CENTER BIASED BY LINEARLY MOVABLE MICROSWITCH ACTUATING CONTROL RODS

Filed May 1, 1968 2 Sheets-Sheet 2

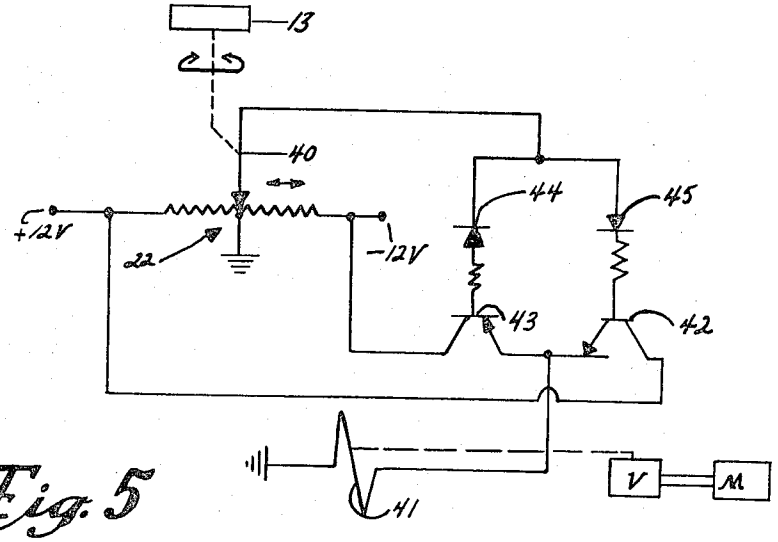


Fig. 5

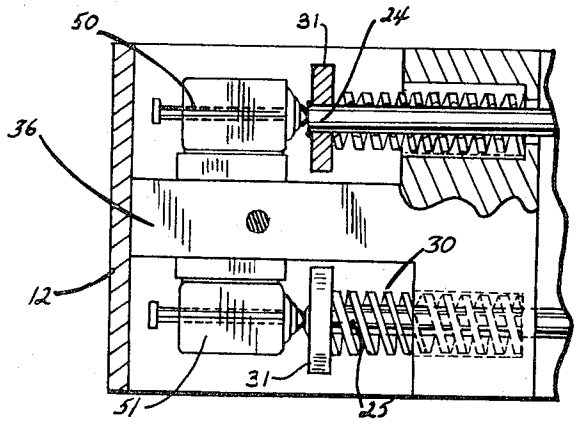


Fig. 6

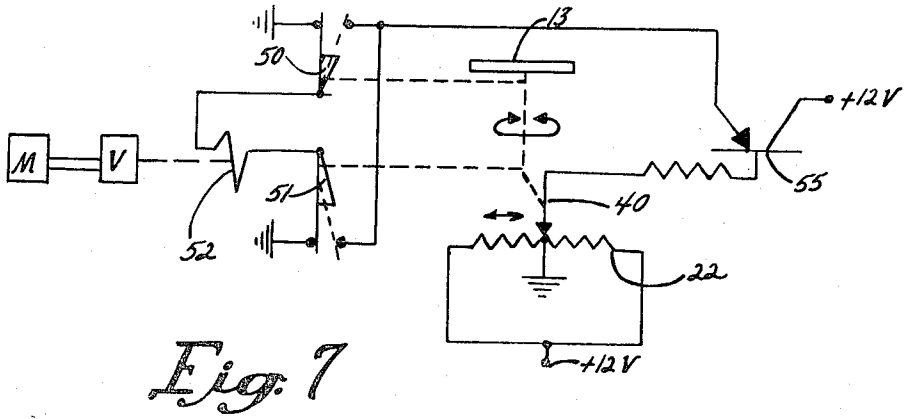


Fig. 7

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3,539,748

CENTER TAP POTENTIOMETER CENTER BIASED BY LINEARLY MOVABLE MICROSWITCH ACTUATING CONTROL RODS

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Int. Cl. H01h 21/24
U.S. Cl. 200—153 14 Claims

ABSTRACT OF THE DISCLOSURE

A control switch of the rotary type having a center off position and controlling movement of a load in two different directions by moving the switch to either side of a center off position. The switch controls a center tap potentiometer and not only turns the load on and off and controls the direction of movement of a load, but also controls speed of the load. The farther the switch is moved from its off position the faster the load is moved. The switch utilizes an improved arrangement for positively returning the switch to its center off position whenever it is released so that very accurate control of the load can be obtained.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention pertains to rotary control switches having a center off position and movable in two opposite rotational directions.

Background of the invention

One of the basic problems in previous rotary switches has been the lack of precise centering of the switch to its off position when the switch is released. Torsion springs weaken, become loose at their center position, and generally are unsatisfactory. Linear switches are satisfactory, but some operators prefer a rotary switch for controlling rotary motion.

SUMMARY OF THE INVENTION

The present invention relates to a rotary control switch which utilizes a positive centering device by using a gear drive to control a rotary control element. The switch uses linearly actuating springs for centering the switch. A gear is drivably mounted directly onto the switch control handle shaft and this gear in turn engages another gear and drives a rotary control element such as a rotary potentiometer. A pair of spring loaded rods are retained in a part annular slot defined in the first gear. The rods are spring loaded so that the springs act on the rods to exert a force tending to rotate the gear to a stopped position when there is no external force on the actuating handle.

The unit can be used with on and off limit switches to obtain two way action where there is only single polarity direct current available, or can be used to direct the power units without the on-off switches when proper power is available.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary top plan view of a control panel mounting a control switch made according to the present invention;

FIG. 2 is a side elevational view of the device of FIG. 1, with parts in section and parts broken away;

FIG. 3 is a sectional view taken as on line 3—3 in FIG. 2;

FIG. 4 is an enlarged sectional view taken as on line 4—4 in FIG. 2;

FIG. 5 is a schematic representation of a typical control circuit used with the switch construction of FIGS. 1–4;

FIG. 6 is a fragmentary enlarged side elevational view showing a modified form of the invention employing micro switches and;

FIG. 7 is a modified control circuit used with the present invention and employed when the switch as shown in FIG. 6 is used.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The control switch shown generally in **10** is installed on top panel **11** of a control console. The top panel is shown only fragmentarily. The switch includes a housing **12** positioned below the panel **11** and a switch control lever **13** is mounted onto a control shaft **14** that extends through a provided opening in the switch housing and in the top panel **11**. The switch lever **13** can be rotationally moved as shown as dotted position in FIG. 1 either to the right or to the left, and when it is centered as shown in solid lines, it is in an "off" position.

The housing **12** includes a center divider member **15** and a top member **16** which is attached just below the panel **11**. Shaft **14** is rotatably mounted in suitable bearings **17** and **18**, which are mounted between the center divider **15** and the top member or wall **16**. The shaft **14** in turn mounts a spur gear **20**. The gear has a hub that rides against a flange on the bearing **17**, and the bearing **18** is shouldered so that the top wall **16** holds the assembly in position. Note that the bearing **18** has a small neck that surrounds the shaft at the opening in the top wall.

The first or drive gear **20** engages a driven gear **21** that is substantially smaller than the gear **20** and which is, as shown, drivably mounted onto a shaft of a rotary, center tap potentiometer **22**. The potentiometer is fastened with suitable fastening means **23** to the divider member or wall **15** and is positioned below the divider wall. The shaft of the potentiometer extends upwardly above the divider wall. The gears are meshed so that the potentiometer **22**, which is a center tap, center off, rotary potentiometer, is off when the switch lever **13** is in its off position.

The positioning of the switch lever is controlled through the use of a pair of control rods **24** and **25**. The control rods each pass through a guide block **26** that is positioned above the divider wall **15** and below the top wall **16** and is held in place with suitable fasteners. The openings in the guide blocks **26** are made so that they form recessed spring pockets **27** surrounding each of the control rods **24** and **25**. The control rods pass through small openings at one end of the spring pockets **27**. A separate spring **30** surrounds each of the control rods and is positioned within the respective pockets, and a spring retainer washer **31** is positioned adjacent the ends of the control rods and is held in place by brazing or otherwise fastening a suitable fastener **32** to the end of the rod.

The rods are urged by the springs **30** in the direction indicated by arrow **33** and in the first form of the invention are stopped from movement in this direction by stop blocks **34** and **35**, respectively, which in turn are fastened onto a center member **36** of the guide member. The stop members or blocks **34** and **35** can be adjustably mounted on the center member **36** so that they can be moved to position the stops where desired.

The rods **24** and **25**, respectively, each have bent over end portions **24A** and **25A**, respectively, and these end portions extend substantially at right angles to the main part of the rods. The end portions are positioned within a part annular slot **37** defined through gear **20**. The slot **37** extends part way around the periphery of the gear. The slot is made so that the end surfaces **38** of the slot **37** is engaged by the rod end portions **24A** and **25A** at the same time that the fasteners **32** engage the respective stop blocks **34** and **35**.

Now, it can be seen, that the springs **30** exert a linear force on the rods and the rods in turn pull against the end surfaces **38** of the slot **37**. This prevents rotation of the gear except when the spring force of one of the springs **30** is overcome. The centering of the switch in its desired position is thus very accurately done. Upon rotation of the switch lever **13**, it can be seen that a gear **20** will be rotated. Assuming that the gear is rotated clockwise as viewed in FIG. 4, the rod **24** will be pulled along with the gear and the spring **30** surrounding the rod **24** will be compressed. The rod **25** will be held against its stop and the end **25A** will merely ride in the slot **37** as the gear rotates. When the switch is released, the spring **30** surrounding the rod **24** will urge the rod in direction as indicated by arrow **33** thus pulling the gear **20** in a counterclockwise direction until it is centered again in its home position. Turning the lever **13** in the counterclockwise direction results in the movement of the rod **25** and compression of the spring **30** surrounding this rod, while the rod **24** stays in its home position. When the lever **13** is released, the spring **30** surrounding rod **25** will again urge the rod in the direction as indicated by arrow **33** and move the gear **20** in a counterclockwise direction to its home position.

The rotation of the gear **20** will cause the gear **21** to rotate and thus will rotate the center tap potentiometer. The gear ratio gives substantially full travel of the potentiometer with a small movement of the control lever.

FIG. 5 shows a schematic representation using the switch of the present invention in a typical circuit to control a servo valve coil. The servo valve can be used to control the flow of oil to a rotary hydraulic motor which in turn can be used to drive rotational components, for example, a grip of a remote manipulator. Servo valve controls are made so that the more current flowing through the servo valve coil, the more the valve will open and the faster the motor will rotate.

Upon rotation of the switch lever **13** the wiper **40** of the center tap potentiometer **22** will be moved. In the center position, it can be seen that the wiper goes to ground and is "off." For operation in this circuit, two voltage sources, one having a minus 12 volts and one having a plus 12 volts is used.

When the wiper **40** is moved in either direction on the potentiometer by movement of the lever **13**, current will flow through the wiper from either the plus 12 or the minus 12 volt source and through a combination of two diodes **44** and **45** and transistors **42** and **43** to supply power to a coil **41** of a servo valve. The amount of power flowing, depends on the position of the wiper **40** and the farther the lever **13** is rotated, the less resistance from the potentiometer **22** there is in the circuit, and the more current that will be flowing through the coil **41**.

The more current to coil **41**, the more the valve opens and the faster the speed of operation of the motor. When the wiper **40** is moved in the opposite direction from its center position, current will flow in the opposite direction through the circuit causing a reverse current flow in the coil **41** (on the minus 12 volts source the positive is grounded) thereby causing the valve controlled by the coil **41** to open in the opposite direction and cause opposite rotation of its controlled motor. Thus, if the unit is used, for example, for a rotating motor for a grip on a remote control manipulator you can obtain opposite rotation of this grip merely by moving the lever **13** in the opposite direction from its center off position. With electric motors the switch can take the place of the linear switches shown in U.S. Pat. No. 3,247,979.

Referring to FIG. 6 and a modified form of the invention, it can be seen that the stop blocks **34** and **35** in this form of the invention have been replaced with micro switches **50** and **51**. These switches are fastened to the center member **36** in any desired manner in a position so that their actuator buttons align with the rods **24** and **25**, respectively. The small collars surrounding the actuator buttons of the switches **50** and **51** form stop members when the actuator buttons are depressed by the rods. The switches **50** and **51** are adjusted so that the actuators are depressed (or actuated) on both of the switches when the lever **13** is in its normal or off position. The switches can be wired into a circuit to obtain reversing functions in combination with a servo valve when only single polarity straight DC power is provided, for example, where the unit uses a 12 volt storage battery.

This circuit is shown schematically in FIG. 7. Lever **13** again drives the gears to move the center wiper **40** on the rotary, center tap potentiometer **22**. The center position is again "off" and leads to ground as shown. Only a plus 12 volt source is used. The solid line portions of micro switches **50** and **51** is when the lever **13** is in its "off" position. When lever **13** is rotated so that the rod **24** moves away from the switch **50**, the switch will move to its dotted position as shown in FIG. 7 and at the same time the wiper **40** will move away from the center position so that current will flow from the voltage source through the wiper, and through a transistor **54** provided in circuit. The micro switch **50** moves to its dotted position and this completes a path through the transistor and the potentiometer to the solenoid servo valve coil **52**. Again, the amount of current flowing through the coil **52** determines the amount of opening of the valve that the coil controls in the conventional manner and this in turn, if the valve is used to control a hydraulic motor, will determine the speed of the hydraulic motor. Thus, the farther the lever **13** is rotated from its center position, the faster the motor controlled by the coil **52** will rotate.

If the switch lever **13** is moved in its opposite direction, the wiper **40** moves in opposite direction along the resistance of potentiometer **22**, and micro switch **51** moves to its dotted position, while the micro switch **50** remains in its solid position. This then completes a circuit for current flow in opposite direction through the servo valve coil **52** to cause the valve to open in opposite direction and cause rotation of its control motor in opposite direction. Again, if the wiper **40** is moved farther in this direction, the current flowing through the servo valve coil will increase and the valve will open more causing the hydraulic motor it controls to rotate faster, thus providing for a speed control proportional to the amount of rotation of lever **13**. Not only that, the micro switches of this circuit provide for reversing where a unidirectional current only is utilized.

All of the components necessary for operation of the switch, other than the external power connections can be mounted within the housing **12**. Referring again to FIG. 2, it can be seen that the transistors **42** and **43** can be mounted onto a bracket **46** that is fastened to the divider member **15**, and the diodes **44** and **45** also can be mounted right within the housing. Suitable resistors that are necessary are easily housed within this switch component as well.

When the form of the invention shown in FIGS. 6 and 7 is utilized, all the components necessary for the circuit except the external power connection also are housed within the switch housing. The transistor **54** can be mounted in place of the transistor **42** and any resistors necessary also fit nicely within this housing.

A junction block **55** can be provided at the bottom of the housing in both forms of the invention so that external connections can also be easily made.

Thus, the use of the linearly slidable rods or links using compression springs for positive centering make the operation of the rotary switch accurate. By proper selection of the gear ratio, the amount of rotation of the lever **13** can be kept to a minimum for obtaining full travel of the potentiometer, and the sensitivity thus can also be controlled by gear ratio selection. As shown, the gears are approximately 15 tooth gear for the gear **21**, and a 50 tooth gear for gear **20**.

The use of a single rod and spring for biasing the unit to its center position is also contemplated. The unit can operate in only one direction from the center position as well. The unit will work for other types of transmitted power, as well, but finds special use in the electrical field for controlling rotary potentiometers.

One of the features with the present design is that the springs can be preloaded to exert a positive retaining or positioning force in the switch center position.

What is claimed is:

1. A rotary switch having a center off position and movable in opposite directions rotationally from its center off position to complete electrical connections, comprising a housing, a first shaft rotatably mounted in the housing, a first gear drivably mounted on said first shaft, a rotary variable rate controller being mounted on said housing and having a controller shaft, a second gear mounted on the shaft of said rotary controller and engaging said first gear, the first gear having slot means defined therein, said slot means having end surfaces, at least two separate control links, means mounting said control links in said slot means, portions of said control links further being slidably mounted with respect to said housing, bias means urging said control links in first directions, said control links engaging opposite end surfaces of said slot means under the urging of said bias means to center said first gear and first shaft in a normal arcuate position comprising the off position of said rotary switch, rotation of said first shaft from its normal position causing unequal force on the control links from said bias means thereby causing one of said links to exert a centering force on said first gear and first shaft through its respective end surface of said slot means to return said first shaft to its normal position.

2. The combination as specified in claim **1** wherein said variable rate controller is a rotary, center tap potentiometer.

3. The combination as specified in claim **1** and stop means on the housing positioned to prevent movement of said control links in the direction of urging of the bias means past a position wherein the switch is in its center off position.

4. The combination as specified in claim **1** wherein said bias means comprises linearly actuated springs.

5. A rotary switch having a center off position and being movable in opposite directions rotationally from its center off position to complete electrical connections, comprising a housing, a first shaft rotatably mounted in said housing, a first gear drivably mounted on said shaft, a rotary center tap potentiometer mounted on said housing and having a second shaft, a second gear mounted on the second shaft and engaging said first gear, said first gear having slot means defined therein, said slot means having end surfaces, at least two separate control links mounted in said slot means, said control links further being slidably mounted with respect to said housing, bias means urging said control links in a first direction, said control links having end portions engaging the end surfaces of said slot means under the urging of said bias means to center said first gear in a normal arcuate position comprising the off position of said rotary switch, separate switch means mounted on said housing, each of said separate switch means being positioned to be actuated by a separate one of said control links, said separate switch means being actuated by its respective control link when the rotary switch is in its center off position, rotation of said first shaft from its center position causing movement of one of said control links away from its associated separate switch means and causing unequal force on said control links from said bias means thereby giving a centering force on said gear and first shaft through said control rods tending to return said first shaft to its normal position.

6. A rotary control device having an off position and being movable rotationally from its off position to control a connected load, comprising a housing, a member rotatably mounted in said housing and movable rotationally to and from a normal position, means connected to said member to control said load responsive to rotational movement thereof, a control rod linearly slidably mounted in said housing, first connecting means between said member and rod to cause linear movement of a portion of said control rod upon rotational movement of said member from the normal position of said member in a first rotational direction, switch means on said housing in alignment with said control rod and being actuated by said control rod when said member is in its normal position, and bias means cooperating with said control rod resisting movement of said member in the first rotational direction from its normal position, rotational movement of said member increasing the biasing force on said control rod tending to move said member back to its normal position.

7. The combination as specified in claim **6** wherein said member is rotatable in first and second rotational directions from its normal position, a second control rod linearly slidably mounted in the housing, second connecting means between said second control rod and said member to cause linear movement of a portion of said second control rod when the member is rotated in the second rotational direction from its normal position, a second switch on said housing in alignment with said second control rod and being actuated by said second control rod with said member in its normal position, bias means on said second control rod resisting movement of the member in the second rotational direction, said first and second connecting means including means to permit relative movement between the member and the first control rod when the member is rotated in said second rotational direction, and to permit relative movement between said member and said second control rod when the member is rotated in said first rotational direction.

8. The combination as specified in claim **7** wherein said control rods are stopped from movement beyond a predetermined position in the direction of urging of their respective bias means.

9. The combination as specified in claim **7** wherein said member includes a disc like member, and said connecting means comprises slot means in said disc like member, said rods having means slidably connecting them in said slot means.

10. The combination as specified in claim **9** wherein said disc like member is a gear.

11. The combination as specified in claim **10** wherein said control means includes a second gear meshing with said first gear, said second gear driving a control member, said control member having means thereon which will vary the controlled function in proportion to the amount of rotation of said second gear from a normal position.

12. The combination as specified in claim **7** wherein said bias means on said control rods comprise linearly actuated springs connected between said housing and said control rod.

13. The combination as specified in claim **12** wherein the control member comprises a center tap rotary potentiometer.

14. The combination as specified in claim **7** wherein the switch means have portions which act as stop means

for said rods to prevent movement of said rods under urging of the bias means past a predetermined position.

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R. A. VANDERHYE, Assistant Examiner

U.S. Cl. X.R.

74—102, 470; 338—162

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,539,748 Dated November 10, 1970

Inventor(s) Karl E. Neumeier

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 13, Line 1 change "Claim 12" to --Claim 11--

(Application, Claim 14).

SIGNED AND
SEALED
MAR 2 1971

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents