July 8, 1947. J. EATON 2,423,693

REVERSAL RESPONSIVE SWITCH

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Fig. 1.

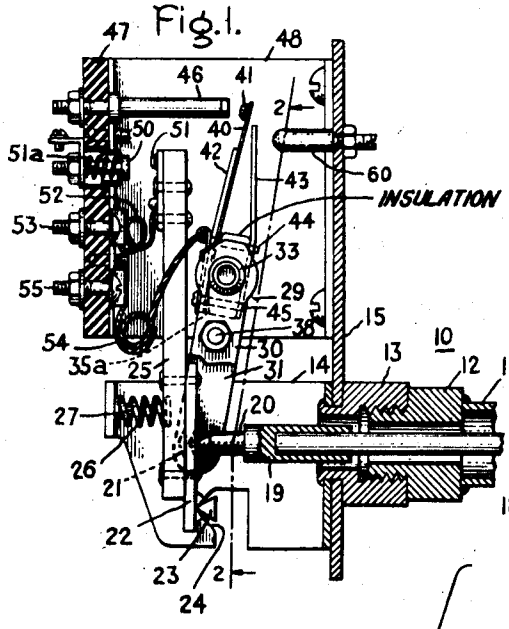


Fig. 2.

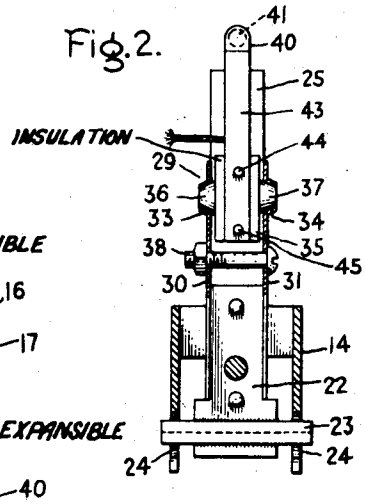


Fig. 3.

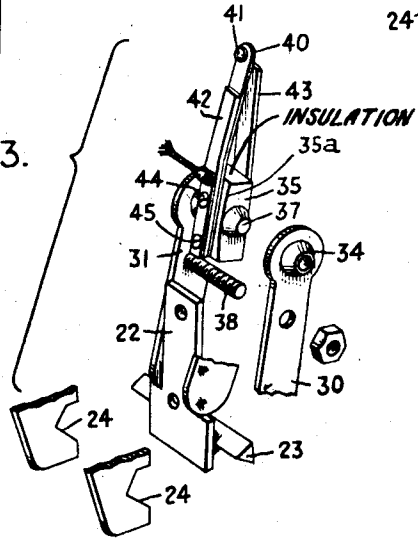
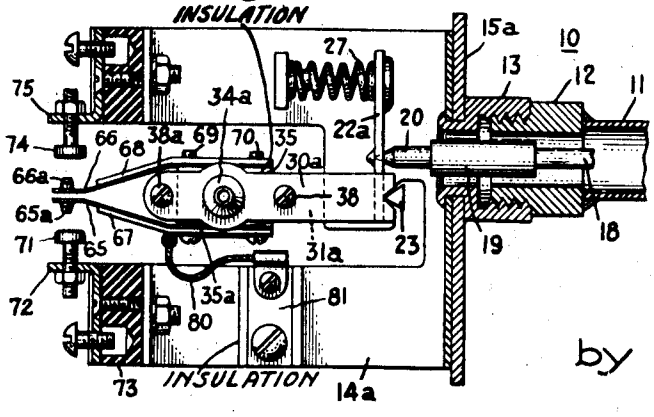


Fig. 4.



Inventor:
John Eaton,
by Harry E. Dunham
His Attorney.

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REVERSAL RESPONSIVE SWITCH

John Eaton, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

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10 Claims. (Cl. 200—137)

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The invention relates to reversal responsive switches, particularly of the type employing a slip friction clutch in operating the switch to oppositely control a circuit or circuits in response to reverse movements of the switch actuator. Such reversal responsive slip switches ordinarily are provided with an automatic actuating element responsive to variations in some widely variable condition, such as temperature or the like, and thus are adapted for use in the automatic control of electrically operated burners as a combustion detector or regulator or in other similar service where it is necessary to detect or control in accordance with the reversals of some essential but widely variable condition.

The principal object is an improved form of friction clutch reversal responsive slip switch whereby more accurate and reliable reversal responsive circuit control may be obtained.

More specific objects are to provide an improved and more reliable complementary tapering pivotal bearing clamping form of slip clutch mechanism wherein the slip friction may be readily adjusted and maintained; to provide an improved form of resilient variable wipe switch contact structure for adjustably cooperating with the improved slip clutch mechanism to control the reversal thereof required to effect circuit controlling actuation of the switch; and to provide an improved slip friction clutch adjustable wipe switch structure that is adapted for either single or double circuit control service and requires only a few cooperating adjustable parts that can be readily manufactured, adjusted, and replaced in service.

Further objects and advantages of the invention will appear in the description of the accompanying drawings in which Fig. 1 is a side view, partly in section, of a friction slip clutch wipe switch structure embodying the improvements of the present invention; Fig. 2 is a partial sectional view along the dash line 2—2 of Fig. 1 revealing more clearly the structure of the improved complementary tapering bearing clamping adjustable slip clutch mechanism; Fig. 3 is a perspective view of the movable switch parts shown in Figs. 1 and 2 with some of the parts broken away and disassembled in order more clearly to reveal the structural details; and Fig. 4 is a side view partly in section of a modified form of the slip clutch switch structure shown in Figs. 1, 2 and 3, adapted for double circuit control service.

The improved reversal responsive slip clutch switch of Fig. 1 is shown provided with an automatic temperature responsive actuator 10 of the

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expansible tube and rod type, and may be adapted for stoker hold-fire control service, as more fully described and claimed in my copending application Serial No. 575,133 filed concurrently herewith. It will be understood, however, that other suitable forms of condition responsive actuators may be employed if desired. As shown, the expansible tube 11 is provided with an annular mounting head 12 detachably screw threaded into the mounting boss 13 which may be peened over, as shown, to secure the pivot frame 14 to the main mounting plate 15. The outer end of expansible tube 11 carries a sealing head 16 provided with the recess 17 for seating one end of the relatively non-expansible rod 18. The other end of rod 18 is inserted into a tubular member 19 from which the pointed actuating pin 20 projects. Thus when tube 11 is subjected to opposite temperature variations, such as may result from variations in the combustion of a stoker, the difference in expansion and contraction between the expansible tube 11 and the relatively non-expansible rod 18 becomes effective to oppositely or reversely move the actuating pin 20.

The pointed end of pin 20 engages with a conical seat or depression 21 formed in the pivoted switch operating arm 22 which is provided at its lower end with a knife-edge pivot bearing bar 23. This bar 23 may be secured to the arm 22 directly by welding, as indicated, with the ends of the bar 23 extending beyond or overlapping the sides of the arm 22 so as to engage with the spaced apart open pivot seats 24 formed in the pivot frame 14, as more clearly shown in Fig. 2.

The pivoted switch operating arm 22, in the particular form of switch structure shown in Fig. 1, carries an auxiliary switch arm 25 and a compression spring 26 having one end seated over the pin 27 carried by the frame 14 and has its other end engaging with the arm 25 so as to exert pressure on the switch arm 22 that tends to maintain the pivot bar 23 in proper seating alignment with its open pivot seats 24 as well as the pointed end of pin 20 in firm operating engagement with its conical seat or depression 21. Thus the compression spring 26 takes up lost motion in the actuator parts and the removal of this spring enables all parts to be disassembled readily for inspection, repair, or replacement.

The improved complementary tapering bearing clamping slip clutch mechanism 29 comprises two spaced apart substantially parallel clutch extensions 30 and 31 formed of somewhat resilient material and secured at their lower ends, to the sides of the pivoted switch operating arm

22, preferably by spot or line welding, and provided at their free ends with the outwardly tapering bearings 33 and 34 in opposing alignment, as more clearly shown in Figs. 2 and 3. The cooperating friction block 35 is formed preferably of suitable moulded insulating material and provided with the opposite complementary outwardly tapering trunnions 36 and 37 for frictionally engaging with the tapering bearing seats 33 and 34 of the resilient clutch extensions 30 and 31 so as to frictionally clamp the insulating block 35 against rotation therebetween. The friction clamping load on the trunnion block 35 is adjusted by tightening or loosening the friction control bolt 38 so as to press the tapering bearings 33, 34 with greater or less force against the tapering trunnions 36, 37 of the block. In this way, the force required to overcome the friction and effect slip rotation of the block 35 in its bearings may be accurately adjusted to a desired value which, with the improved complementary opposite tapering pivotal bearing clamping construction, will be maintained over a long period of service.

The movable switch arm 40 carried by block 35 is formed of resilient material and carries the movable contact 41 at its upper end into and out of abutting engagement with the cooperating stationary contact 46. The switch arm 40, together with the pair of stop members or arms 42 and 43 that serve to limit the resilient movements of the switch arm 40 therebetween, are clamped for relative adjustment on the trunnion block 35 by means of the two clamping screws 44 and 45. In order to provide for adjustment of the switch arm 40 and its normal abutting limit stop 42 relative to the spaced apart resilient motion limit stop 43, one face 35*a* of the trunnion block 35 may be slightly rounded so as to serve as an adjusting pivot, as indicated in Fig. 1 and as more clearly shown in Fig. 3, or other suitable means for pivotally mounting these parts for relative adjustment may be provided. Thus, by loosening the screw 44 and tightening the screw 45, or vice versa, the free space between the stops 42 and 43 may be increased or decreased. In either case, even though the trunnion block 35 should be reversely assembled with the rounded face 35*a* pivotally mounting the stop 43, when the space between these stops is increased, then the resilient movement of the switch arm 40 therebetween is correspondingly increased, and vice versa. As pointed out more fully hereinafter, the amount of resilient movement of the resilient switch arm 40 predetermines the wipe of contact 41 with the cooperating stationary contact 46 and, at the same time, predetermines the reverse movement of switch arm 22 required to slip the friction clutch 29 after the limited resilient movement of the switch arm 40 dependent upon the relative adjustment of the limit stops 42 and 43, has occurred.

The stationary contact 46 may be adjustably mounted in the insulating panel 47 carried by the frame 48 in opposing spaced apart relation with the main mounting plate 15. Likewise, a stationary contact 50 may be adjustably mounted on the insulating panel 47 in cooperating relation with the movable contact 51 that is carried on the auxiliary switch arm 25. A flexible lead 52 connects the movable contact 51 with the stationary terminal 53. Likewise, a flexible lead 54 connects the movable resilient switch member 40 with terminal 55.

Operation of Fig. 1

With the parts in their respective positions shown in Fig. 1, a decrease in the temperature to which tube 11 is subjected will result in a contraction thereof which will be transmitted through the relatively nonexpansible rod 18 and the pointed operating pin 20 to rotate the switch operating arm 22 about the knife-edge pivot bearing provided by bar 23 in a counterclockwise direction. Thus upon movement of pin 20 to the left due to contraction of the temperature responsive tube 11, the ends of bar 23 are more firmly pressed against notches 24 as the spring 26 is further compressed. As a result arm 22 along with bar 23 pivot about the notches 24 and at the same time the conical seat 21 formed in arm 22 for receiving the pointed end of pin 20 readily enables the change in the angular relation between pin 20 and arm 22 to be effected. Upon movement of pin 20 in the opposite direction, a reverse pivotal movement of arm 22 is produced by spring 26. Initially all the clutch and movable switch parts are carried as a unit with operating arm 22. Thus the trunnion block 35 is carried bodily along by the friction clamping extensions 30 and 31 to move the contact 41 on the end of the switch arm 40 into engagement with the stationary contact 46. As the contraction of tube 11 continues, switch arm 40 is flexed away from its adjacent stop 42 and into engagement with the resilient movement limit stop 43. Such flexure of the resilient switch arm 40 provides a contact wipe that is predetermined by the relative adjustment of the stops 42 and 43. Upon engagement of the flexed arm 40 with limit stop 43, further flexing of arm 40 is stopped, and the resulting increase in contact pressure between the movable contact 41 and the stationary contact 46 is then transmitted through the resilient movement limit stop arm 43 to overcome the friction load of the slip clutch mechanism and thereby produce slip rotation of the trunnion block 35 in its bearings 33 and 34. The slip rotation of the trunnion block 35 will continue as the tube 11 continues to contract and in this way the auxiliary switch contacts 50 and 51 will be brought into engagement when a predetermined contraction of the tube 11 occurs. Any further overrunning of the temperature will cause spring 51*a* to yield.

When the variation of the temperature to which the tube 11 is subjected becomes reversed, the separation of the auxiliary contacts 50 and 51 is the first thing that occurs. However, movable contact 41 is maintained in wiping engagement with the stationary contact 46 due to the strain or bias of the resilient switch arm 40 until the adjacent limit stop 42 engages with the resilient switch arm 40. Thereupon, contact 41 is separated from contact 46 and all parts of the slip clutch mechanism and the adjustable wipe contact mechanism again will move as a unit with the switch operating arm 22. This unitary movement of all the parts will continue until the stop 40 engages with the adjustable reverse slip stop 60 carried by the main mounting plate 15. Thereupon further motion of arm 40 is arrested, and hence the trunnion block 35 necessarily will reversely slip in its bearings 33, 34 during further expansion of the tube 11. In this way, the trunnion block 35 along with the switch arm 40 may be returned to the same relative position with respect to the switch arm 22 and the extensions 30 and 31 in which it is shown in Fig. 1,

or to some other relative position depending entirely upon the amount of reverse slip of the clutch mechanism 29 due to the expansion or overtravel of the tube 11. In any case, a subsequent reversal in the temperature to which the tube 11 is subjected will, after a predetermined reverse movement determined by the adjustment of the reverse slip stop 60, again operate the contact 41 of the movable switch member 40 into engagement with the stationary contact 46 in the manner previously described.

Thus, it will be seen that the adjustment of the reverse slip stop 60 predetermines the amount of reverse movement of the switch operator required to effect circuit closing engagement of the contacts 41 and 46, while the relative adjustment of the resilient motion limiting stops 42, 43 serves to predetermine the reverse movement of the actuator required to effect circuit opening disengagement of the contacts 41 and 46.

In case the contact wipe stops 42 and 43 should be adjusted so as to provide for a materially increased resilient movement of the switch arm 40 with a resultant increased wipe of the contacts 41 and 46, an increased contact wiping pressure will be exerted due to the increased flexing of the switch arm 40. Since for long service it is desirable that the friction load of the slip clutch mechanism should be adjusted so as to be only slightly in excess of the resilient contact wiping pressure, the proper adjustment of the slip friction load can be obtained by adjusting bolt 38. In case the clutch friction load is too low, the spring force exerted by the resilient switch arm 40 upon engagement with contact 46 might of itself become sufficient to slip the clutch 29 before the switch arm 40 engages with the resilient motion limiting stop 43 and thereby destroy the accuracy of the reversal responsive control. On the other hand, if the friction clutch load is made too large, then the resulting clutch wear may become excessive.

The modified form of reversal responsive slip clutch double circuit controlling switch shown in Fig. 4 is particularly adapted for service as an oil burner flame detector. The switch actuating arm 22*a* is pivotally mounted in the same way as arm 22 in Fig. 2 and has the resilient clutch extensions 30*a* and 31*a* secured thereto so as to extend substantially in alignment with the actuator tube 11 and rod 18. In this double circuit controlling modification, the trunnion friction block 35 is provided with a pair of reversed resilient switch arms 65, 66, each of which is biased into engagement with a corresponding adjacent stop arm 67, 68 and these parts are mounted for relative adjustment on the block 35 by means of the adjusting screws 69, 70 in substantially the same way as previously described. Thus, by a selective tightening and loosening of the screws, a relative adjustment of the switch arms 65, 66, together with their cooperating limit stops 67, 68 may be obtained due to the pivoting action on the rounded face 35*a* so as to increase or decrease the free space between the contact ends of the switch arms and thus the contact wiping movement of each switch arm.

The adjustable mounting of the reversed switch arms 65, 66 on the trunnion block 35 enables a double reversal responsive circuit control to be obtained. For this purpose, the stationary contact 71 cooperating with the contact 65*a* is adjustably mounted in the bracket 72 carried by the insulating block 73 on a modified form of pivot frame 15*a*. Likewise, the adjustable contact 74 cooperating with the movable contact 66*a* is similarly adjustably mounted on the bracket 75.

Operation of Fig. 4

With the switch parts in their respective positions shown in Fig. 4, an increase in the temperature to which the expansible tube 11 is subjected will move actuating pin 20 to the right. Consequently, the compression spring 27 will rotate the arm 22*a* in a clockwise direction about the knife-edge pivot provided by bar 23 to carry the trunnion block 35 with the pair of reversed resilient switch members 64*a* and 65*a* and the stops 67 and 68 as a unit clamped between the pair of resilient extensions 30*a* until the switch contact 66*a* engages with the cooperating contact 74. Thereupon the resilient arm 66 is flexed by the continued unitary movement of the trunnion block 35 until the arm 66 engages with the arm 65 which limits the resilient movement of the arm 66. Thereupon the increased contact pressure between the contacts 66*a* and 74 will be transmitted through arm 65 and stop 67 to slip the trunnion block 35 in the friction bearings 34*a* formed in the extensions 30*a*. The extent of such slipping of the trunnion block 35 will vary depending upon the extent of the variation of the temperature to which the tube 11 is subjected.

When a reverse variation of the temperature of tube 11 occurs, the contact 66*a* is maintained in engagement with the contact 74 due to the bias of resilient arm 66 until the stop arm 68 is engaged thereby. Thereupon contact 66*a* is separated from contact 74 and the moving contact and slip clutch parts are then carried as a unit along with the extensions 30*a* and the actuating member 22*a* in a counterclockwise direction about the pivot provided by the knife-edge bearing bar 23. As the reverse variation of the temperature of the tube 11 continues, contact 65*a* will be brought into abutting engagement with the contact 71 and the resilient arm 65 will flex into engagement with the arm 66 and thereby transmit force through the stop 68 to reversely slip the trunnion block 35 an amount dependent upon the extent of variation of the temperature of the tube 11.

Upon a subsequent reversal in the temperature of tube 11, the bias of resilient arm 65 will maintain contact 65*a* in wiping engagement with the contact 71 until the stop 67 engages with the resilient arm 65. Thereupon contact 65*a* is separated from the contact 71.

With both of the movable contacts 66*a* and 65*a* electrically connected through the flexible shunt 80 to the wiring terminal 81 which is suitably insulated from the auxiliary frame 14*a*, a double reversal responsive circuit controlling action suitable for oil burner safety flame detecting service is obtained by the engagement and disengagement of the movable switch contacts with the two spaced apart stationary contacts in response to the reversal in the variations of the oil burner flame temperature to which the tube 11 may be subjected. In each case, a wiping of the switch contacts is provided and this wiping may be varied by relative adjustment of the parts to increase or decrease the distance between the reversed resilient switch arms 64*a* and 65*a*. Accurate adjustment of the friction load required to slip the trunnion to slip the trunnion block 35 is obtained by means of the two adjusting screws 38 and 38*a*, both of which serve to vary the clamping action of the two resilient extensions

36a on the tapering trunnions of the trunnion block 35.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A reversal responsive switch having, in combination, a pair of switch contacts, a resilient arm for carrying one of said contacts into and out of abutting engagement with the other of said contacts, a stop for limiting the resilient movement of said arm upon engagement of said contacts, an insulating block having adjustable means for mounting said arm and stop for relative adjustment thereon to predetermine said resilient movement, and a variable condition responsive operating element for reversely moving said block and having a pair of slip friction bearing members adjustably clamping said block therebetween to effect said predetermined resilient movement of said arm before slipping relative to said block.

2. A reversal responsive circuit controlling switch having, in combination, a reversely movable operating member, a resilient switch arm having an adjustable slip friction connection with said member and provided with a relatively adjustable stop for limiting the relative flexing movement of said arm, and means for slipping said connection including a contact for engaging in abutment with and flexing said switch arm into engagement with said relatively adjustable stop to slip said connection upon movement of said operating member in one direction and thereby regulate the subsequent reverse movement of said operating member required to disengage said switch arm from abutment with said contact.

3. A reversal responsive switch having, in combination, an adjustable contact, a cooperating movable contact, a resilient arm carrying said movable contact at one end thereof into and out of abutting engagement with said adjustable contact, a stop for limiting the resilient movement of said arm upon engagement of said contacts, an insulating mounting block having oppositely tapered bearings for pivotally supporting the other end of said arm and having adjustable means for mounting said arm and stop for relative adjustment thereon to predetermine said resilient movement, an operating element for reversely moving said block and having a pair of adjustable resilient extensions provided with complementary tapered bearings for frictionally clamping said oppositely tapered bearings of said block therebetween to effect said predetermined resilient movement of said arm before slipping in one direction, and stop means for limiting the reverse movement of said movable contact out of engagement with said stationary contact to reversely slip said trunnions.

4. A reversal responsive control switch having, in combination, a pair of circuit controlling contacts, a movable switch arm of resilient conducting material carrying one of said contacts adjacent one end thereof, an insulating mounting block for the other end of said arm, an operating element having oppositely tapered bearings means for pivotally supporting and frictionally clamping said block to slip relatively thereto, and means including a pair of relatively adjustable stops carried by said block on opposite sides of said resilient switch arm for limiting the resilient relative movement of said one end of said arm to provide a predetermined wipe for said contacts before slipping said block.

5. A reversal responsive switch having, in combination, a pair of switch contacts, a relatively movable resilient arm for carrying one of said contacts into and out of abutting engagement with the other, a stop for limiting the resilient relative movement of said arm upon engagement of said contacts, operating means having relatively movable slip clutch members, one formed of insulating material and provided with adjustable means for mounting said arm and stop for relative adjustment thereon to predetermine the resilient relative movement of said arm after engagement of said contacts and the other having adjustable means for frictionally clamping said one member to prevent relative movement thereof in one direction until after said resilient relative movement of said arm, and separate stop means for engaging said resilient movement limit stop to effect relative movement of said slip clutch members in the other direction upon a predetermined separation of said contacts.

6. A reversal responsive switch having, in combination, a pair of switch contacts, a movable resilient arm for carrying one of said contacts at one end thereof into wiping engagement with the other, an insulating mounting block for said arm having opposite tapering bearings and adjustable means for pivotally mounting the other end of said switch arm on said block, operating means including a pivoted member having a pair of movable arms provided with complementary tapering bearings for pivotally mounting and frictionally clamping said oppositely tapered bearings to slip therebetween, and means including a pair of adjustable stop members for clamping said other end of said switch arm and said block in adjustable pivotal engagement and extending therefrom for adjustably limiting the resilient relative movement of said one end of said arm to wipe said contacts and thereafter slip said bearings.

7. A reversal responsive switch having, in combination, a stationary contact, a cooperating movable contact, a resilient wipe arm for carrying said movable contact into and out of abutting engagement with said stationary contact, a pair of stop arms for limiting the resilient wipe movement of said arm therebetween upon engagement of said contacts, an insulating mounting block having adjustable pivot means for mounting said wipe arm and stop arms for relative adjustment thereon to predetermine said resilient wipe movement, operating means having a pivoted element provided with a pair of adjustable resilient bearing arms pivotally supporting and frictionally clamping said block to effect said predetermined resilient wipe movement of said arm before slipping said block, and adjustable means for varying said clamping friction.

8. A reversal responsive switch having, in combination, a reversed pair of relatively movable resilient switch arms, each having one of different pairs of wiping contacts adjacent one end thereof, an insulating mounting block between the other ends of said arms, a reversely movable operating element having means frictionally clamping said block to slip relative thereto, and adjustable stop means for clamping said arms to said block and for limiting the relative resilient movement of said arms upon wiping said different pairs of contacts to slip said block.

9. A reversal responsive switch having, in combination, a reversely movable operating member, a pair of opposing resilient switch arms having a common slip friction connection with said member and each provided with an adjustable stop for limiting the flexing movement of said arms in a corresponding direction, and means for reverse-

ly slipping said connection including a pair of contacts each for engaging with and flexing a corresponding one of said switch arms into engagement with the other arm upon movement of said operating member in the corresponding direction to predetermine the reverse movement of said operating member required to disengage said one switch arm from the corresponding contact.

10. A reversal responsive switch having, in combination, a reversely movable operator having a pair of adjustable friction clamping members, a pair of resilient switch elements having an insulating mounting block provided with pivotal bearing means carried between said clamping members, a pair of relatively adjustable stops carried by said block for limiting the flexing movement of said arms therebetween, and means for reversely slipping said block including a pair of adjustable contacts each for engaging with and flexing a corresponding one of said switch elements into engagement with the other upon a predetermined reverse movement of said operating member.

JOHN EATON.

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