

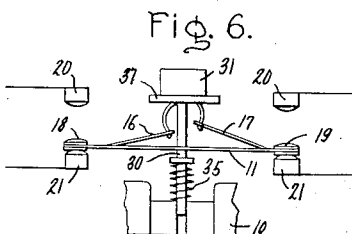
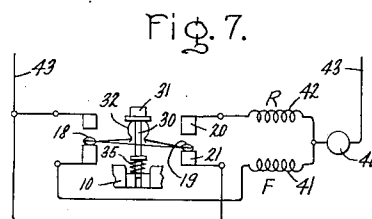
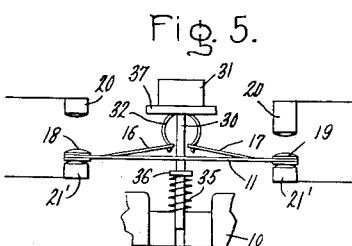
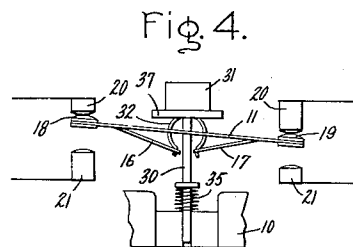
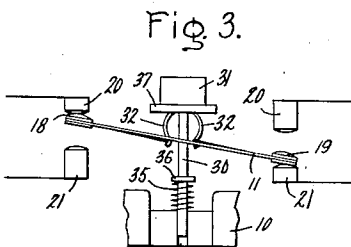
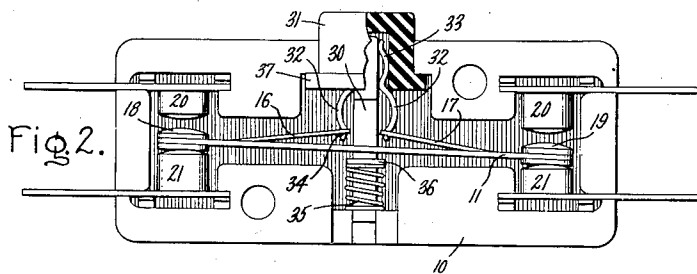
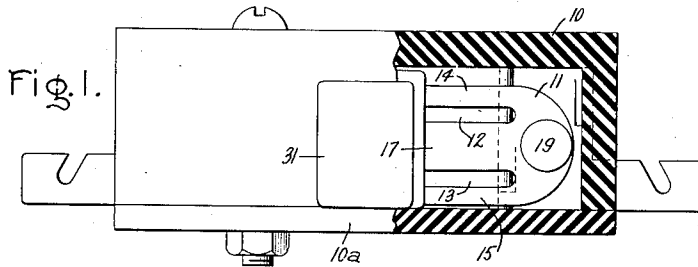
Oct. 10, 1944.

G. M. HAUSLER

2,360,128

SNAP-ACTION DEVICE

Filed March 12, 1943



Inventor:
George M. Hausler,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,360,128

SNAP-ACTION DEVICE

George M. Hausler, Ballston Lake, N. Y., assignor
to General Electric Company, a corporation of
New York

Application March 12, 1943, Serial No. 478,927

11 Claims. (Cl. 74-100)

My invention relates to snap-action devices, and more particularly to snap-acting switches of the sequence type and the like and has for its object the provision of a simple and reliable device of this character which has a minimum number of parts and which is inexpensive to manufacture.

In carrying out my invention I support upon a reciprocable actuating member a switch member comprising a pair of compression arms pivotally mounted on opposite sides of the actuating member and extending in opposite directions therefrom and a tension member connected between the free ends of the compression members to permit overcenter movement of the pivoted ends of the compression members with respect to the plane of the tension member, copending application. Preferably, the switch member comprises a single unitary strip of spring material slotted to provide a pair of outer tension arms and a central pair of spaced-apart compression arms juxtaposed in opposing relation such as described and claimed in my copending application, Serial No. 435,220, filed March 18, 1942. The juxtaposed inner ends of the compression arms are pivotally mounted upon the reciprocable actuating member which is arranged to move the pivoted ends of the compression arms over center with respect to the plane of the strip, thereby to move the outer ends of the strip in the opposite direction with a snap action. The outer ends of the strip and the actuating member are provided with suitable stops to limit the movement of the various parts of the device. A pair of stops is provided for limiting movement of the outer ends of the spring strip in each direction and in order to render the overcenter movement of the outer ends of the spring strip non-simultaneous or sequential in any desired order, one or both of these pairs of limiting stops may be displaced longitudinally of the direction of movement of the actuating member so that a line drawn between one or both pairs of stops is slightly inclined with respect to the direction of movement of the actuating member. According to another form of the invention sequential overcenter movement of the compression arms and hence sequential snap action of the opposite ends of the strip is attained by pivoting the compression arms upon the actuating member at different perpendicular distances from the plane of the tension arms.

Such a device may be built in very small sizes and, when used to actuate the contacts of an electric switch, the switch possesses remarkable

interrupting capacity for both alternating and direct current in comparison to its physical dimensions. The switch is suitable for precision work, since movement of the actuating member required to effect circuit making or circuit breaking movement of the contacts at the outer ends of the spring strip is quite small and remains substantially constant. For example, in a typical switching device in which the switch member of spring material was approximately one inch in length, the actuating movement was approximately $\frac{1}{4}$ of an inch and was found to be substantially invariable after many thousands of operations. In this device the contact movement was of the order of only $\frac{1}{400}$ of an inch; yet this switch successfully made the circuit of a $\frac{1}{2}$ horsepower stalled rotor capacitor motor and interrupted the full load running current of the motor thousands of times.

For a more complete understanding of my invention and for a further appreciation of its objects and advantages, reference should now be had to the following detailed specification taken in conjunction with the accompanying drawing in which Fig. 1 is a plan view partly in section of a snap-action electric switch embodying my invention; Fig. 2 is a side elevation, partly in section, of the device shown at Fig. 1 with the cover removed; Figs. 3 and 4 are simplified diagrams of the snap-action switch of Figs. 1 and 2 showing various phases of the operation; Figs. 5 and 6 are simplified diagrams illustrating other embodiments of the invention; and Fig. 7 is a simplified circuit diagram of a motor control circuit illustrating a typical application of the electric switch shown at Figs. 1-4 inclusive.

Referring now to the drawing, I have shown my invention applied to a push-button operated snap-action switch of the type described and claimed in my copending application, Serial No. 435,220, filed March 18, 1942 and assigned to the same assignee as the instant application. The switch is mounted in a casing 10 of suitable configuration which is preferably made of a molded insulating compound and provided with a cover 10a. The switch member itself is a unitary flat strip of spring material 11, slotted at 12 and 13 to provide a pair of outer tension arms 14 and 15 and a central pair of opposing compression arms 16 and 17. The compression members 16 and 17 are deformable and are formed by dividing a single central arm transversely in the region of its center so that the inner ends of the arms 16 and 17 are juxtaposed

in spaced relation. At opposite outer ends of the strip 11 are mounted movable contact members 18 and 19.

Two pairs of fixed contact members 20 and 21 are disposed adjacent the movable contacts 18 and 19 for engagement with the movable contacts to limit their movement in opposite directions longitudinally of a reciprocable actuating and supporting member. The actuating and supporting member comprises a shank portion or rod 30, a moulded head portion 31 and a pair of bowed spring strips 32.

Each pair of fixed contact members 20 and 21 is arranged for engagement with the movable contacts 18 and 19 in one of the two positions of equilibrium of the spring strip 11. To provide for sequential actuation of the movable contacts 18 and 19 upon movement of the reciprocable member 30, the contacts of each pair of fixed contacts 20 and 21 are displaced longitudinally of the direction of movement of the member 30, so that a line drawn between each pair of fixed contacts, such as a line drawn between the contact surfaces of the pair of fixed contacts 20, will be inclined with respect to the direction of motion of the reciprocable actuating member 30, 31, 32. It will be understood that the contacts of each pair of fixed contacts 20 and 21 adjacent the same end of the spring strip 11 are spaced apart to permit movement of the associated movable contact 18 or 19 therebetween. In the form of the invention shown at Figs. 1-4, inclusive, and Fig. 6, the spacing between the fixed contacts at each end of the spring strip 11 is the same, so that the lines drawn between the contact surfaces of each pair of fixed contacts will be parallel and hence, similarly inclined with respect to the direction of motion of the rectilinearly movable actuating member 30, 31, 32.

The actuating and supporting rod 30 is slidably supported in the casing 10 for movement of the juxtaposed pivoted inner ends of the compression arms 16 and 17 overcenter with respect to the plane of the spring strip 11. The actuating member 30, 31, 32 may be arranged for manual push button operation by extension of the head portion 31 through a suitable aperture in the casing 10. In the form of the invention shown, the actuating member also comprises the pair of bowed spring strips 32 clamped between the actuating rod 30 and the push-button head 31. The spring strips 32 are provided with slightly curved base sections 33 arranged for insertion in suitable slots in the push-button head portion 31 in clamping relation between the actuating rod 30 and the push-button head 31. The portions 33 of the springs 32 serve frictionally to attach the head portion 31 to the actuating rod 30 and to attach the spring strips 32 to the actuating member. Each of the spring strips 32 is notched at its lower end, as at 34, pivotally to support one of the juxtaposed inner ends of the deformable compression members 16 and 17. The springs 32 are biased outwardly to apply endwise forces to the members 16 and 17, thereby to bend and spread the members 16 and 17. The notched ends of the spring strips 32 provide a pivotal supporting and actuating connection between the actuating member 30, 31, 32 and the resilient switch member 11. The normal spacing between the pivotal notches 34 in the actuating member is greater than the space between the juxtaposed ends of the members 16 and 17 in the plane of the spring strip 11. It will of course be under-

stood that, if desired, the springs 32 may be made integral, as in the form of a resilient yoke bridging the gap between the juxtaposed inner ends of the compression members 16 and 17.

The push-button actuating member is preferably biased to the position shown in Fig. 1 by means of a small compression spring 35, one end of which engages a portion of the casing 10 and the other end of which engages a shoulder 36 formed on the actuating rod 30. The movement of the push button in both directions is limited by suitable stops. As shown in the drawing, upward movement of the push button is limited by engagement of a peripheral flange 37 on the head portion 31 of the actuating member with the casing 10. Downward movement of the push button is limited by the limit of compression of the spring 35 between the shoulder 36 and the base of the casing 10.

With the foregoing understanding of the constructional features of my snap-action switch, the mode of operation of the switch will be clear from the following brief description. Referring now particularly to Figs. 1, 2, 3 and 4, the switch is shown at Fig. 2 in its normal position with the actuating member 30, 31, 32 biased upwardly by the spring 35 and the contacts 18 and 19 in engagement with the lower pair of stationary contacts 21. If now the actuating rod 30 is depressed by pushing downwardly upon the head portion 31 of the actuating member, the compression arms 16 and 17 of the resilient switch member 11 will be forced over center in sequential relation with respect to the plane of the tension arms 14 and 15. Such over-center movement will be accomplished partly by the deformation of the spring strips 32 against their outward or spreading bias and partially by deformation of the resilient compression arms 16 and 17 themselves.

It will be noted from Fig. 2 that the plane of the tension arms 14 and 15 is inclined with respect to the direction of motion of the actuating member 30, 31, 32 by reason of the fact that the contact points of the two stationary contacts 21 define a line which is so inclined. Because of this inclination of the plane of the tension members 14 and 15, the pivoted end of the compression arm 16 will pass overcenter with respect to this plane prior to a like overcenter movement of the pivoted end of the compression arm 17. As soon as the pivoted inner end of the compression arm 16 passes overcenter, the outer or free end of this compression arm carrying the movable contact 18 will move in the opposite direction, in this case upwardly, with a snap action under the influence of the compression member 16 and the associated spring 32. At Fig. 3 I have shown the switch in this intermediate position where the compression arm 16, which is first to pass overcenter, has raised the movable contact 18 to its upper position, while the pivoted end of the compression arm 17 has not yet passed the plane of the tension members 14 and 15 in its downward movement. A further depression of the actuating member 30 will effect overcenter movement of the pivoted inner end of the compression arm 17, thereby to raise the movable contact 19 to its upper position with a snap action. The final position of the switch, upon downward movement of the actuating member 30, is shown at Fig. 4.

It will be appreciated from the foregoing description that it is the inclination of the plane

of the tension members 14 and 15 with respect to the direction of movement of the actuating rod 30 which causes the pivoted end of one of the compression arms to move overcenter prior to overcenter movement of the pivoted end of the other compression arm. It will also be evident from Fig. 3 that the upward snapping movement of the first movable contact 18 changes the inclination of the plane of the tension members 14 and 15 and, therefore, moves the plane of the tension members nearer to the pivoted inner end of the compression arm 17 which has not yet moved over center. It is possible, if desired, to so orient the parts of the device that this change in the inclination of the plane of the tension members 14 and 15 by snapping movement of the first contact will of itself effect overcenter operation of the pivoted inner end of the compression arm 17, thereby to produce a very rapid sequential operation of the contacts without further downward movement of the actuating rod 30. On the other hand, the device may be so arranged that, as shown in Fig. 3, a slight additional downward movement of the actuating member is necessary in order to snap the second movable contact 19 to its upper position. In this case the switch member will be in equilibrium in the intermediate position of Fig. 3 as well as in the two opposite overcenter positions shown at Figs. 2 and 4.

Fig. 4 indicates that a certain amount of overtravel of the pivoted inner ends of the compression arms 16 and 17 is desirable after overcenter movement of the last of the compression arms. Such overtravel ensures positive engagement of the movable contacts 18 and 19 with the upper stationary contacts 20. However, any such additional downward movement of the actuating rod 30 must be limited, as by engagement of the turns of the spring 35 with each other, in order to prevent the actuating member from carrying the entire switch member 11 downwardly to such an extent that the movement of the contacts 18 and 19 is reversed, thereby to reengage the contact 21.

From the foregoing description of the operation of the devices of Figs. 1-4, inclusive, it will be evident that upon upward movement of the switch actuating member 30, 31, 32 under the influence of the compression spring 35, the compression arm 17 will pass over center prior to overcenter movement of the compression arm 16, so that the contact 19 will be actuated to its lower position before downward movement of the contact 18. Thus, upon reversal of the direction of motion of the actuating member 30, 31, 32 the sequential actuation of the movable contacts takes place in reversed order.

By way of illustration of a typical application of my sequential snap-action switch illustrated at Figs. 1-4, I have shown in Fig. 7 a circuit including such a switch for controlling a reversible direct current series motor. The motor includes an armature 40, a forward field exciting winding 41 and a reverse field exciting winding 42. The field exciting windings 41 and 42 are alternatively connected in series circuit relation with the armature 40 to a source of direct current supply 43 through the contacts 18 and 19 of a snap-action switch embodying my invention. As illustrated at Fig. 6, the circuit for the armature and forward field exciting winding 41 is completed through the movable contacts 18 and 19 and the upper pair of stationary contacts 20, while the circuit for the armature and reverse field exciting winding 42 is completed through the movable

contacts 18 and 19 and the lower pair of stationary contacts 21. When the switch is in its normal position, as shown at Fig. 6, the circuit for the forward field exciting winding 41 is completed. In operation, when the actuating member 30, 31, 32 is depressed, the movable contact 18 is first actuated to open the forward motoring circuit and the contact 19 is subsequently moved to its upper position to then complete the reverse motoring circuit. Similarly, upon upward movement of the actuating member 30, 31, 32 the reverse motoring circuit is first broken at the contact 19 before completion of the forward motoring circuit at the contact 18.

At Fig. 5, I have shown another embodiment of my invention in which the upper pair of stationary contacts 20 are relatively displaced longitudinally of the direction of movement of the actuating member 30 in the manner heretofore described, but in which the lower pair of stationary contacts 21' are so positioned that a line drawn between their contacting surfaces is perpendicular to the direction of movement of the actuating member 30, 31, 32. By this arrangement, it will be seen that sequential operation of the movable contacts is effected only upon upward movement of the actuating rod 30 to move the movable contacts 18 and 19 to their lower position. In the embodiment of Fig. 5, a downward movement of the actuating rod 30 will effect simultaneous overcenter movement of the pivoted inner ends of the compression members 16 and 17 and, therefore, a simultaneous upward actuation of the movable contacts 18 and 19.

Sequential snap action of the movable contacts 18 and 19 may also be effected by displacement of the pivot points of the compression arms 16 and 17 as well as by displacement of the stationary contacts or stops at the outer ends of the compression arms. At Fig. 6 I have shown an arrangement in which each pair of stationary contacts 20 and 21 are symmetrically positioned so that lines defined by the contact points of each pair of contacts are perpendicular to the direction of motion of the actuating member 30, 31, 32. At Fig. 6, however, the pivotal notches 34 in the springs 32 are displaced longitudinally of the actuating rod 30, so that the pivot points of the inner ends of the compression arms 16 and 17 are unequally spaced from the plane of the tension arms 14 and 15 in both overcenter equilibrium positions. It will be evident from the foregoing description of the operation of other embodiments of my invention that when the rod 30 of Fig. 6 is moved in either direction the pivot points of the compression arms will pass over center with respect to the plane of the tension arms in sequential relation and that the movable contacts 18 and 19 will be snapped in like sequential relation. It will, of course, be understood that if it is desired to render snapping movement of the contacts of a device such as that of Fig. 6 sequential in only one direction, one pair of fixed contacts or stops may be so displaced that they lie on a line drawn between the longitudinally displaced pivot points 34 for the compression members.

I wish to have it understood that when I refer in the appended claims to two "equilibrium positions" of the switch member, I mean the two opposite overcenter equilibrium positions, such as those of Figs. 2 and 4; rather than the optional intermediate position of equilibrium shown at Fig. 3.

While I have described only certain preferred

embodiments of my invention by way of illustration, many modifications will occur to those skilled in the art and I, therefore, wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

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

1. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted upon said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and fixed stop means arranged for limiting movement of said free ends of said compression members in each direction longitudinally of said reciprocable actuating member, thereby to provide two positions of stable equilibrium for said tension member, said stop means for limiting movement in at least one direction being so arranged that the distances between said tension member and the pivoted ends of said compression members are unequal in at least one position of equilibrium of said tension member, thereby to render overcenter movement of said compression members sequential in at least one direction.

2. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted upon said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and fixed stop means for limiting movement of said free ends of said compression members in each direction longitudinally of said reciprocable actuating member, thereby to provide two positions of stable equilibrium for said tension member, said stop means being so arranged that in each of said positions of stable equilibrium the distances between said tension member and the pivoted ends of said compression members are unequal, thereby to render overcenter movement of said compression members sequential.

3. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted upon said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and fixed stop means for limiting movement of said free ends of said compression members in each direction longitudinally of said reciprocable actuating member, said stop means for limiting movement in at least one direction including a pair of stop members disposed on opposite sides and displaced longitudinally of said actuating member, thereby to render overcenter movement of said pivoted ends of said compression members sequential.

4. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression

members pivotally mounted upon said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and fixed stop means for limiting movement of said free ends of said compression members in each direction longitudinally of said actuating member and thereby to provide two positions of stable equilibrium for said tension member, said stop means for limiting movement in at least one direction being so arranged that in one of said equilibrium positions said tension member is inclined with respect to the direction of movement of said actuating member, thereby to render overcenter movement of said pivoted ends of said compression members sequential.

5. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted upon said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and a pair of stop members for limiting movement of said free ends of said compression members in each direction longitudinally of said actuating member, the line between at least one of said pairs of stop members being inclined with respect to the direction of movement of said actuating member, thereby to render overcenter movement of said pivoted ends of said compression members sequential when the free ends of said compression members are held by said one pair of stops.

6. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted upon said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and a pair of stop members for limiting movement of said free ends of said compression members in each direction longitudinally of said reciprocable actuating member, the lines between each of said pairs of stop members being inclined with respect to the direction of movement of said actuating member, thereby to render overcenter movement of said pivoted ends of said compression members sequential in both directions of movement.

7. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted upon said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and a pair of stop members for limiting movement of said free ends of said compression members in each direction longitudinally of said reciprocable actuating member, the lines between said pairs of stop members being parallel and inclined with respect to the direction of movement

of said actuating member, thereby to render overcenter movement of said pivoted ends of said compression members and consequent snap-action of said free ends of said compression members sequential and in inverse order in opposite directions of movement.

8. A snap-action device comprising an integral flat strip of spring material slotted longitudinally to form a plurality of substantially parallel resilient arms connected together at opposite outer ends of said strip, one of said arms being divided transversely immediate its ends to provide a pair of spaced-apart opposing compression members having their inner ends in juxtaposition, an actuating and supporting member disposed between the juxtaposed ends of said compression members, said actuating member being wider between said juxtaposed ends of said compression members than the space between said ends and the plane of said strip, means for supporting said actuating member for limited reciprocal movement to move the juxtaposed ends of said compression members over center with respect to the plane of said strip, and stop means for limiting the movement of both outer ends of said strip in both directions longitudinally of the direction of movement of said actuating member to provide two positions of stable equilibrium of said strip, said stop means being so arranged that in at least one position of equilibrium the plane of said strip is inclined to the direction of movement of said actuating member.

9. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted at longitudinally displaced points along said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and fixed stop means for limiting movement of said free ends of said compression members, thereby to provide two positions of stable equilibrium for said tension member,

said stop means for limiting movement in at least one direction being so arranged that the distances between said tension member and the pivoted ends of said compression members are unequal in at least one position of equilibrium of said tension member, thereby to render overcenter movement of said compression member, sequential in at least one direction.

10. A snap-action device comprising a base, an actuating member mounted upon said base for limited reciprocal movement, a pair of compression members pivotally mounted at longitudinally displaced points along said actuating member and extending laterally in opposite directions therefrom, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and stop means for limiting movement of said free ends of said compression members in both directions longitudinally of the direction of movement of said actuating member, thereby to provide two positions of stable equilibrium of said tension member, said stop means being so arranged that in at least one of said positions of equilibrium said tension member lies perpendicular to said direction of movement of said actuating member.

11. A snap-action device comprising a base, an actuating rod mounted upon said base for limited reciprocal movement, a pair of compression arms pivotally mounted at longitudinally displaced points along said actuating rod and extending laterally therefrom in opposite directions, a tension member connected between the free ends of said compression members to permit overcenter movement of the pivoted ends of said compression members with respect to said tension member, and two pairs of fixed stop members for limiting movement of said tension member in opposite directions longitudinally of the direction of movement of said actuating member, at least one of said pairs of stop members being arranged to hold said tension member perpendicular to said actuating rod.

GEORGE M. HAUSLER.