June 10, 1941. G. B. MOROSS 2,244,958

VARIABLE ELECTRIC RESISTANCE DEVICE

Filed Feb. 1, 1939

Fig. 1

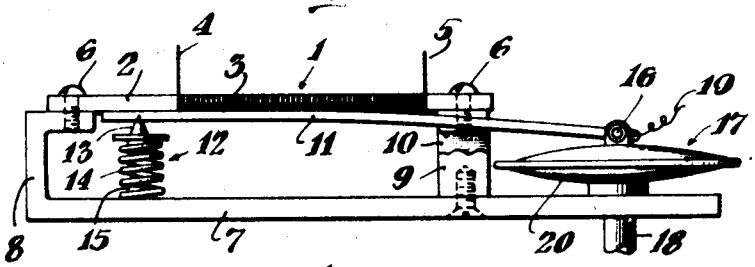


Fig. 2

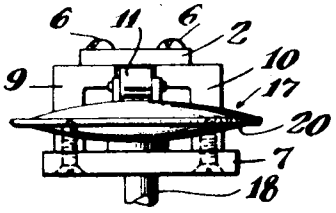


Fig. 3

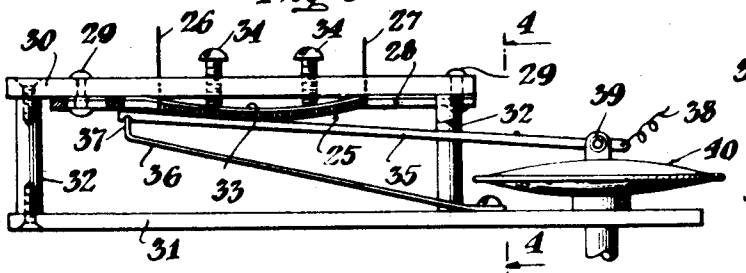


Fig. 4

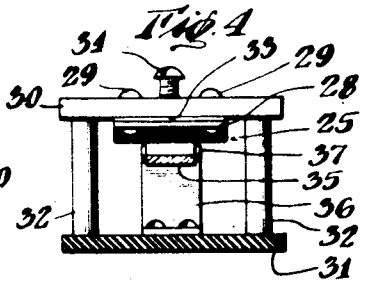


Fig. 5

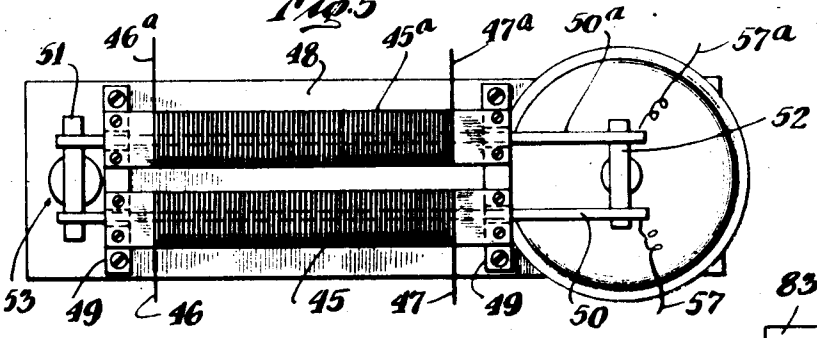


Fig. 8

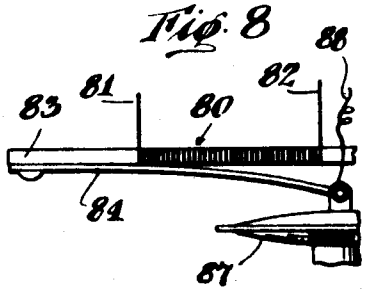


Fig. 6

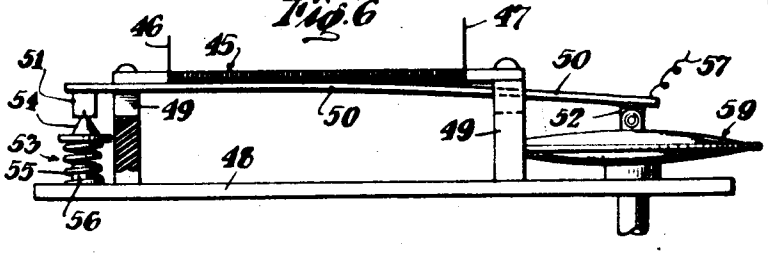
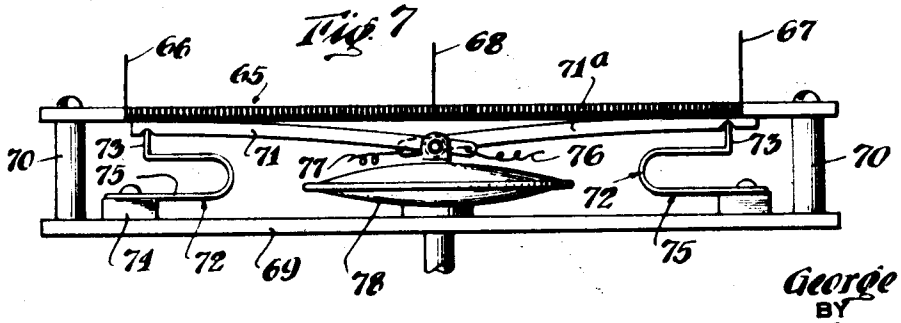


Fig. 7



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VARIABLE ELECTRIC RESISTANCE DEVICE

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3 Claims. (Cl. 201—55)

This invention relates to variable electric resistance devices of the type having a contact element movable on a resistance element for the purpose of varying the effective resistance of the device, and more particularly devices of this type which are suitable for automatic actuation.

In sensitive variable resistance devices such as are employed in controlling the current flowing in a circuit in an indicating or measuring instrument or the like, as for example, gauges for measuring manifold, gasoline or oil pressures, it is desirable that the contact element and the resistance element be relatively movable for varying the resistance, without substantial friction between these members. Furthermore, it is desirable that the contact element be maintained against the resistance element with sufficient contact pressure to prevent sparking and to maintain a low contact resistance. It is further desirable, especially where the available actuating pressure is low, that the device shall be of such construction as to be readily operable by relatively small forces.

According to the present invention, a resistance element of suitable construction, as for example, a wire wound resistance, a carbonaceous member, or the equivalent, is provided. A contact element is provided for establishing an adjustable contact with the resistance element. Actuating means, which in the present illustrative example, may be a fluid-pressure operated mechanism, is operatively connected to the contact element for moving relatively to the resistance element for the purpose of varying the effective resistance of the latter. The contact element is maintained in contact with the resistance element by resilient means which preferably also serve to resiliently oppose the action of the actuating means whereby to return the contact element to its initial position upon discontinuance or diminution of the actuating force.

An object of the present invention is the provision of a variable resistance device of the type described, including a resistance element and a contact element relatively movable for the purpose of varying the effective resistance of the resistance element, in which device the aforesaid relative movement is effected without undue friction.

Another object of the invention is the provision of a variable resistance device of the character described wherein the contact element and resistance element are relatively movable without undue friction, but sufficient slip is provided to maintain the surfaces of the contacting elements in clean condition.

Another object of the invention is the provision of a variable resistance device wherein the contact element is actuated in accordance with fluid pressure, the existence or extent of which it is desired to measure or employ in controlling the current in an electric circuit.

Still another object of the invention is the provision of a variable resistance of the type having a movable contact element adapted for automatic actuation to vary the effective resistance of the device wherein the device is capable of exerting a force opposing the action of the actuating means, which force varies according to the displacement of the contact element.

Still another object of the invention is the provision of a variable resistance device which is simple and rugged in construction, which is effective and accurate in operation and which is generally suitable for the purposes desired.

Various other features and advantages of the invention will be apparent from the following particular description and from an inspection of the accompanying drawing.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawing forming a part hereof, in which

Fig. 1 is a side elevational view of one form of variable resistance device constructed in accordance with the invention;

Fig. 2 is an end elevational view of the device shown in Fig. 1;

Fig. 3 is a side elevational view of a second embodiment of the invention and illustrating particularly a variable resistance device having an adjustable resistance element;

Fig. 4 is a transverse cross-sectional view taken along line 4—4 of Fig. 3;

Fig. 5 is a top plan view of a third embodiment of the invention and illustrating particularly a variable resistance device having a plurality of resistance elements and contact elements adapted to be operated as a unit;

Fig. 6 is a side elevational view of the device illustrated in Fig. 5;

Fig. 7 is a side elevational view of still another embodiment of the invention and illustrating

particularly another form of multiple variable resistance device; and

Fig. 8 is a fragmentary side elevational view of still another embodiment of the invention.

For the purposes of illustration, the present invention is disclosed in connection with several forms of variable resistance devices suitable for use in gauges for indicating fluid pressure, such as the manifold, gasoline or oil pressure of an internal combustion engine, such as commonly employed in aircraft, automobiles and the like, but it will be understood that the invention is capable of application to other uses. It will also be understood that, in certain cases, the desired relative movement between the contact element and resistance element in response to an actuating or impulse force can be effected in other ways than by the fluid-pressure responsive mechanism herein disclosed.

Referring now particularly to the embodiment of the invention illustrated in Figs. 1 and 2, the variable resistance device comprises a resistance element 1 which may be wire wound as illustrated, or of any other suitable construction, and which, for the purposes of illustration, comprises a base or support 2 having a resistance wire 3 wound thereon and provided with leads 4 and 5 for connection to an electric circuit. The resistance element 1 is suitably secured, as by screws 6, to upstanding posts 8, 9 and 10 of a frame or base 7.

A contact element or member 11 is mounted in electrical contact with the resistance element 1 and preferably comprises a conductive member of arcuate shape and sufficient rigidity to resist substantial distortion in operation. The contact element 11 is suitably connected, as by a pivot 16, to a suitable actuating means or device 17 which, in the present example, comprises a pressure responsive diaphragm 20, the interior of which is connected by a conduit 18 to the source of fluid pressure which is employed to effect the desired movement of the contact 11. The controlling force of the actuating means or device is effective through a predetermined path of movement.

The contact element 11 is provided with a lead 19 for connection to an electric circuit.

The contact element 11 is resiliently maintained in contact with the resistance element 1 by a pressure element 12 and is operative to rock on the resistance element 1 under the influence of the actuating element 17. The pressure element 12 preferably comprises a head 13 having a tapered point engaging the contact element 11, a spring 14 urging the head 13 against the contact element, and means, such as a stud 15, for positioning the spring 14 relative to the frame 7. The member 11 is linked or positively joined at one of the ends thereof to the pressure element 12 or actuating means so that motion of the means is directly utilized in the operation of the device.

The operation of the variable resistance device is as follows:

The variable resistance device is connected in an electric circuit, the resistance of which is to be controlled, the lead 19, and either the lead 4 or the lead 5 being connected in the circuit. For the purpose of illustration, let it be assumed that the lead 19 and the lead 4 are connected in a circuit.

Assuming that there is no fluid pressure applied to the diaphragm 20, or that the minimum pressure is applied, the pressure element 12 maintains the contact element 11 against the resistance element 1, with the point of contact of these elements (hereinafter called the "contact point") at or near the left hand end (as viewed in Fig. 1) of the resistance element 1. When the fluid pressure in the diaphragm 20 is increased, the latter expands and causes the contact element 11 to rock on the resistance element 1 and the contact point therefore is shifted to the right (as viewed in Fig. 1), thus increasing the resistance between the leads 4 and 19, and thereby increasing the effective resistance of the variable resistance device.

The distance between the point of application of pressure by the pressure element 12, contact point 11, and the point at which the actuating element 17 is connected to the contact element 11 may be suitably adjusted for providing the desired leverage for actuating the contact element 11. If desired, the pressure of the element 12 may be such as to permit a slight slippage of the contact element 11 on the resistance element 1 when the former is rocked, thereby to burnish the contacting surfaces and to maintain a uniform, low, contact resistance.

It will be noted that the pressure element 12 not only maintains the contact element 11 against the resistance element 1 but also opposes the rocking of the contact element in response to the force exerted by the actuating device 17. As the contact element 11 is rocked, it compresses the spring 14 and thereby increases the resistance thereof. Moreover, owing to the movement of the contact point to the right, the lever arm constituted by the portion of the contact element 11 between the contact point and the pressure element 12 becomes longer and the lever arm formed by the portion of the contact element 11 between the contact point and the actuating device 17 becomes shorter. Thus, the opposition offered by the pressure spring increases for this reason also. It will be apparent from the foregoing that the characteristics of the opposing force presented by the pressure device can be selected as desired, by suitable construction or adjustment of the several members.

Referring now to Figs. 3 and 4, there is illustrated another embodiment of the invention, in which the variable resistance device comprises a resistance element which is adjustable whereby the characteristics of the device can be readily adjusted.

The variable resistance device comprises a resistance element 25 having a base or support 28 which is flexible, at least at the portion carrying the conductive material. In the present case a wire wound resistance element is illustrated which has terminal leads 26 and 27. The resistance element 25 is suitably secured to a frame 31 having upstanding posts 32 supporting a top member 30.

The resistance element is secured to the top member 30 as by rivets 29 and an insulating member 33 is interposed between the resistance element 25 and the top member 30. One or more adjusting screws 34, 34 are threaded through the top member 30 and engage the insulating member 33 whereby the shape of the conducting portion of the resistance element can be varied. It will be understood that the base 28 of the resistance element 25 may be slotted at one of the rivets 29 as indicated in the drawing or may be otherwise constructed to permit adjustment by the adjusting screws 34, 34.

A contact element 35, which in the present embodiment is a straight member, is connected to

an actuating element 40 which may be generally similar to the actuating element 17 previously described. The contact element 35 is resiliently and firmly maintained in contact with the resistance element 25 by a pressure element 36 which takes the form of an elongated leaf spring rigidly secured at one end to the frame 31 and having an upturned end portion 37 engaging the free end of the contact element 35.

A terminal lead 38 is connected to the contact element 35 and the connections to an electrical circuit can be made in a manner generally similar to that above described.

In the embodiment of the invention illustrated in Figs. 3 and 4, the device operates generally similar to the device illustrated in Figs. 1 and 2, except that the rocking action of the contact element 35 on resistance element 25 is possible by the reason of the arcuate form of the resistance element 25. It will be seen that the resistance characteristics of the variable resistance device can be adjusted by adjusting the shape of the resistance element 25.

Referring now to Figs. 5 and 6, there is illustrated a third embodiment of the invention wherein a plurality of resistance elements and contact elements are provided, the contact elements being actuated by a single actuating element.

In this form of the device, two resistance elements 45 and 45*a* are provided, having respectively terminal leads 46, 47 and 46*a*, 47*a*. The resistance elements 45 and 45*a* may be of any suitable construction and in the present example, they are wire wound.

The resistance elements 45 and 45*a* are mounted side by side on a frame 48 having upstanding posts 49 to which the resistance elements are secured.

A pair of contact elements 50 and 50*a* are arranged in contact with the resistance elements 45 and 45*a* respectively, the contact elements 50 and 50*a* being connected preferably at their ends by cross bars 51 and 52. The cross bar 52 is connected pivotally to a pressure element 53 which may be generally similar to the pressure elements previously described.

The contact elements 50 and 50*a* are resiliently maintained in contact with their respective resistance elements 45 and 45*a* by a pressure element 53 which may comprise a head 54 bearing against the cross bar 51, a spring 55 and means such as a stud 56 for maintaining the spring 55 in position relative to the frame 48. The resistance elements 45 and 45*a* preferably are insulated from each other in suitable manner as by constructing the bases 49 thereof from insulating material or by interposing insulating material (not shown) between those parts which are to be insulated. The contact elements 50 and 50*a* are insulated from each other by constructing the cross bars 51 and 52 of insulating material or by interposing insulating material (not shown) between them.

The contact elements 50 and 50*a* are provided with flexible terminal leads 57 and 57*a*.

The resistance elements 45 and 45*a* and their respective contact elements 50 and 50*a* may be connected in separate circuits and the variable resistance device thus can be employed to vary the resistance of these separate circuits in accordance with fluid pressure, the existence or extent of which it is desired to indicate or measure. The two resistance elements 45 and 45*a* may, if desired, have different resistance characteristics whereby the resistances of the two circuits to be varied will vary dissimilarly.

Referring now to Figure 7, there is illustrated another form of multiple variable resistance device capable of controlling the resistance in two circuits simultaneously in accordance with the variation in a single fluid pressure.

The variable resistance device comprises a resistance element 65 which may be of any suitable construction and which has terminal leads 66 and 67 at each end and a third terminal lead 68 intermediate of the ends of the resistance element, providing, in effect, two independent resistances.

The resistance element 65 is mounted on a frame 69 having upstanding posts 70 to which the resistance element is suitably secured.

Two contact elements 71 and 71*a*, which are of arcuate, rigid construction, are mounted in position to contact the two sections of the resistance elements 65 respectively. The contact elements 71 and 71*a* are suitably connected to a pressure element 78 which may be similar to the pressure elements hereinbefore described.

Each contact element 71 is resiliently maintained in engagement with the corresponding section of the resistance element 65 by a pressure element 75 which may be constituted by a leaf spring 72 suitably secured to the frame 69 and having an end portion 73 engaging the contact element 71 preferably adjacent its end. For the purpose of providing a compact construction, the leaf spring 72 may be rebent as illustrated in Fig. 7. The contact elements 71 and 71*a* have suitable terminal leads 76 and 77, respectively.

The variable resistance device illustrated in Fig. 7 may be employed in a manner analogous to the construction above described and may be connected in a single electric circuit in which case connections may be made between the terminal lead 66 and the terminal lead 76 or between the terminal leads 67 and 77. Where the device is thus employed, it will be understood that the contact elements 71 and 71*a* are insulated from each other. If desired, the contact elements may be electrically connected in which case the connections to the electric circuit are made at the terminal leads 66 and 67.

Where the variable resistance device is to be employed for controlling the resistance of two separate circuits, connections may be made between the terminal leads 66 and 76, and between the leads 67 and 77 or between the terminal lead 68 and leads 76 and 77 or in other ways which will occur to those skilled in the art.

Referring now to Fig. 8, there is illustrated a further form of variable resistance device wherein the contact element is securely fixed relatively to the resistance element.

In this form of the device a resistance element 80 of suitable construction is provided which has terminal leads 81 and 82, the resistance element being provided with or secured to a suitable support 83 which may be of rigid construction or which may be firmly secured in any position of adjustment.

A contact element 83 of suitable flexible construction is firmly fixed at one end relative to the resistance element, as for example, by attachment to the base 83. The contact element is pivotally connected to an actuating element 87 which may be similar in construction to the above mentioned actuating elements.

In this form of variable resistance device the variation in resistance is produced by the vary-

ing extent of contact between the contact element and the resistance element as the contact element is forced into or out of engagement with the resistance element accordingly as the pressure element moves the adjacent end of the contact element. The contact element 84 preferably is of resilient construction so that it is resiliently held in engagement with the resistance element 86, to the extent determined by the position of the actuating element 87.

In this form of the invention the device is preferably connected in an electric circuit by connection to the terminal leads 81 and 82. However, if desired, a terminal lead 88 may be connected to the contact element 84 or the actuating element 87 in which case the circuit connections are made at the terminal leads 88 and 82.

It will be noted that in construction illustrated in Fig. 8 the spring contact element 84 serves to oppose upward movement of the actuating element 87. Owing to the distorting of the spring and to the shortness of the lever arm between the contact point and actuating element 87, the opposition to the actuating force increases as the actuating element moves upwardly. This increase can be made very rapid, owing to the relatively large movement of the free end of the contact element 84 as compared to its effective length.

While certain novel features of the invention have been disclosed herein, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. A variable electric resistance device comprising a resistance element, a rockably positioned member making a movable contact intermediate its ends with the resistance element to vary the effective resistance of the device, actuating means, the force of which is effective through a predetermined path of movement, means for connecting one end of the rock member and the actuating means so the member is positively directed thereby to cause slippage between the member and the resistance element, and resilient means for engaging the other end of the rock member to maintain the contact of the member with the resistance element.

2. A variable electric resistance device comprising a relatively flexible resistance element, means for mounting said resistance element to provide the same with a definite curved surface, a rockably positioned member making a movable contact intermediate its ends with the curved surface of the resistance element to vary the effective resistance of the device, actuating means for the device, means connecting said actuating means and one end of the rock member to directly utilize the movement of the actuating means to operate the device, means for yieldingly engaging the other end of the rock member to maintain the contact of the member with the resistance element and also permit slippage of the rock member with respect to the resistance element, and means by which the curvature of the flexible resistance element may be varied.

3. A variable electric resistance device comprising a plurality of resistance elements, a rockably positioned member making a movable contact intermediate its ends for each of the elements to vary the effective resistances thereof, a common actuating means, the force of which is effective through a predetermined path of movement, means for joining said actuating means and one end of each of the rock members so the respective members are positively directed by the movement of the actuating means to cause slippage between each of the members and its associated resistance element, and yielding means for engaging the other end of each of the rock members to maintain the contacts thereof with the respective resistance elements.

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