Oct. 20, 1959 E. W. PITZER 2,909,750

ADJUSTABLE ELECTRICAL RESISTOR

Filed Sept. 26, 1955 2 Sheets-Sheet 1

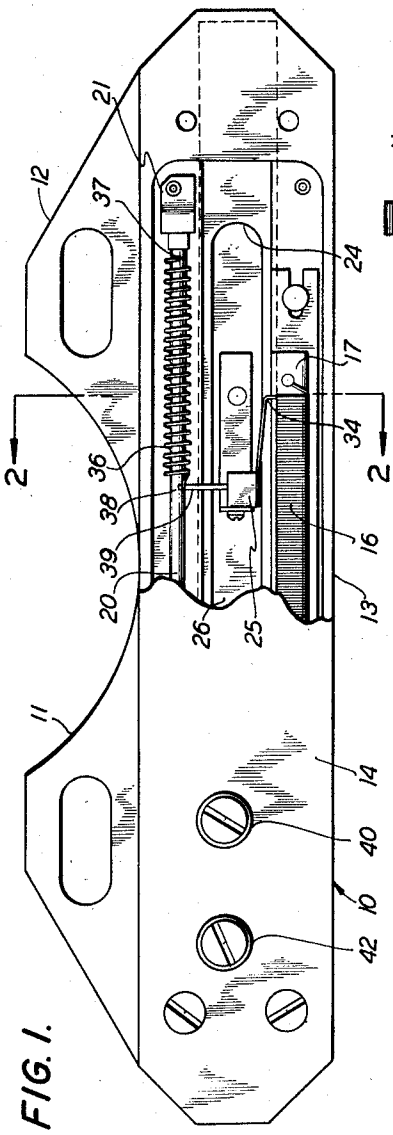


FIG. 1.

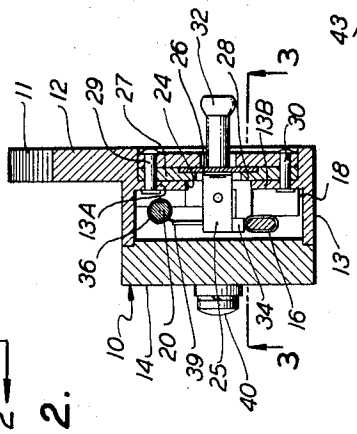


FIG. 2.

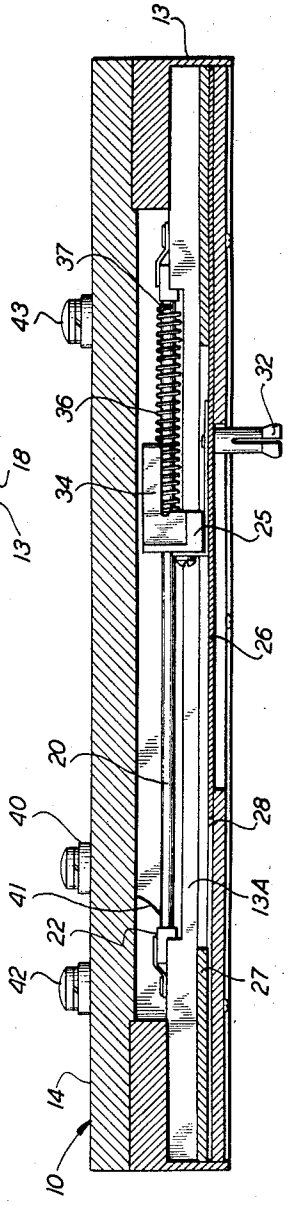


FIG. 3.

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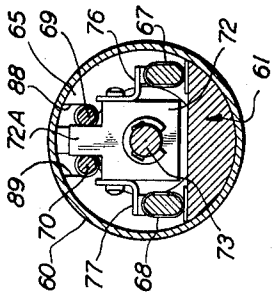


FIG. 6.

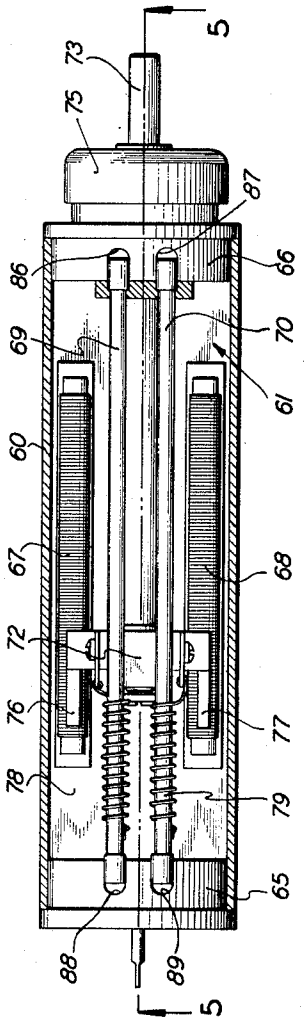


FIG. 4.

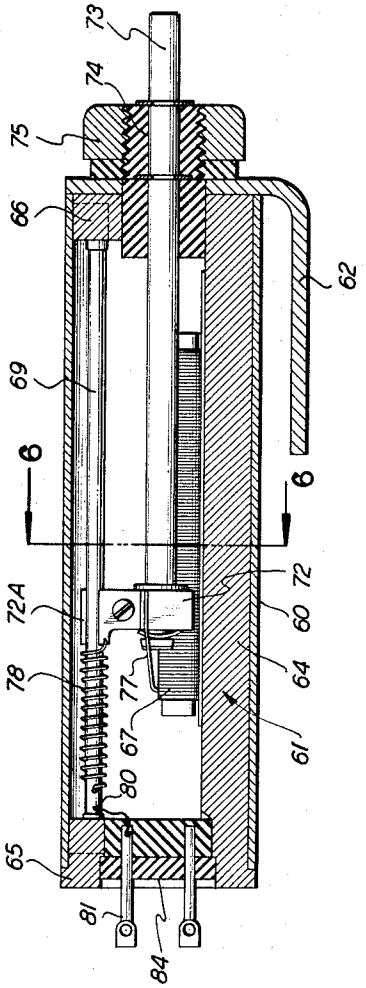


FIG. 5.

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ADJUSTABLE ELECTRICAL RESISTOR

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Application September 26, 1955, Serial No. 536,355

2 Claims. (Cl. 338—176)

This invention relates to improvements in adjustable resistors and particularly to improved means for interconnecting an adjustable tap or contactor of such a resistor to a fixed electrical terminal.

A potentiometer is one form of adjustable resistor in which it is desired to develop, by means of an adjustable tap, a fraction of the voltage impressed across the potentiometer resistor element. These instruments are used in many applications, as for example as position sensitive transducers, where a high degree of accuracy is required. Any artificial electrical noise developed within the instrument or any vibration sensitivity attendant upon the interconnection of the moving contact with the fixed terminal is a limitation on the utility of the device.

It is presently conventional to mount a so-called bus bar in parallel relation to the resistor of an adjustable resistor such as a potentiometer, and to provide a contactor which slides on the resistor and bus bar to electrically bridge between the resistor and the bus bar whereby a fixed terminal at an end of the bus bar is effectively connected electrically to the adjustable contactor. This conventional system has inherent limitations attendant principally upon the moving contact between the slider and the bus bar, noise created by inherent variation in contact potential between the relatively moving elements and the sensitivity of the system to shock or vibration.

I have now developed a construction in which these limitations are overcome largely by reason of the fact that the electrical system does not depend upon moving contact between the adjustable slider and any element other than the resistance coil itself. To this end the invention contemplates in an adjustable resistor having a resistance element mounted in a housing and a contactor movable along the resistor, the combination comprising a rod mounted in the housing and spaced from the resistor, and an electrically conductive coil spring-mounted on the rod to elongate and retract thereon. One end of the coil spring is electrically connected to the contactor by a fixed joint such as a conventional solder joint. The other end of the coil spring is electrically connected to an electrical terminal, likewise by a fixed joint, so that the adjustable contact is in effect connected through the coil spring into the fixed terminal for incorporation into a circuit externally of the housing without any moving contact between the contactor and this external circuit.

Preferably in the above construction the spring supporting rod is mounted parallel to the resistor element and spaced a short distance therefrom and is made conductive. In this latter instance the inboard end of the coil spring, this being the end remote from the contactor, may be connected directly to the rod and the end of the rod may be combined into the desired fixed terminal connection.

In many potentiometers, and this is particularly true of some rectilinear potentiometer designs, there is the problem of adequately supporting and guiding the sliding contact member. In accordance with another preferred feature of my invention, the spring supporting rod may

double as a guide rod to center and fix the course of travel of the contact slider.

The invention will be clearly understood from the following detailed description thereof taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a partially cut away plan view of a rectilinear potentiometer embodying the invention;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a section taken on the line 3—3 of Fig. 2;

Fig. 4 is a plan view of an alternative type of potentiometer with the enclosure cut away to display the interior thereof;

Fig. 5 is a longitudinal sectional elevation taken on the line 5—5 of Fig. 4; and

Fig. 6 is a transverse sectional elevation taken on the line 6—6 of Fig. 5.

The potentiometer shown in the various views of Figs. 1, 2 and 3 comprises a generally rectangular housing **10** provided in this instance with mounting flanges **11** and **12**. The housing consists of a base **13** and a cover member **14**. The base forms a body cavity between inwardly extending flanges **13A**, **13B** and the inner face of the cover **14**. A resistance coil **16** is mounted between supports **17** and **18** along base flange **13B** and a rod **20** is mounted between supports **21** and **22** along the base flange **13A** and extending parallel to the resistance coil.

The two longitudinal flanges **13A**, **13B** define a longitudinally extending slot **24** through which a slider **25** is slidably mounted in the housing. The slider **25** is supported on a thin plate **26** which is retained between two mating plates **27**, **28** fastened to the bottom of the base **13** as by rivets **29**, **30**. The plates **27** and **28** are slotted to accommodate the contactor **25** and a manipulating pin **32** extending outwardly from the base of the housing. The plate **27** is milled along its inner edges defining the aforementioned slot to accommodate the slider plate **26**. The slider **25** carries a wiper **34** which bears against resistance coil **16** and is positioned longitudinally of the coil in accordance with the position of the carriage longitudinally of the housing. The manipulating pin **32** may be engaged manually or mechanically to vary and fix the position of the wiper on the coil.

A helical spring **36** is mounted around rod **20** and is connected at one end **37** to the rod and at the opposite end **38** to a finger **39** carried by the carriage **25**. The wiper **34** and the finger **39** are electrically connected so that the wiper, the finger, the spring **36** and the rod **20** provide electrical continuity with the point on the resistance coil in which the wiper is in engagement. The rod **20** is electrically connected to an exterior terminal **40** mounted in the cover **14** by a conventional jumper strip **41** and is otherwise insulated from the potentiometer housing. The resistance coil **16** is similarly connected at its opposite ends to terminals **42**, **43**, also in the cover **14**, by like jumper strips (not shown).

In operation of a potentiometer of the type shown in these figures, a suitable voltage is connected across terminals **42** and **43** and thereby across the coil **16**. Any desired fraction of this voltage can be made to appear at the terminal **40** by adjustment of the position of wiper **34** along the coil **16**, this adjustment being accomplished by the manipulating pin **32**.

The significant feature of the invention is the unbroken connection between the wiper **34** and the terminal **40** through the continuity spring **36**, coupled with the fact that the continuity spring is supported within the housing by the fixed rod **20** so that it cannot vibrate or otherwise interfere with the operation of the potentiometer by virtue of its inherent flexibility. The spring **36** is restrained by the rod **20** which I have found to be an essential comple-

ment to the use of such a continuity spring in an adjustable resistor as described.

The rod 20 is preferably conductive so that it forms continuity with the spring 36. In such instance the inboard end 37 of the spring need only be fastened to the rod, no terminal connection being required at this part. Alternatively, the support rod 20 may be insulating material, in which event the inboard end of the spring is interconnected to a suitable fixed terminal.

The illustrated continuity arrangement has many advantages over conventional means now employed and as described above. In the first place, there is no possibility in this device of intermittent contact. There is no friction contact between the coil wiper and its external terminal. No reasonable amount of acceleration or vibration can interfere with this continuity. Further, in the present system, there is no wear. The spring is stressed well below its fatique limit and the effects of hysteresis are so small in comparison with the actuating force required to move the carriage 25 as to be undetectable. Actually, the force required to extend the spring 36 is of itself so small compared to the force required to move the carriage as to have no effect, and the effects of hysteresis are only a small percentage of this negligible force.

The construction of the invention is less expensive than presently conventional techniques in that no precious metals are required. The spring, as well as its guide bar, may be of phosphor bronze, nickel or any corrosion-resistant metal as distinguished from precious metal alloys normally required in the presently conventional units. In applications where a high brush current is required, the system of the invention is preferable because of the materially greater load carrying capacity of the wiper continuity spring arrangement.

Because the spring diameter diminishes as the spring is stretched, suitable tolerance between the spring and its supporting rod is required to accommodate this change. The necessary tolerance is a mere matter of design length and the anticipated stretch and convolution uniformity of the spring in any given instrument. At the same time, and to fully appreciate the advantages of the spring support afforded by the rod, the spring should preferably not exceed about twice the diameter of the rod.

As previously mentioned, some types of rectilinear potentiometers present the problem of adequately supporting the slider carriage in its travel within the potentiometer. Also, as previously mentioned, the continuity spring guide bar may double to serve this function. An alternative form of potentiometer is illustrated in Figs. 4, 5 and 6 to exhibit this feature.

The potentiometer shown in these figures is a dual, linear-motion potentiometer, meaning simply that it includes two adjustable resistor units embodied in a single housing. The potentiometer comprises a cylindrical case 60 substantially enclosing a framework 61 to one end of which a mounting flange 62 is attached. The framework 61 includes a base 64 having upstanding end portions 65, 66. Two resistance coils 67, 68 are mounted parallel to each other and respectively along opposite edges of the base section 64, and two rods 69, 70 are mounted respectively parallel to each other and to the coils 67 and 68 between the upper extremities of the upstanding end sections 65, 66 of the base. The result of this construction is that the rods 69 and 70 are disposed generally above the coils 67 and 68.

A carriage 72 is supported on the inner end of an operating rod 73 which is journalled through a bushing 74 held in the end of the instrument by a nut 75. The rod 73, for reasons having to do with uses to which this type of instrument may be put, is preferably rotatable with respect to the carriage 72 so that the rod does not furnish any restraint on angular motion of the carriage 72. The carriage 72 carries a pair of wipers 76, 77 respectively engaging the coils 67 and 68. A pair of springs 78, 79 are respectively mounted on the rods 69, 70 and are electrically connected respectively to the wipers 76 and 77 through the carriage 72. The ends of each of the springs opposite the end connecting to the carriage 72 are fastened respectively to the supporting rods 69 and 70, which are in turn connected by suitable jumper strips to external leads. In Fig. 5, the rod 69 is shown connected through a jumper strip 80 to an external terminal 81. The terminal 81 and like terminals forming contacts for the other continuity spring and rod and for the several coils may be carried through a bushing 84.

The carriage 72 is provided with an upstanding portion 72A which engages snugly between the continuity rods 69, 70, this engagement always being in advance of the continuity springs 78, 79 which therefore do not in any way interfere with the secondary guiding function of the rods 69, 70.

Conveniently, as illustrated, the upstanding end sections 65, 66 of the base 61 are notched to receive the respective ends of the rods 69 and 70 which are held in position within these notches by the placement of the cylindrical cover 60 around the end sections as illustrated. The end section 66 is to this end provided with notches 86, 87 in which one end of each of rods 69, 70 respectively fit, and the end section 65 is provided with notches 88, 89 in which the opposite ends of these two rods respectively fit.

The feature particularly illustrated in the potentiometer shown in Figs. 4 through 6 involving the use of the continuity rods as guide means for the potentiometer slider is not limited to incorporation in a so-called dual potentiometer. A single continuity rod may be positioned to accomplish this same objective, as by for example notching an upper portion of the slider to ride on such a rod.

The invention has been described particularly with relation to its application to potentiometers. However, potentiometers are only one form of adjustable resistors and it will be apparent that the invention is applicable to any type of adjustable resistor in which there is present the problem of electrical continuity between an adjustable tap and a fixed electrical terminal.

I claim:

1. An adjustable linear resistor comprising a tubular housing, a framework enclosed within the housing, a resistor supported by the framework, a contactor movable along the resistor, a rod mounted in spaced and aligned grooves in the framework and extending between the spaced grooves and spaced from the resistor, the rod being held in the grooves by the enclosing housing, an electrically conductive linear coil spring mounted on the rod to elongate and retract linearly thereon at low loads, one end of the coil spring being electrically connected to the contactor and the other end of the coil spring being electrically connected to an electrical terminal by means of which the contactor may be connected into a circuit external of the housing, the coil spring providing an electrical conducting path from the contactor to the electrical terminal.

2. An adjustable linear resistor comprising a housing, an electric terminal mounted on said housing, a longitudinally extending resistance element, means mounting the resistance element in the housing, an electrically conductive coil spring, an elongated rod passing through and supporting said spring, means for fixedly mounting said rod in said housing in spaced relation to said resistance element, a contactor electrically connected in a rigid fashion to one end of said spring, the other end of said spring being electrically connected in a rigid fashion to said terminal, means for mounting said contactor for sliding movement along said elongated resistance element, said sliding movement causing elongation and compression of said spring, said means for mounting said contactor for sliding movement including means for providing a threshold of force required for movement thereof sufficiently great to eliminate all effects of force present in

said spring in all conditions of elongation and compression.

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