

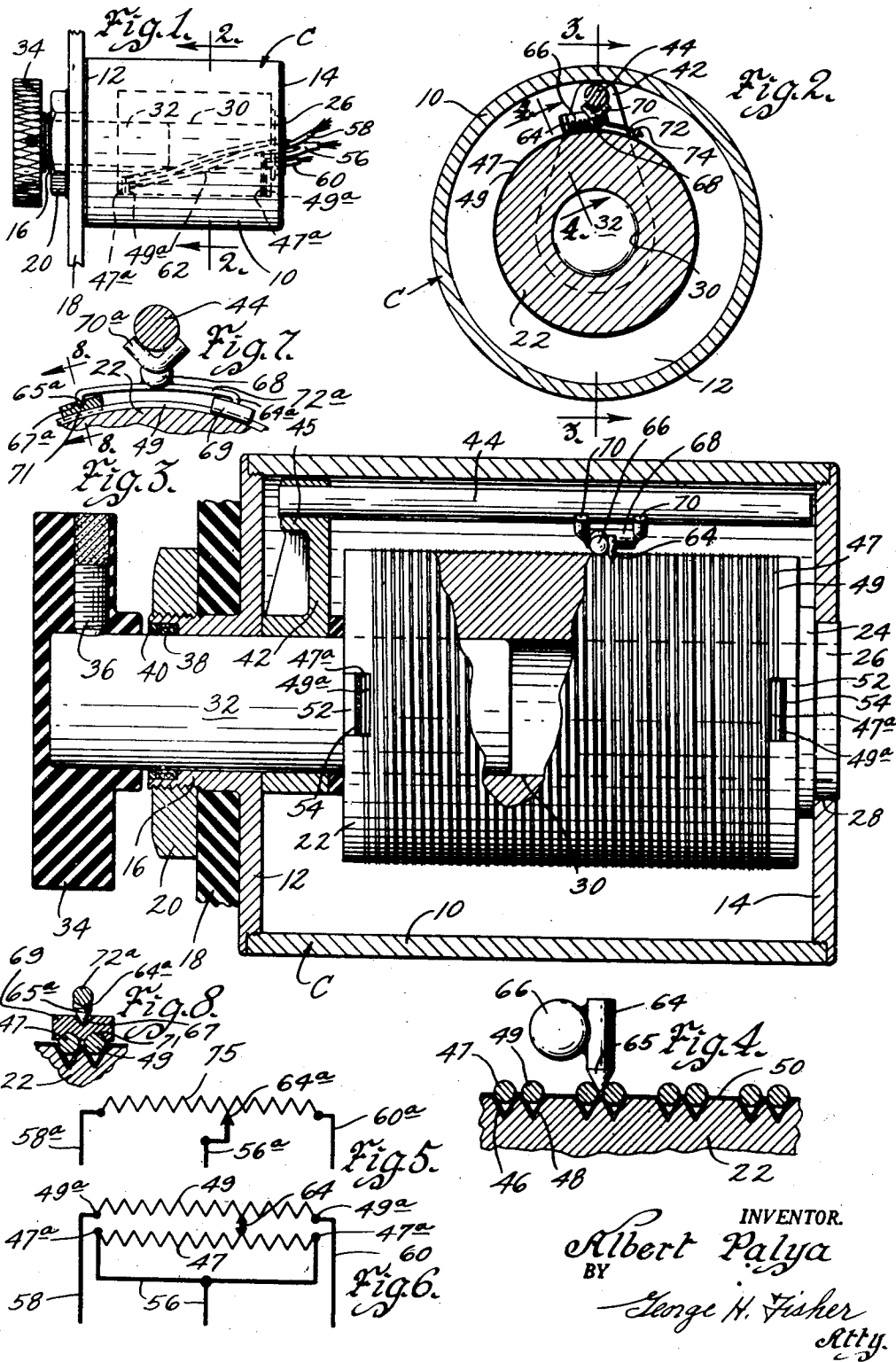
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SENSITIVE RESISTANCE DEVICE

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SENSITIVE RESISTANCE DEVICE

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My present invention relates to a potentiometer or rheostat which has great sensitivity even when made in quantity production.

One object of the invention is to provide an adjustable resistance device which can be produced with an accuracy within .02% of absolute accuracy.

Another object is to provide a potentiometer or rheostat that secures this degree of accuracy without the necessity of hand-honing the resistance wire, individually calibrating the dials for the potentiometer or rheostat or performing other hand operations to bring it up to the desired degree of accuracy.

Still another object is to provide a potentiometer or rheostat in which maximum accuracy is also secured by eliminating all pigtails and reducing the contact surfaces to a minimum.

Still a further object is to provide a potentiometer or rheostat of such design that the parts may readily be made accurately and a bridging contact structure is provided which is so designed as to eliminate all lost motion, thereby giving for each increment of movement of a control knob or the like, a proportional change in resistance within very close limits.

More particularly it is my object to provide a potentiometer or rheostat in which the resistance wire is wound on a core that can be accurately machined to reduce the variation from absolute accuracy to a minimum, and to provide a guide that rotates on the axis of such core and at all times parallel to it, the guide carrying a bridging contact designed to give a maximum of accuracy of its position with relation to the guide, thereby reducing constructional variations to the least possible minimum, and having as the only variable resistance, that across the resistance wires and the bridging contact.

Still a further object is to provide a potentiometer or rheostat which is sensitive enough to be used in calculating machines such as bomb-sights and the like, with a degree of accuracy high enough to come within only slight allowable variations from absolute accuracy.

Finally it is an object of my invention to provide a potentiometer of this character which may be inexpensively manufactured so that many of them can be used in a single calculating machine without prohibitive expense.

With these and other objects in view my invention consists in the construction, arrangement and combination of the various parts of my sensitive rheostat or potentiometer whereby the objects contemplated are attained, as here-

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inafter more fully set forth, pointed out in my claims and illustrated in the accompanying drawings, wherein:

Figure 1 is an elevation of my potentiometer substantially full size, although of course its size may be increased or decreased as desired.

Figure 2 is an enlarged sectional view on the line 2—2 of Figure 1.

Figure 3 is a sectional view on the line 3—3 of Figure 2.

Figure 4 is a further enlarged sectional view taken on the line 4—4 of Figure 2, and showing the bridging contact and its relation to the resistance wires of the potentiometer.

Figure 5 is a diagrammatic view of the ordinary type of potentiometer.

Figure 6 is a diagrammatic view of my potentiometer to show its analogy to the ordinary type.

Figure 7 is a view similar to a portion of Figure 2 on an enlarged scale, and showing a modified type of bridging contact arrangement, and

Figure 8 is a further enlarged sectional view on the line 8—8 of Figure 7.

On the accompanying drawing I have used the character C to indicate in general a casing. The casing C may consist of a tubular portion 10 closed by end plates 12 and 14. The end plate 12 has a hub 16 which may extend through a hole in a mounting panel 18 and may be retained in mounted position by a nut 20 screwed onto the hub.

Within the casing C, I provide a core 22 formed preferably of metal (such as aluminum alloy) so that it may be accurately machined. The core 22 has at one end a stop shoulder 24 and a stud 26. The stud 26 is adapted to be snugly fitted into an opening 28 of the end plate 14.

The core 22 has a centrally located bore 30 which journals one end of a shaft 32. The other end of the shaft 32 extends rotatably through the hub 16, and has a suitable connection at its outer end to any device desired for rotating the shaft. By way of example, a manually controlled knob 34 is shown locked to the shaft by a set screw 36, although it is to be understood that shaft 32 could be rotated automatically rather than manually. In the hub 16, a packing 38 around the shaft is retained by a retainer ring 40 to prevent entrance of dust into the casing C which would be detrimental to the accuracy of the potentiometer.

A guide supporting arm 42 is secured to the shaft 32 and supports a guide rod 44 in a hub 46 of the arm. The shaft 32 is relatively large

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in diameter to minimize wear and maintain accuracy and the arm 42 and rod 44 are relatively heavy so that there is no springing of the rod relative to the shaft for an important purpose that will hereinafter appear.

The periphery of the core 22 has machined therein a pair of threads or helical grooves 46 and 48. The core is thereafter dipped in, or sprayed with, a suitable insulation such as one of the thermo-plastic or phenolic types indicated at 50 in Figure 4. A pair of resistance wires 47 and 49 are then wound in the grooves 46 and 48 and their ends connected with terminal straps 47a and 49a.

The terminal straps as shown in Figure 3 are counter-sunk into the ends of the core 22 and retained therein by retainer plates 52 suitably held in position by screws threaded into the core with insulation plates 54 interposed between the retainer plates and the terminal straps. The straps are also separated by a sheet or coating of insulating material so that they are electrically insulated with relation to each other. The terminal straps may have leads 56, 58 and 60 connected thereto, as shown by dotted lines in Figure 1 and diagrammatically in Figure 6. The core 22 may have an inclined opening 62 shown in Figure 1 to accommodate some of these lead wires without interference with the shaft 32.

A bridging contact 64 is provided which is made of relatively hard metal to minimize wear. The resistance wires 47 and 49, as shown, may likewise be made of hard metal, preferably harder than the usual Nichrome wire. The bridging contact 64 is welded or brazed to a short rod 66 which in turn is welded or brazed to another short rod 68. The rods 66 and 68 constitute a rocker arm. At the ends of the rod 68 a pair of V-guides in the form of rods 70 are attached by welding or brazing. The rods 68 and 70 constitute a rocker. It will be noted that the rods 66, 68 and 70 are relatively large in diameter so as to give rigidity without any possibility of undesirable springing action.

The V-guides 70 contact with the rod 44 and the bridging contact 64 has a pointed end 65 contacting between the resistance wires 47 and 49 as shown in Figures 2 and 4. To retain these parts in contact under a predetermined degree of resiliency, a leaf spring 72 is attached to the rod 68 and carries a contact 74 similar to the contact 64 and likewise engaging between the wires 47 and 49. In order to reduce wear on the wires, the point of the contact 74 may be a different shape so that its contact is along different lines on the wires than the contact of the point 65 therewith.

Referring to Figures 7 and 8, a modified type of bridging contact is shown wherein, in place of the elements 66 and 72, a spring wire 72a is provided which may be welded or brazed to the rod 68. The wire 72a has down turned ends 64a, terminating in points 65a which seat in depressions 67 of rider blocks 69. Each rider block, as shown in Figure 8, has a pair of grooves 71 for the respective wires 47 and 49, and these grooves may be formed to closely fit the outer surfaces of the wires, thereby reducing wear considerably due to greater surface contact when compared with the type of bridging contact 64 shown in Figure 4. The point 65a in the seat 67 permits slight freedom of movement so that the block 69 can readily follow the wires 47 and 49, and at all times substantially equal resistance of the contacting surfaces is had. The lower end of the

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point 65a may be rounded slightly and likewise the seat 67 to provide greater area contact at this point, thus further contributing to the reduction of variables introduced due to resistance at joints where there is merely surface contact. Also, the relation of parts is such that there is substantially no variation in the distance from the bridging contact 69 to the rod 44 when any irregularities in the wires 47 and 49 tend to move the contact 69 inwardly or outwardly relative to the center of rotation.

Practical operation

In the operation of my potentiometer, rotation of the shaft 32 causes the rod 44 to be rotated about the core 22, and remain at all times parallel to its axis of rotation. As the rod 44 rotates the contact 64, the spring 72 holds the contact against the resistance wires with predetermined pressure.

As the rod 44 is swung about the axis of the core 22 and the contact 64 engages between the resistance wires 47 and 49, the contact will be shifted longitudinally of the core due to the wires being wound in helical grooves of the core. Therefore, the contact will follow the resistance wires without the necessity of a screw thread for this purpose in addition to the resistance wires themselves.

Referring to Figure 5, leads 56a, 58a and 60a are shown, corresponding to the leads 56, 58 and 60 of my potentiometer as shown in Figure 6. Corresponding to the resistance wires 47 and 49 of Figure 6, I show in Figure 5, a single resistance wire 75. The slider 64a corresponds to the bridging contact of Figure 6. Obviously movement of the slider 64a toward the left will reduce the resistance across 56a—58a, and increase it across 56a—60a, or vice-versa.

In Figure 6, movement of the bridging contact 64 toward the left will likewise reduce the resistance across 58—56 and increase it across 56—60, or vice-versa.

In my potentiometer, the movement of the contact 64 one complete turn will change the resistance twice as fast as the potentiometer of Figure 5, assuming the resistance wires to be of the same size.

In the event that the device is to be used as a rheostat, connection can be made across 56 and 58 only or 56 and 60 only. Thus the potentiometer may be used as a rheostat or the ends of the resistance wires at one end of the core may be anchored, but terminal connections need not be provided for them if it is to be used only as a rheostat.

As to the features which make my potentiometer extremely sensitive and capable of quantity production without the necessity of individual hand work on each one, I point out the following:

The core 22 must be accurately machined both as to the bore 30 and the grooves or threads 46 and 48. Thus when the shaft 32 is rotated in the bore 30, the guide rod 44 will have a predetermined increment of movement around the grooves 46 and 48 for each angular degree of rotation of the shaft. By being careful with the rod 44 to see that it is parallel to the axis of rotation of the shaft 32 and has its center in a plane that passes through the axis of the shaft, I am assured that this proportional movement of the rod around the core will be accurate at all points along the rod, and I am further assured that the rod will always be at the same distance away from the grooves.

By interposing the contact 64 between the rod and the resistance wire, and utilizing the spring 72 in the manner disclosed, I am assured that there will be no erraticism in the movement of the contact as the potentiometer is adjusted. The rigidity of the rods 66, 68 and 70 all contribute to the elimination of any sloppiness in movement of the contact with relation to the guide rod 44. This also prevents any tendency for a buckling action between the rod 44 and the contact 64, as when the direction of adjustment is reversed from a clockwise direction in Figure 2 to a counter-clockwise direction, and preserves predetermined distance between the rod and the contact at all times.

The modified bridging contact arrangement shown in Figures 7 and 8 also has the same advantages as outlined in connection with the elements 64, 66, 72 and 74, with the additional advantage that there is less wear on the wires 47 and 49 and consequently less variation in resistance over an extended period of time due to such wear.

It is important that the insulation 50 be of uniform thickness, and I have found that this is possible where a thermo-plastic insulation is used and applied by either dipping or spraying. It is also important that the resistance wires 47 and 49 be of uniform diameter as any non-uniformity of either their size or the thickness of the insulation 50 will result in a larger diameter at the contact point between the resistance wires and the contact point 65. Obviously, any portion of the wire of larger diameter also has less resistance, and there would be variation in proportion between the resistance value and the amount of rotation of the shaft 32, where such is the case. I have found that commercially available resistance wires where taken from the same spool usually are uniform enough in diameter to satisfy the requirements of a potentiometer of this kind where such requirements are within .02% of absolute accuracy.

By thus reducing all mechanical considerations to a minimum of variation from absolute accuracy, the only remaining consideration to be given is the variation in surface contact between the contact 64 and the resistance wires 47 and 49.

In actual practice, I find that by having the spring 72 or 72a of the proper strength, this variation is very slight so that I believe it possible to secure accuracy to within .0125% on a production basis.

A potentiometer of the kind herein disclosed compares favorably with laboratory rheostats and potentiometers which have hand-honed resistance wires and individually calibrated scales. Such rheostats are usually made with heavy resistance wire as it is impractical to hand-hone fine wire and they are relatively bulky even when they are not required to carry very much current. Laboratory potentiometers and rheostats of this character are, therefore, quite expensive.

On the other hand, I have provided a potentiometer which can be readily constructed on a production basis and can be of small size, as small resistance wire (only large enough to carry the small current necessary) can be used, and shorter lengths of wire are therefore possible with great variation in ohmic resistance. All pigtail connections are eliminated, since the terminals for circuit connections are stationary and the only movable part (the contact 64) serves merely as a bridging contact, thereby eliminating the require-

ment of a commutator introducing another variable contact surface or a pigtail connection that would have to permit of several revolutions of the contact in order to obtain as much resistance value and fineness of adjustment possible with the arrangement I disclose.

As to the present day commercially available potentiometers made on a production basis, their accuracy is considerably lower. I find that they range from 2 to 5% and that is much too great a variation from absolute accuracy to permit of their use in many present day commercial applications.

It is obvious from the foregoing that I have provided a potentiometer structure which has a high degree of sensitivity, overcomes the objections noted, and is therefore adaptable for installations where a high degree of accuracy and a minimum cost of the instrument is required.

Some changes may be made in the construction and arrangement of the parts of my device without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope without sacrificing any of the advantages thereof.

I claim as my invention:

1. In a resistance device of the character disclosed, a cylindrical metallic member having a pair of helical grooves machined therein and coated with insulating material, a resistance wire in each of said grooves, a guide element parallel to the axis of said member, said member and said guide element being relatively rotatable, and a contact element movable longitudinally of said guide element and engaging both of said resistance wires and thereby electrically bridging them.

2. In a resistance device of the character disclosed, a core having a pair of helical grooves therearound, a resistance wire in each of said grooves, a guide element parallel to the axis of said core, said core and said guide element being relatively rotatable, a rocker movable longitudinally of said guide element and having a lateral arm, and a contact element carried by said arm and engaging both of said resistance wires and thereby electrically bridging them, said wires serving as a thread with relation to said contact element to advance it axially relative to said core.

3. A sensitive variable resistance device comprising a stationary cylindrical core having a pair of grooves formed helically in the periphery thereof, and having a central bore, a resistance wire in each groove, a housing supporting said core at one end, a shaft entering the other end of said housing and having a pair of portions, one journaled in said other end of said housing and the other journaled in said bore of said core, an arm carried by said shaft between said journaled portions thereof and thereby rotatable about the axis of said core, a guide rod supported by said arm in a position substantially parallel to said axis, and a slider movable along said rod and resiliently interposed between it and said core, said slider having a bridging contact engaging between said resistance wires.

4. In a resistance device, a stationary cylindrical core having a double thread therearound, a pair of resistance wires in said threads, terminal connections for said resistance wires, an elongated guide parallel to the axis of said core and rotatable about said axis, and a contact element movable longitudinally of said guide and comprising a seat member against the guide, an arm

extending laterally in one direction from the guide and having a contact element provided with contact faces of V-shape engaging both of said resistance wires, and a spring extending laterally in the opposite direction from said guide and having a contact engaging said resistance wires to effect such engagement of said seat member against said guide.

5. A sensitive resistance device of the character disclosed comprising a cylindrical core having a pair of helical grooves formed in the periphery thereof, a resistance wire in each groove, an arm, the arm and said core being relatively rotatable, a round guide rod supported by said arm in a position substantially parallel to the axis of said core, and a slider movable along said rod and interposed between it and said core, said slider having a bridging contact engaging between said resistance wires and having a double V-seat with each seat engaging at only two points against that side of said rod next to said core, and means to cause the engagement of said bridging contact with said resistance wires and of said seat against said rod to be resilient.

6. An instrument of the character disclosed comprising a stationary cylindrical core having a pair of thread grooves formed in the periphery thereof, a resistance wire in each groove, an arm rotatable about the axis of said core, a guide rod supported thereby in a position substantially parallel to said axis, and a slider movable along said rod, said slider comprising a pair of seats spaced longitudinal of said rod, and each having only two point engagement with said rod, a bridging contact interposed between and engaging said rod and said resistance wires respectively, and means to cause said engagement to be resilient.

7. In a sensitive resistance device, a cylindrical member having a helical groove, a resistance wire in said groove, an elongated guide element parallel to the axis of said cylindrical member, said member and guide element being rotatable in respect to each other, a rocker arm having means of engagement intermediate its ends against said guide element, a contact element carried by one end of said rocker arm, and a second contact carried by the other end of said rocker arm, said contacts engaging said resistance wire whereby the rocker arm is moved along said guide element upon relative rotation of the guide element and said cylindrical member.

8. A sensitive resistance device of the character disclosed comprising a core having a double helical groove formed in the periphery thereof, a resistance wire in each groove, a guide parallel to, and rotatable about, the axis of said core, and a slider movable along said rod and comprising a pair of V-elements, an arm carried thereby and projecting laterally from said rod and a bridging contact carried by the other end of said arm and engaging between said resistance wires, said arm and bridging contact being spring-biased relative to said rod for resilient contact of said bridging contact with said resistance wires.

9. In a resistance device, a stationary cylindrical core having a double groove therearound, and a bore at its center, a housing enclosing said core and supporting it at one end with its other end spaced from the other end of said housing, said housing having a bearing at said other end thereof, a pair of resistance wires in said double groove, terminal connections for said resistance wires, a contact element bridging said resistance wires, and means for guiding said contact element in a circular path around said core, and

following the convolutions of said resistance wires due to contact between the element and the wires, said means including a shaft journaled in said bearing and said core, an operating arm secured to said shaft and extending therefrom in the space between said other ends of said core and said housing, a rod rigidly mounted in the outer end of said arm and arranged parallel to the axis of said bore, said contact element being slidable along said rod.

10. A resistance device of the character disclosed, comprising a stationary cylindrical core having a pair of grooves formed in the periphery thereof, a resistance wire in each groove, a slider having a contact bridging said resistance wires, and means for controlling the path of travel of said contact comprising an elongated guide parallel to and movable around the axis of said core; a pair of bearing elements spaced from each other along said guide and each engaging the guide with two point contact only, said bearing elements rigidly carrying said contact, and resilient means biasing said contact to engage said resistance wires.

11. In a variable resistance device, a metallic cylindrical member having an accurately machined outer surface and inner concentric bore, the outer surface of said member being provided with a helical groove, a coating of insulating material in said groove, a resistance wire wound in said groove outside of said coating, a contact supporting assembly comprising a rod closely fitting said inner bore, a guide spaced from the outer surface of said cylindrical member and extending parallel to the axis thereof and a contact means slidable upon the guide and engaging a side of said resistance wire whereby relative rotation of said cylindrical member and contact supporting assembly causes movement of said contact means longitudinally along said guide in a direction parallel to the axis of said cylindrical member.

12. A sensitive resistance device of the character disclosed, comprising a core having a double helical groove formed in the periphery thereof, resistance wires in said grooves, a guide parallel to and rotatable about the axis of said core, and a slider movable along said rod and comprising a seat element seated thereagainst and a bridging contact interposed between said seat element and said resistance wires, said bridging contact having grooves fitting the wires and having a seat between the wires, and a spring interposed between said rest element and said bridging contact, said spring having an end seated in said seat of said bridging contact whereby the contact may seat with equal pressure against the resistance wires in said grooves.

13. An instrument of the character disclosed, comprising a stationary cylindrical core having a pair of thread grooves formed in the periphery thereof, a resistance wire in each groove, an arm rotatable about the axis of said core, a guide rod supported thereby in a position substantially parallel to said axis, and a slider movable along said guide rod, said slider comprising a pair of V-seat elements and a bridging contact interposed between said rod and said resistance wires, said slider including a spring carried by said V-seat elements and engaging against said bridging contact at a point between said resistance wires.

14. A sensitive resistance device of the character disclosed, comprising a cylindrical core having a pair of helical grooves formed in the periphery thereof, a resistance wire in each groove, terminal connections to said resistance

wires, an arm, the arm and said core being relatively rotatable, a guide rod supported by said arm in a position substantially parallel to the axis of said core, and a slider movable along said rod and interposed between it and said core, said slider having a bridging contact provided with grooves receiving said resistance wires and with a depression on the opposite side of said grooves, and a spring interposed between said slider and said bridging contact and having a portion seated in said depression of said bridging contact to permit universal movement thereof relative to the spring.

15. In a variable resistance device, a cylindrical member having an accurately machined outer surface and an inner concentric bore, the outer surface of said member being provided with a helical groove, a resistance wire wound in said groove, a contact supporting assembly comprising a rod closely fitting said inner bore and a guide spaced from the outer surface of said cylindrical member and extending parallel to the axis thereof, and a contact means slidable upon the guide and engaging a side of said resistance wire whereby relative rotation of said cylindrical member and contact supporting assembly causes movement of said contact means longitudinally along said guide in a direction parallel to the axis of said cylindrical member, said contact means having a depression-like seat and said contact assembly including a spring having a pointed end seated therein to permit floating of the contact means relative to the spring.

16. A sensitive resistance device of the character disclosed, comprising a cylindrical core having a pair of helical grooves formed in the periphery thereof, a resistance wire in each groove, terminal connections to said resistance wires, an arm, the arm and said core being relatively rotatable, a guide rod supported by said arm in a position substantially parallel to the axis of said core, and a slider movable along said rod and interposed between it and said core, said slider having a pair of bridging contacts, each provided with a depression on the opposite side from the resistance wire engaging side thereof, and a leaf spring having its central portion engaging said slider and its ends pointed and seated in said depressions of said bridging contacts to permit universal movement of the contacts relative to the spring, the spring being under tension to provide pressure of said slider against said rod and said contacts against said resistance wires.

17. An instrument of the character disclosed having a core provided with a pair of grooves, a resistance wire in each groove, a guide rod supported in a position substantially parallel to the surface of said core, a slider movable along said rod and comprising a pair of seats spaced longitudinally of the rod, each seat having only two-point engagement with said rod, and a bridging contact interposed between and engaging said rod and said resistance wires respectively, and means to cause said engagement to be resilient.

18. In a sensitive resistance device of the ad-

justable type, an element having a cylindrical surface, a resistance wire wound helically around said surface, an elongated guide element parallel to said surface and at substantially right angles to said resistance wire, said surface and said guide element being relatively rotatable about the axis of said cylindrical surface, a rocker arm having means of engagement intermediate its ends against said guide element, a contact element carried by one end of said rocker arm, and a second contact carried by the other end of said rocker arm, said contacts engaging said resistance wire between adjacent turns thereof whereby the rocker arm is moved along said guide element upon relative rotation of the guide element and said surface.

19. An instrument of the character disclosed having a core provided with a pair of grooves, a resistance wire in each groove, a guide rod supported in a position substantially parallel to the surface of said core, a slider movable along said guide rod and comprising a pair of V-seat elements, and a bridging contact interposed between said rod and said resistance wires, said slider including a spring carried by said V-seat elements and engaging against said bridging contact at a point between said resistance wires.

20. A sensitive resistance device of the character disclosed comprising a core having a pair of grooves formed therein, a resistance wire in each groove, a guide rod, said guide rod and said core being relatively movable and the rod being supported in a position substantially parallel to the surface of the core, a slider movable along said rod and interposed between it and said core, said slider having a pair of bridging contacts each provided with a depression on the opposite side from the resistance wire engaging side thereof, and a leaf spring having its central portion engaging said slider and its ends pointed and seated in said depressions of said bridging contacts to permit universal movement of the contacts relative to the spring, the spring being under tension to provide pressure of said slider against said rod and said contacts against said resistance wires.

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