Feb. 28, 1939. E. R. STOEKLE 2,148,785

ADJUSTABLE RESISTANCE

Filed Aug. 19, 1935 2 Sheets-Sheet 1

Fig. 1.

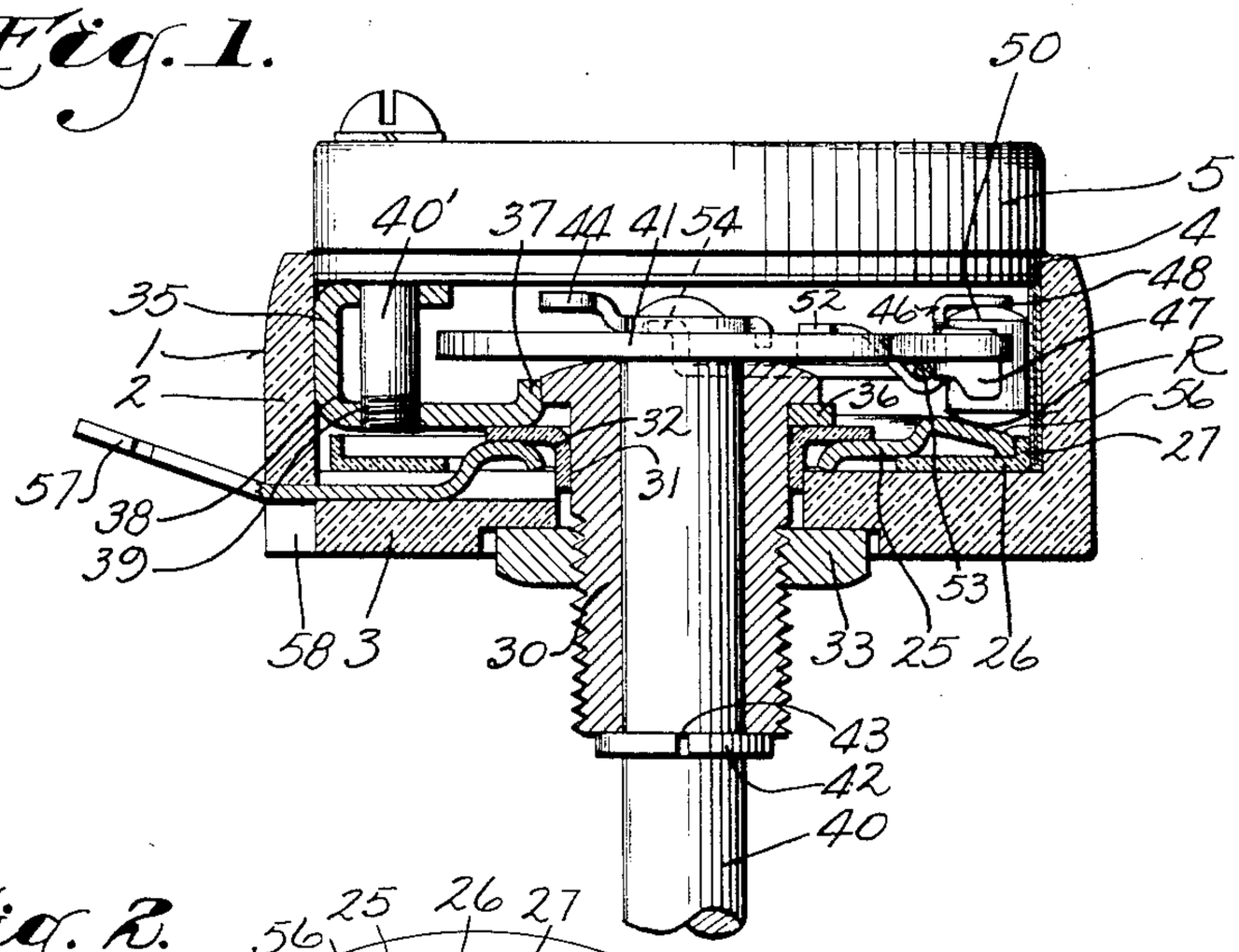

Fig. 2.

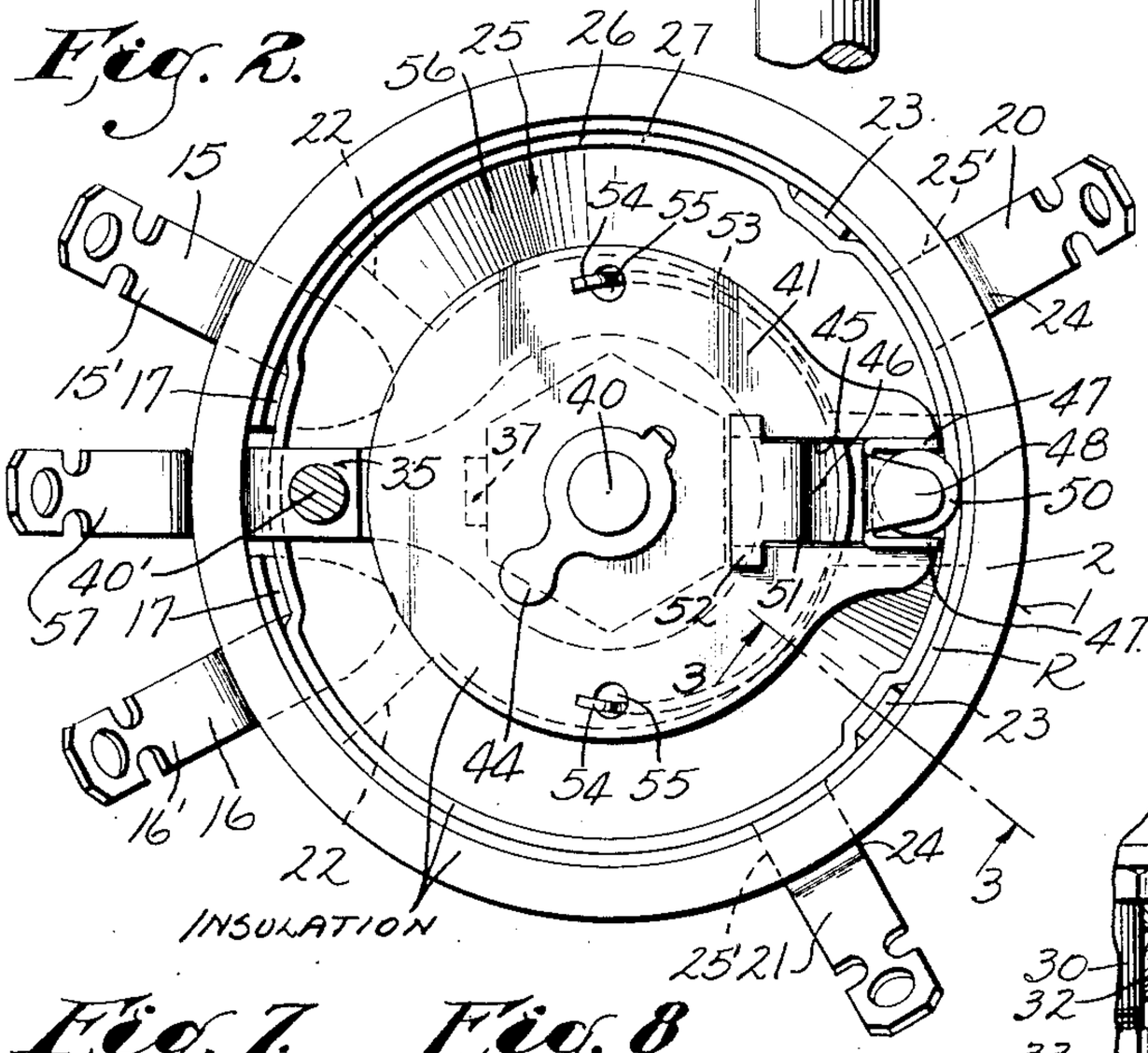

Fig. 3.

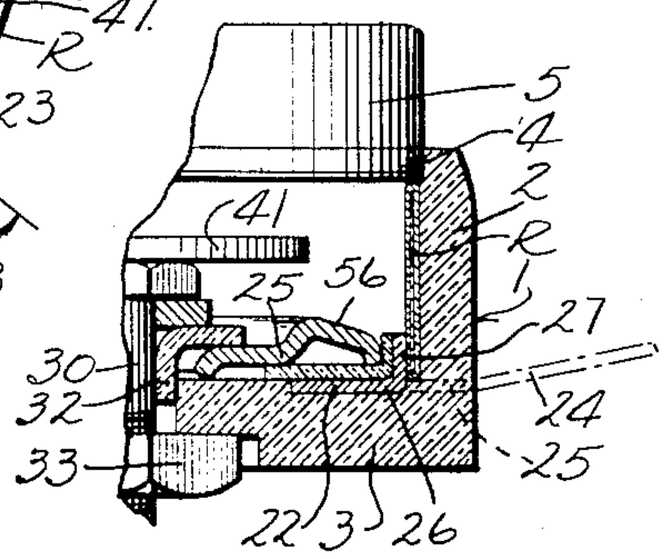

Fig. 7.

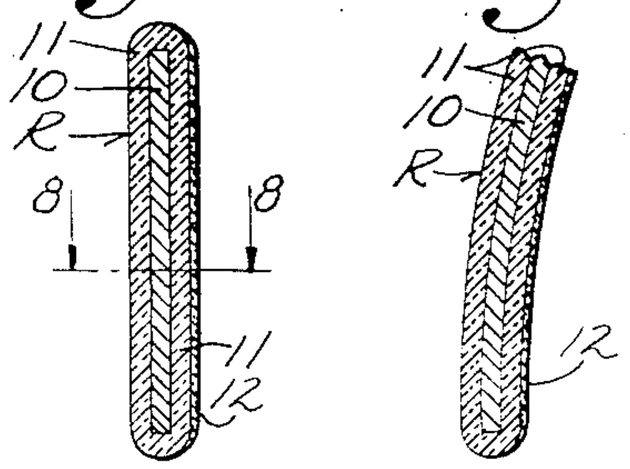

Fig. 8

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Fig. 4.

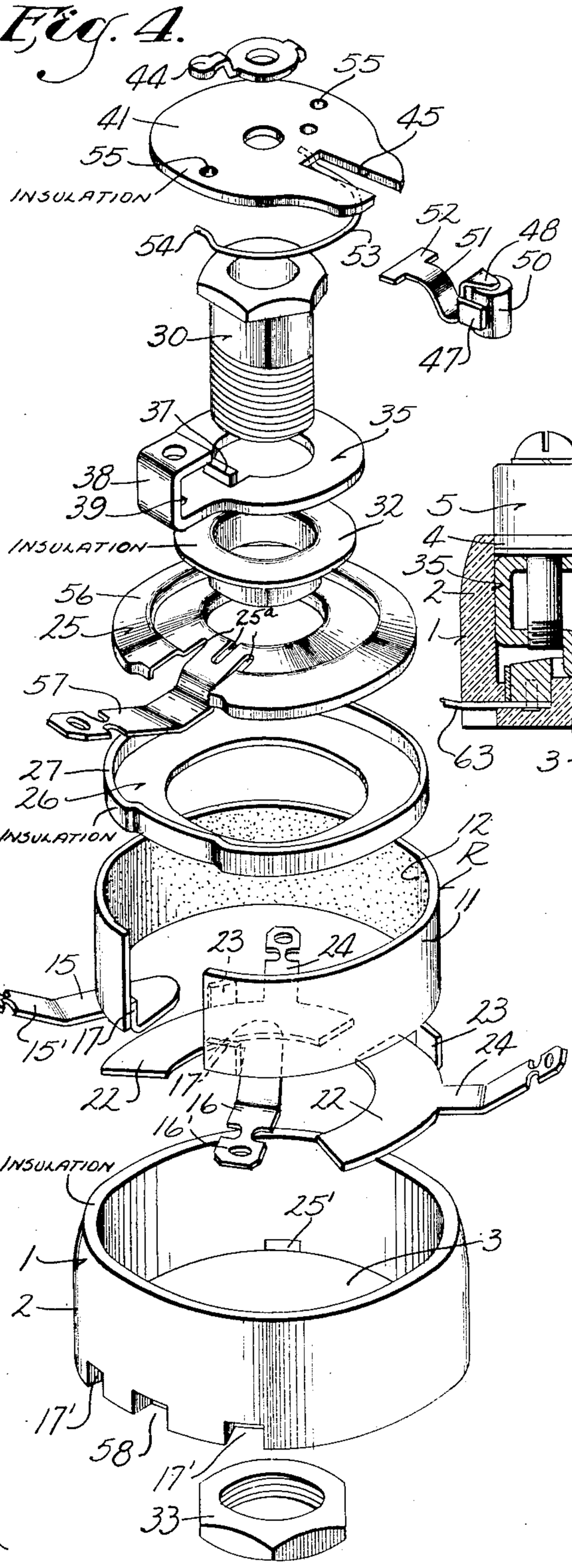

Fig. 5.

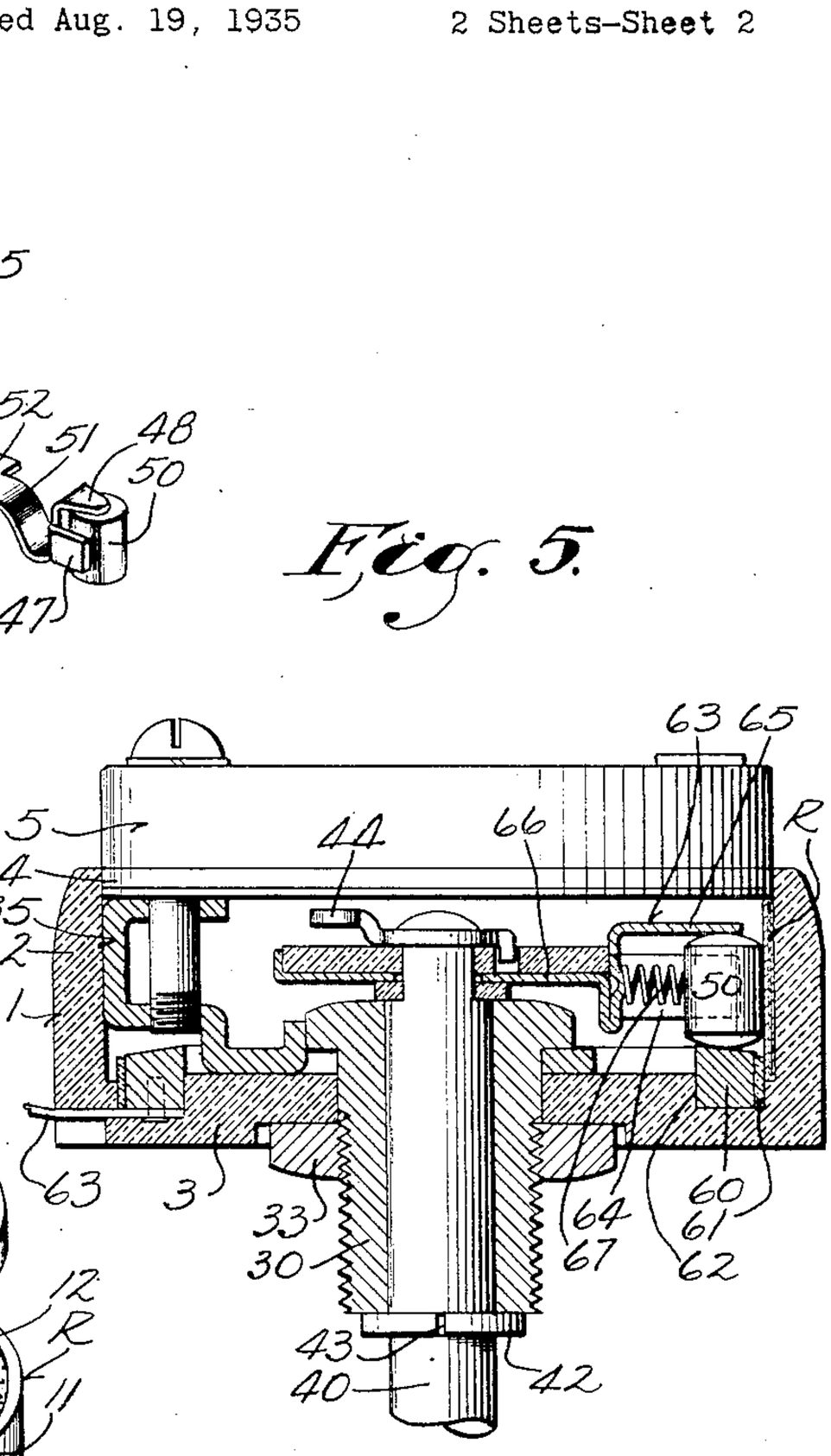

Fig. 6.

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ADJUSTABLE RESISTANCE

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Application August 19, 1935, Serial No. 36,771

8 Claims. (Cl. 201—55)

This invention relates to an improvement in adjustable resistances of the type wherein the resistance element consists of a coating such as a carbonaceous coating applied to a flex-backing strip having cooperable therewith a rotary contact member for varying the value of the effective resistances.

In the pending application of Erwin R. Stoekle for Adjustable resistances, filed July 7, 1933, Serial No. 679,291, which has matured into Patent No. 2,041,380 the resistor was made in the form of a flexible strip having applied thereon a resistive coating of a carbonaceous material. This resistance coating, because of the requirements of a tapering value of resistance most generally called for in this type of resistance device, must necessarily be applied in such a manner as to have a variable specific resistance along the length of the strip. The obvious advantages of coating a resistor in the form of a strip, as compared with the more commonly used flat annular ring form, were pointed out in the above mentioned prior application.

At the time that the above mentioned prior application was filed, it was necessary to interpose a contact member between the resistor and the rotatable pressure arm, so as to avoid the direct rubbing or sliding of the adjustable contact upon the resistor. With the resistors concurrently used at that time, such sliding or rubbing contact caused undue change of the resistance value of the device. Since that time, however, carbonaceous resistance films have been developed which will withstand a certain degree of sliding or rubbing contact without undue change in resistance.

One of the objects of the present invention is to provide an adjustable resistance of the type having a coated strip resistor mounted on the inner wall of the housing of the device and directly cooperable with a novel form of adjustable contact which is so mounted and controlled as first, to have linear contact in all adjustments with the resistor, and second, to maintain such linear contact for the full transverse width of the resistor strip in any adjustment. These advantages are realized by combining with the resistor strip a special form of movable contact not only adjustable but also floatably mounted in all adjustments and so biased as to have proper engagement with the resistor strip.

With a construction of this character the adjustable contact has intimate engagement with the resistor strip entirely across its width, although the contact is made only along a restricted length of the strip so as to make possible engagement between the movable contact and every element of the length of the strip. Furthermore, the contact element is, to some extent, free to roll in the direction of its motion along the resistor.

Another object of the invention is to provide a device of this character which is so advantageously and highly organized as to be a very compact construction and yet readily produced with economy and reliable and efficient when in use.

It has been customary to construct resistors for this type of unit in the past by coating a resistance material upon an insulating strip of paper, fiber or Bakelite. As previously pointed out the specific resistance of the film on such resistors varies from rather low values to very high values in resistors of this character to meet the requirements of volume controls and tone controls in radio circuits. The results of this are that the portions of the film having high specific resistance are required to dissipate much more energy than the portions having lower specific resistance. Using the materials for these strips which are now commonly used, such as paper and Bakelite, it is found that the electrical load-carrying capacity of these resistors is very small.

The present invention aims to overcome the disadvantages of this type of resistor by virtue of the provision of a novel resistor structure, one that is capable of carrying relatively heavy currents without disintegration or break down. In general, this advantage is realized by utilizing for the backing or mounting strip of the resistor a material of high thermal conductivity and consequently high heat dissipating properties and so intimately combining with such a mounting strip the resistive material that while the resistive material is electrically insulated from the strip it is in intimate heat interchanging relation with respect thereto.

Other objects and advantages reside in certain novel features of the construction, arrangement and combination of parts which will be hereinafter more fully described and particularly pointed out in the appended claims, reference being had to the accompanying drawings forming a part of this specification and in which:

Figure 1 is a view partly in transverse diametrical section and partly in elevation showing an adjustable resistance embodying the invention;

Figure 2 is a view in top plan illustrating the resistance shown in Figure 1, with the switch and cover plate removed;

Figure 3 is a fragmentary view in transverse section taken on line 3—3 of Figure 2;

Figure 4 is a group view in perspective illustrating the various elements of the adjustable resistance prior to assembly;

Figure 5 is a view similar to Figure 1 but showing a modified type of construction in which the invention may be embodied;

Figure 6 is a detail view in top plan illustrating the resistor construction per se;

Figure 7 is a view thereof in transverse section taken on line 7—7 of Figure 6, the thickness of the insulating layer being much exaggerated for the sake of clarity in illustration; and

Figure 8 is a fragmentary view in section taken on line 8—8 of Figure 7.

Referring to the drawings, and more particularly to Figures 1 to 4, inclusive, it will be seen that an adjustable resistance embodying the present invention comprises an insulating housing designed generally at 1 and made up of a peripheral body portion 2 and an integral end wall or bottom 3. The end of the housing opposite the wall 3 is open but in the assembly this is preferably closed by a cover plate 4 on which a switch designated generally at 5 is mounted and secured.

Within the housing 1 a resistor designated generally at R is provided. While many of the advantages of the invention may be realized with the resistor constructed in various ways well known to those skilled in the art, preferably, the resistor is constituted as illustrated to advantage in Figures 6 to 8. As therein shown, the resistor comprises a flexible strip 10 constituted of aluminum, copper, or similar material. Material is selected which has a high thermal conductivity and the ability to dissipate heat rapidly and yet flexible and also susceptible to the application of first an insulating and then a conducting layer. In instances where the strip is constituted of aluminum it is first treated by a process known as anodizing and then coated with an insulating japan as indicated in an exaggerated fashion at 11, and finally coated on one surface or face with a resistance film 12 which may be a carbonaceous material and a suitable binder. Where the strip 10 is constituted of a copper it is sufficient to japan it and thereafter coat one face with a conducting coating or film. As previously suggested, it is desirable to have different portions of the conductive coating of different specific resistances and the present invention lends itself admirably to this and yet produces a resistor which has a capacity to carry relative heavy electrical loads. This advantage is mainly realized because of the ability of the metal strip of the character mentioned to rapidly dissipate the heat generated as a result of the passage of considerable current through the zone or portion of the conductive film having a high specific resistance. In this connection it should be noted that while the conductive film is electrically insulated from the metallic carrying strip it is in intimate heat interchanging relation thereto so that the heat generated in the film of high specific resistance is transmitted rapidly by conduction to the adjacent portion of the metal strip and then dissipated throughout the entire strip. Hence, the portions of the resistance of high specific resistance as well as the other portions do not have heat conditions set up therein which are likely to break down the conductive coating.

Terminals 15 and 16 are provided for the ends of the resistor R. These terminals have portions located within the housing and provided with vertical tabs 17 which bear directly against the conductive film or coating of the resistor and also have portions 15' and 16' which project exteriorly of the housing through appropriate slots 17'.

The construction also lends itself to the use of the so-called tap terminals which may be connected up with the resistor at any desired point intermediate its ends. In Figures 2 and 4, two such tap terminals are illustrated and are indicated at 20 and 21. They are of identical construction and each has a segmental portion 22 resting flatly against the bottom of the housing and provided with an integral tab 23 bearing immediately against the conductive film or coating of the resistor R. The projecting portions 24 of these tap terminals extend through suitable slots or openings 25' provided therefor in the housing 1 (see Figure 4).

The resistor R is held in proper place against the inner wall of its housing and the terminals are forced into firm, mechanical and electrical connection therewith by means of an expansible metal disc or washer 25, which exerts its securing action through a flanged insulating disc 26. The disc 26 rests directly on the bottom of the housing and its peripheral flange 27 bears against the lower inner peripheral face of the resistor. The peripheral edge of the expansible washer 25 engages this flange 27 and when the washer 25 is expanded firmly clamps the flange, the terminal tabs and the lower portion of the resistor in position in the housing. The body of the disc 25 is bulged or buckled upwardly in approximately convex form when not compressed and hence compression and consequent flattening thereof expands the disc or washer radially.

The disc 25 may be provided with transversely extending slots 25a but usually it is desirable to have one of the slots immediately adjacent the terminal 57 extend for the full transverse width of the washer so that the washer is a split washer and thus better adapted for radial expansion.

For the purpose of expanding the washer 25 and obtaining this securing action in respect of the terminals and the resistor a bushing 30 is provided and extends through central openings provided in the washer 25, its cooperable insulating disc 26 and in the bottom 3 of the insulating housing.

Encircling the unthreaded peripheral portion 31 of the bushing 30 is the apertured body portion 36 of a bracket 35 and interposed between the body of this bracket 35 and the central portion of the expanding disc or washer 25 is a flanged insulating washer 32, the latter serving to insulate the expansible washer 25 from the bushing 30. In the assembly, a nut 33 is threaded on the lower portion of the bushing and bears against the under part of the housing to cause the hexagonal head or flange of the bushing to firmly clamp the parts 36, 32 and 25 in place. The clamping action results in a compression of the bulged or dished portion of the washer 25 and a consequent expansion of its periphery. The expanded periphery of the disc 25 acting through the flange 27 of the disc 26 firmly clamps the terminals and the resistor in place.

At one point the bracket body 36 has a lug 37 struck up therefrom to engage one face of the hexagonal flange of the bushing 35 to preclude relative rotation of these parts. Integral with the body of the bracket is a U-shaped extension 38, provided with alined apertures, one of which is threaded as at 39 to coact with an attaching

screw 40' utilized to hold the switch 5 and cover 4 in place.

Rotatably mounted in the bushing 30 is an operating shaft 40. To the inner end of this shaft a switch operating arm 41 is suitably secured. The shaft is held against axial movement by the engagement of this arm with one end of the bushing and by the provision of a split ring 42 which snaps into an annular groove 43 in the shaft 40 and bears against the other end of the bushing. The end of the shaft to which the arm 41 is attached may also have an operating arm 44 fixed thereto and designed to coact with the operating element of the associated switch 5 in a manner well known in the art.

As shown to advantage in Figures 2 and 4, the arm 41 is provided with a radial slot 45. This slot 45 accommodates a contact carrier designated generally at 46. The carrier 46 is formed up from sheet metal and has its main portion provided with side ears 47 and a top ear 48 which engage diametrically opposite peripheral portions and the top, respectively, of a cylindrical contact member designated at 50. Integral with the main portion of the carrier is an offset T-shaped extension 51 which extends up through the slot 45 of the arm and has its laterally projecting portions 52 riding on the arm 41 along the margins of the slot 45. Associated with the contact carrier 46 and arm 41 is a stirrup-shaped spring 53, the bowed portion of which engages the extension 51 of the carrier at the point where it merges with the main portion of the carrier and beneath the arm 41. The ends of the spring 53 are offset and hooked as at 54 to engage in openings 55 in the arm 41. In the assembly, the spring is distorted or under compression so as to bias the carrier 47 downwardly and outwardly, thereby pressing the movable contact 50 downwardly and also outwardly against the resistor. Due to the fact that the body of the movable contact 50 is cylindrical it has substantially linear contact with the resistor R. Further, its ends are rounded and the lower end of the movable contact 50 bears on the outwardly and downwardly inclined surface 56 of the washer 25. In fact, this surface 56 lies on a cone whose apex is somewhere in the center line of the shaft 40. With this arrangement the contact 50 is, within limits floatably mounted in its carrier, and consequently it may rock or move to adapt itself to any irregularities transverse to the width of the resistor strip.

The extent to which the arm 41 and its movable contact 50 may be turned in either direction is limited by the engagement of the arm with the screw 40'.

The expansible metal washer 25 has, of course, an immediate and direct engagement with the movable contact 50 and it may be conveniently utilized as the means for connecting this movable contact up with the external circuit. For this purpose it may have integral therewith a terminal 57 which projects through the slot 58 in the housing to the exterior thereof.

In the modified form of construction shown in Figure 4, the expansible washer 25 and its flanged insulating washer 36 are omitted. In Figure 5 the resistor R and its terminals are held in position by means of a wedging ring 60, either continuous or in the form of a split spring annulus, which acts through an annular insulating strip 61 to press the resistor R firmly up against the inner wall of the housing and the terminals firmly against the resistor. The ring 60 is firmly driven into an annular groove 62 of correspondingly wedge-shaped cross section provided therefor in the bottom wall of the housing immediately adjacent its peripheral wall. The ring 60 is itself of conductive material and may be provided with a terminal 63. Its upper surface is of the same form as the portion 56 of the washer 25 and provides a track on which the lower rounded edge of the movable contact 50 rides. In Figure 5 there is also a modified form of carrier for the movable contact. As before, the movable contact here designated at 63 has side ears 64 and a top ear 65 engaging the periphery and top respectively of the movable contact and accommodated in the slot 45 of the arm 41. The attaching portion 66 of this carrier may, however, rest flatly against the underside of the operating arm and be secured thereto in any appropriate way inasmuch as the spring 53 is omitted and in lieu thereof a helical spring 67 is employed, this spring having one end bearing against and suitably interconnected with the carrier and having its other end pressing outwardly on the movable contact 60. In this arrangement the top ear 65 is preferably resilient and exerts a downward pressure on the movable contact.

In both embodiments of the invention, the advantage of a simplified movable contact is had and the movable contact coacts in an advantageous manner with the resistor. Furthermore, in both constructions a resistor is employed which is capable of carrying considerable current without excessive heating and consequent break down.

While I have shown and described several constructions in which the invention may be embodied, it is to be understood that these constructions have been selected merely for the purposes of illustration or example and that various changes in the size, shape and arrangement of the parts may be made without departing from the spirit of the invention or the scope of the subjoined claims.

The invention claimed is:

1. An adjustable resistance comprising a housing having a base and a cylindrical peripheral wall, a resistor disposed in the housing against said cylindrical peripheral wall, means for securing the resistor in position in the housing, a track of conductive material disposed on said base just inwardly of said resistor and angled downwardly toward the resistor, a terminal connected to said track, terminals connected to the resistor, and adjustable contact means comprising a rotatable arm, a movable contact of rounded cross section in rolling linear contact with the resistor and having its lower end bearing upon and riding on said track, and means carried by said arm and cooperable with the body and upper end of the contact for biasing it into linear contact with said resistor for the full transverse extent thereof and for causing its lower end to press against the track.

2. An adjustable resistance comprising a housing, a resistor disposed in the housing, means for securing the resistor in position in the housing, adjustable contact means cooperable with the resistor and comprising a rotatable arm, a movable contact having a cylindrical body portion provided with rounded ends, a carrier mounted on said arm and having resilient ears engaged with opposed portions of the body of the movable contact and with the top thereof, and a track angled toward the resistor on which the lower end of the movable contact rides whereby the movable contact is biased into rolling linear en-

gagement with the resistor for the full transverse extent thereof.

3. An adjustable resistance comprising a housing, a resistor including a flexible member positioned against a wall of the housing, terminals disposed against said resistor, a resilient metallic disc of convex buckled form and radially expansible and positioned in the housing, and means for flattening the disc and expanding it peripherally to cause it to press the terminals against the resistor and the resistor against the housing.

4. A variable electric resistance comprising a housing having a cylindrical interior wall, an electrical resistance element disposed about said wall of said housing, terminals engageable with the surface of said resistance element, an expansible washer positioned within the housing and formed to be convex toward the open side of said housing and insulated from said resistor and said terminals but capable of being flattened into a plane parallel to the closed bottom of said housing whereby said expansible washer will expand radially to exert pressure against said resistor and its associated terminals and will hold said resistor against the wall of said housing and said terminals in intimate contact with said resistor.

5. An electrical resistance adjustable as a rheostat or potential divider comprising a housing having an interior cylindrical wall, a resistor in the form of a strip curved to conform to said wall and held firmly thereagainst but electrically insulated therefrom, terminals having portions adapted to lie against said resistor and means for firmly holding said resistor against said wall and also for pressing said terminals into firm electrical contact with said resistor, an insulating arm fixed to a rotatable shaft coaxial with said interior cylindrical wall, a metal housing loosely retained in a slot in said arm, a spring urging said metal housing radially outward from said shaft, a cylindrical contact element retained in said metal housing and having its axis substantially parallel to the axis of the operating shaft, said contact having a portion of its cylindrical surface exposed and pressed into substantially linear contact with the inner surface of said resistor by means of said spring whereby contact can be made at any desired location on the resistor strip.

6. An adjustable electrical resistance comprising a housing having an interior cylindrical wall, a resistor in the form of a strip curved to conform to said wall, suitable terminals having portions adapted to be pressed against said resistor, an exteriorly flanged insulating washer with its flanged edge adjacent to the surface of said resistor and its associated terminals, an expansible metal washer fitting within the flanged edges of said insulating washer and formed convexly toward the open side of said housing, a terminal in electrical contact with said washer and extending through an opening in said housing, means for drawing the convex central part of said metal washer toward the bottom of said housing thus causing said washer to expand and to exert a radial pressure on said resistor strip and its associated terminals holding them firmly in contact and firmly within the housing, a substantially cylindrical contact element with rounded ends carried by an insulating arm fastened to a rotatable shaft, a spring carried by said arm and adapted to urge the cylindrical surface of said contact into electrical contact with said resistor and simultaneously to urge a portion of said contact into contact with said expansible metal washer whereby electrical contact may be established from any desired location on said resistor to said expansible metal washer.

7. An adjustable electrical resistance comprising a housing having an interior cylindrical wall, a resistor in the form of a strip curved to conform to said wall, suitable terminals having portions adapted to be pressed against said resistor, an exteriorly flanged insulating washer with its flanged edge adjacent to the surface of said resistor and its associated terminals, an expansible metal washer fitting within the flanged edges of said housing, a terminal in electrical contact with said washer and extending through an opening in said housing, means for drawing the convex central part of said metal washer toward the bottom of said housing thus causing said washer to expand and to exert a radial pressure on said resistor strip and its associated terminals holding them firmly in contact and firmly within the housing, and an adjustable contact cooperable with said resistor and in electrical connection with said washer.

8. An adjustable electrical resistance comprising a housing, a resistor including a flexible member positioned against a wall of the housing, terminals disposed against said resistor, a flanged insulating washer having its flange adjacent the surface of said resistor and its associated terminals, an expansible metal washer fitting within the flange of said insulating washer, and means for expanding the expansible metal washer to cause it to exert holding pressure against the flange of said insulating washer which, in turn, secures the terminals and resistor in position in the housing.

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