Nov. 24, 1931. N. C. SCHELLENGER 1,833,042

VOLUME CONTROL

Filed Jan. 20, 1930 2 Sheets-Sheet 1

Fig. 1.

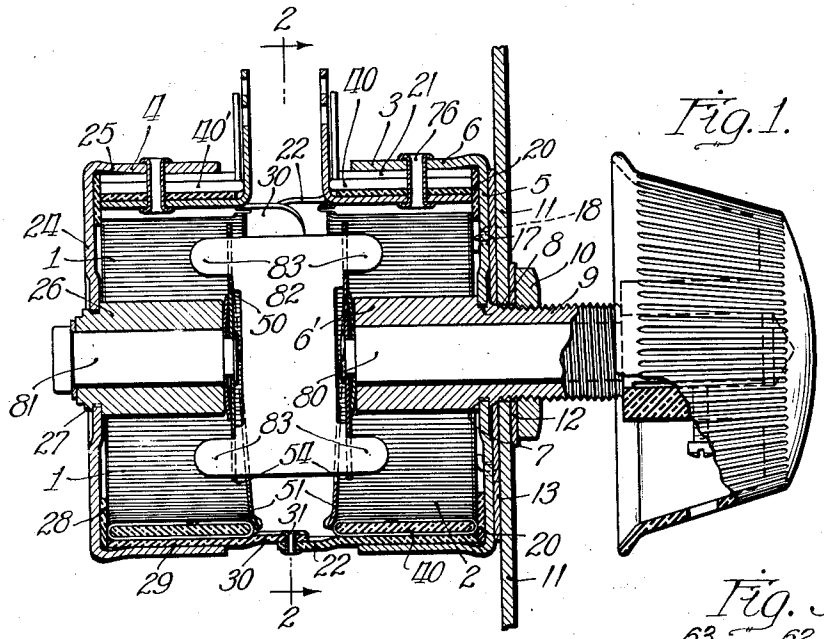



Fig. 3.

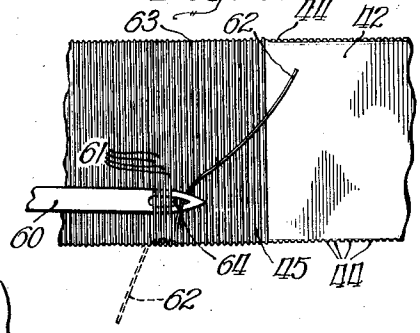
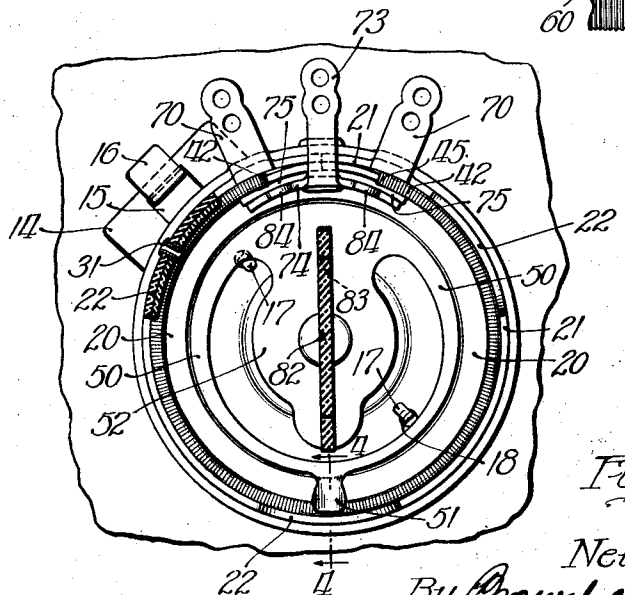



Fig. 2.



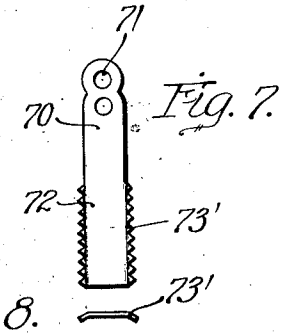




Fig. 7.

Fig. 8.

Inventor
Newton C. Schellenger
By Thompson Bruce & Simmons
Attys

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VOLUME CONTROL

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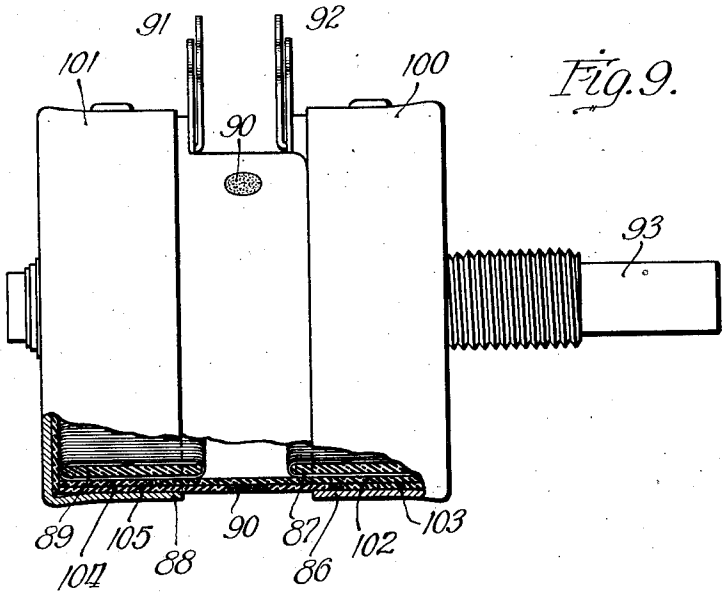



Fig. 9.

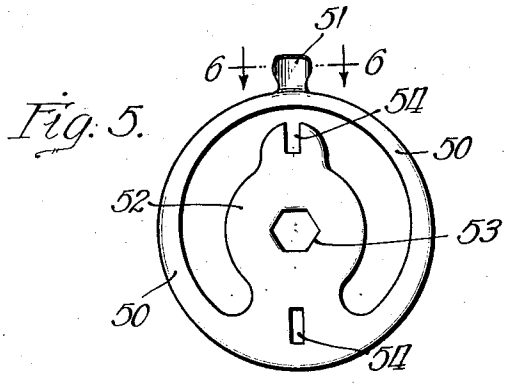



Fig. 5.

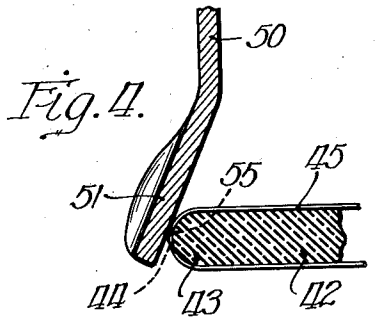



Fig. 4.




Fig. 6.

Inventor
Newton C. Schellenger

By Brown Jackson Boettcher & Steiner
Attys

Patented Nov. 24, 1931 1,833,042

# UNITED STATES PATENT OFFICE

NEWTON C. SCHELLENGER, OF ELKHART, INDIANA, ASSIGNOR TO CHICAGO TELEPHONE SUPPLY COMPANY, OF ELKHART, INDIANA, A CORPORATION OF INDIANA

## VOLUME CONTROL

Application filed January 20, 1930. Serial No. 422,028.

This invention relates to volume controls, more particularly to volume controls of the tandem type and has for its principal object the production of a new and improved volume control that can be manufactured cheaply without sacrificing quality of materials and workmanship.

In electrical apparatus such as radio sets, audio frequency amplifiers, X-ray apparatus and the like, in which vacuum tubes are employed to amplify or generate high frequency alternating current, it has become the standard practice to control the amplitude of such alternating current by means of resistors which have therefore assumed the trade name of volume controls. In a radio set for example the loudness of the set is generally controlled by a resistor which is usually bridged across the secondary of a coupling transformer with the grid of one of the vacuum tubes connected to the rider of the volume control.

Frequently in radio sets it is desirable to control the gain of the amplifiers at more than one point in the set, and for this reason volume controls are frequently constructed with two or more resistors mechanically connected together to be operated by a single knob on the panel of the radio instrument. Although the resistors are mechanically connected together, they are electrically insulated from each other and connected into entirely different parts of the electrical circuit of the radio set. The volume control of the present invention is of this multiple unit or so-called tandem type, although many of the principles of its construction can be employed in single unit resistors or volume controls.

To this end I have provided a compact unit which can be constructed cheaply without sacrificing quality, either of materials or workmanship, and provide a simple and inexpensive means of rigidly connecting two of these units together to form the tandem control.

The present invention further provides an improvement in supporting and coupling two rheostats or control units so that they may be operated in unison for joint control, also an improvement in securing the resistance element in the shell of its associated unit and an improvement in the resistance element and manner of cooperation of the contacting arm therewith.

The details of this construction can best be understood from the detailed description of the drawings which show a preferred embodiment of my invention to acquaint one skilled in the art with the teachings of it, and in which:

Figure 1 is a cross sectional view through a completely assembled tandem volume control.

Figure 2 is a view through Figure 1 taken along the line 2—2 looking in the direction of the arrows;

Figure 3 is a fragmentary detail view of the resistance element showing the method of coupling the separate sections of it electrically together;

Figure 4 is a fragmentary section taken along the line 4—4 of Figure 2 looking in the direction of the arrow and showing the details of the contactor;

Figure 5 is a plan view of the contactor;

Figure 6 is a cross-sectional view taken along the line 6—6 of Figure 5 and drawn to an enlarged scale;

Figure 7 is a plan view of a terminal lug of the unit;

Figure 8 is an end view of the lug shown in Figure 7; and,

Figure 9 is a side elevational view partly in section, of a modified form of my invention.

Referring to the drawings now in more detail, the volume control comprises two main units 1 and 2 which are bound within cup-like metallic shells 3 and 4, which shells are placed with their open ends adjacent and with their axes coinciding.

The shell 3 comprises a planar portion 5 and side wall 6 projecting therefrom at substantially right angles to the planar portion 5. This cup is preferably a metallic cup made of brass or other suitable non-magnetic material, although the specific material used may be made within the teachings of the invention.

Centrally located within the planar portion 5 of the cup 3 is a perforation having serrated edges into which the shouldered bushing 6′ is fitted with the shoulder 7 firmly engaging the inside surface of the planar portion 5.

The bushing 6′ is provided with a collar-like portion 8 which accurately fits into the serrated opening in the planar portion 5 and which is riveted therein preferably by a ring stake which swedges the metal of the bushing out into the serrations in the portion 5 to rigidly lock the bushing 6′ against rotation in the shell 3. The outward end of the bushing 6′ is threaded at 9, adapting it to receive the mounting nut 10 by which the unit is mounted on the panel 11 with washer 12 interposed between the nut 10 and the panel.

The planar portion of the shell 3 is also provided with a positioning plate 13 which is provided with a rectangular projection 14, Figure 2, containing a perforation 15 through which an ear of metal 16 of the panel 11 is projected to prevent rotation of the unit around the bushing 6′ when the nut 10 is being tightened. This positioning plate 13 is held on to the shell 3 by ears 17 which are bent up through perforations 18 in the planar portion 5 of the shell.

Within the shell I have placed a gasket 20 which plays against the inside surface of the planar portion 5 adjacent the side wall 6. I have also placed an insulator 21 around the inside surface of the side wall 6, the bottom edge of that insulator resting against the gasket 20. Preferably the insulator 21 contains a plurality of ears 22 which project outward beyond the free edge of the side wall 6 of the shell 3 and serve as mounting ears for attaching the unit 4 to the unit 3.

The unit 4 is similarly constructed and comprises a metallic cup having planar portion 24 and side wall 25, the planar portion 24 containing a serrated opening through which the bushing 26 is projected and staked as at 27 to rigidly attach it to the shell member. The shell 4 is provided with an insulating gasket 28 and with the side wall insulator 29, and the latter insulator is provided with ears 30 which register with the ears 22 on the insulator 21.

The ears of the one insulator are connected to the ears of the other in any convenient manner as by eyelets 31 which are riveted through the two projecting ears 22 and 30.

The resistance element 40 is disposed within the shell 3 and a similar element 40′ is disposed in the shell 4, the lower edges of these elements bearing against the insulating gaskets 20 and 28 respectively and outer surfaces of the elements bearing against the side wall insulators 21 and 29 respectively.

The resistance units 40 and 40′ preferably comprise an insulating strip 42 which is of generally rectangular cross-section and of sufficient length to accurately fit around the side walls of the shell inside of the insulator with its opposite ends abutting each other. The edges of the strip 42 are formed to a somewhat oval shape as at 43, and grooves 44 are cut in the extreme end of this rounded portion, those grooves serving as spacers to space the wire 45 on the strip and to rigidly hold it against movement thereon.

Volume control resistors of this type are usually of rather high resistance and in order to make the unit sufficiently compact to fit within commercial radio sets and other similar devices, it is necessary to employ a rather fine or small size resistance wire having a rather high specific resistance.

Generally the wire used for this purpose is a nickel alloy metal and the diameters are frequently as small as two or three thousandths of an inch. By making the grooves 44 sufficiently deep to practically imbed the wire over the very edge of the strip, and by spacing these grooves properly the small size wire can be uniformly and rigidly wound on to the element 42 to secure a permanent resistor.

The rider or contactor which must bear against the wire 45 to establish an electrical connection therewith is shown in detail in Figures 5 and 6 and comprises an annular portion 50 containing a projecting contacting arm 51 which is formed as an arc, as will be seen in Figure 6. Centrally located within the annular ring 50 is a lobe 52 containing a hexagonal opening 53 located at the geometric center of the ring 50. This lobe 52 also contains rectangular slots 54 which are provided to permit coupling the two units of the volume control together in a manner which will hereinafter appear.

If the contactor 51 were made in the usual manner, that is so that it contained a flat portion in engagement with the wire of the unit, and upturned edges to permit that flat portion to ride over the wires as the contactor is moved to adjust the volume control, the sharp or relatively sharp edges at the point at which the metal is broken from the flat planar portion to the upturned edges would dig into and injure the fine wires employed in the volume control. This would be particularly so if any irregularity in the diameter of the wires was encountered, as is frequently the case in commercial practice.

To obviate this difficulty I have provided an arcuate member 51 which presents a perfectly smooth contacting surface which can ride over the small wires 45 on the resistor without dislodging or injuring them in any way.

To further insure that the contactor 50 will not dislodge or injure the turns of the winding and to prevent engagement of the contact member with the insulating strip 42 rather than with the wire such as might occur were

the contactor to engage the wire along the portions of the turns thereof which lie in the grooves 44, the contactor is arranged so that it bears against the wire 45 where the wire emerges from the grooves. The full thickness or substantially the full thickness of the wire is thereby interposed between the contact member and the surface of the insulating strip nearest the contact member which assures proper spacing of the contact member from the insulating strip and prevents engagement of this contact member with the strip rather than with the wire. At the same time, engagement of the contact member with the wire where it emerges from the grooves places the contacting engagement between the contact member and the wire where the wire is held against displacement on the insulating strip by the movement of the contact member. In the particular embodiment illustrated, the contacting member 51 is formed so that it bears against the wire on the strip 42 at an angle of approximately 65 degrees to the side of the strip 42, but this may, of course, vary widely.

The slot can therefore be made deep enough to practically embrace half of the wire without danger of the contactor 51 riding over the insulation rather than over the wire 45. The bearing point of the contactor 51 on the wire is sufficiently close to the slot so that the wire is not moved longitudinally of the insulator 42 as the volume control is adjusted.

In these high resistance resistors used in volume controls and similar apparatus, it is frequently advantageous to form the resistance unit of more than one kind of wire. This is particularly advantageous if a non-uniform variation of resistance is required as the volume control is moved in arcuate path responsive to a turning of its control knob. To this end various arrangements have been tried heretofore, some employing different size wires of the same material, and others employing wires of the same size but of different specific resistance.

In either event, because of the smallness of the wire, that is a wire having a diameter of two or three thousandths of an inch, it is difficult to establish a good electrical connection between the various sections forming the resistor. To form such a connection I have provided a method which threads the end of the wire of one section under the first few turns of the adjacent section and also threads the end of the wire of the adjacent section under the last few turns of the first section.

When the resistor is gripped in the shell of the unit, the overlapping wires are pressed tightly together with sufficient force to insure a good electrical contact.

In carrying out this method, I employ a bodkin 60 which is threaded under the last few turns 61 of one winding of the resistor. The end 62 of the wire of the adjacent winding 63 is threaded through the eyelet 64 in the bodkin which is then pulled to thread the wire 62 under the turns 61 where it is disposed substantially at right angles to the wire in those turns. In Figure 3 this operation is illustrated, the bodkin 60 being shown in the position it assumed prior to pulling the wire 62 under the wires 61 and the wire 62 being shown dotted in the position it occupies after the bodkin has been removed. The free end of the wire 62 is then cut off flush with the surface of the wires 61 and the process repeated to pull the end of the wires 61 under the first few turns of the wire 63 to complete the joint. When the unit is compressed with the wires 61 and 63 firmly held against the insulator 42, the end 62 and corresponding end of the wire 61 is firmly held against its companion wire to insure a good electrical contact.

This method of lacing the end of the wire back under the last few turns of the winding is also employed at the extreme end of the resistor to prevent the winding thereon from unraveling when the unit is handled during assembly.

To establish electrical connection with the resistor, I have provided contacts 70 which are provided with perforations 71 or other suitably shaped ends to which the wires of the external circuit may be attached. The terminal 70 is also provided with serrated edges 72 which are offset slightly to form the lower end of the terminal 70 into a planar portion as shown at 73′ in Figure 8. The serrations 72 are bent outward away from the central portion of the terminal and when the terminal is assembled in the volume control unit between the resistor 40 and the insulator 21, Figure 2, the serrations point outward and imbed themselves in the insulator 21. One of these terminals 70 is disposed at each end of the winding 45 on the resistor unit, and held therein in the following manner.

The resistor 40, insulator 21 and terminals 70 are placed in the shell 6 on the gasket 20, with the ends of the resistor abutting. The shell is then shrunk by passing a die down over the outside of it, the die being stopped before it reaches the planar portion of the shell to prevent crushing that portion. This reduction in size of the walls of the shell presses the insulator 21 and terminals 70 firmly against the resistor 40, which is prevented from moving inward by its own hoop strength, and this pressure alone is sufficient to prevent the resistor from being pulled out of the shell.

The shell 6 is then pierced with a hole located midway between the terminals 70, this operation also piercing the abutting ends of the resistor 40. A central terminal 74 is placed inside the resistor 40 and insulated therefrom by an insulator 75, both of which are held in place by a rivet or eyelet 76 ex-

tended through the hole that has just been pierced in the shell. The base portion of the terminal 74 overlaps the terminals 70 and thereby assists in keeping those terminals tightly in place.

The unit 4 is, of course, finished in a similar manner.

The contactor 50 of the unit 3 is fitted on to a shaft 80 which is disposed within the bushing 6 and which projects from the threaded end of that bushing to receive a knob, not shown, by means of which the contactor is turned to adjust the volume control. The contactor 51 of this spring bears against the resistor 40 and it will be noted that the extreme end of this arm 51 falls inside of the projecting ear 22 of the insulator 21 so that the contactor may be turned around without striking those ears.

Similarly the contactor 50 of the rearward unit 4 is mounted upon a stud shaft 81 disposed within the bushing 26 of the rear unit, and the contacting arm 51 of this spring likewise rides over the element 40′ without striking the ears 30 of the insulator 29.

To drive the two units by the operation of a single knob, I have provided an insulating coupling 82. The coupling 82 is in the form of a thin, flat plate of insulation notched at its opposite ends to form a pair of ears 83 at each end of the plate. The ears 83 may be rounded at their free ends as shown, and these ears extend into the diametrically disposed parallel sided slots 54 formed in the lobe of the contact member 50. One of the slots 54 is at the free end of the lobe 52 opening at one edge therefrom, and the other slot is disposed in the connecting stock between the base of the lobe 54 and the surrounding ring portion of the contact member and is completely enclosed by the surrounding edge of the contact member. The contact member 50, like the coupling plate 82, is thin so that upon engagement of the ears 83 in the slots 54, as shown in Figure 1, the thin character of the coupling and contact plates will present substantially edge to edge engagement therebetween, and substantially thin edge to thin edge engagement without appreciable surface engagement between these parts.

Obviously, this engagement of the ears 83 in the slots 54 and between only thin edges of the members 50, enables holding the two shafts together for rotary or angular motion with very little play, and at the same time the thin edged cooperation between the parts 82 and 50 permits relatively great universal freedom therebetween. Great relative tilting movement between the members 82 and 50 is permitted, and the thin edged cooperation therebetween permits this relatively great tilting with very slight and almost imperceptible clearance between the ears 83 and the thin edges of the slots 54. The engagement of one of the ears 83 in the closed slot in the connecting stock between the base of the lobe 54 and the surrounding ring portion of the contact holds the coupling plate 82 in place against edgewise motion diametrically of the shaft.

To limit the rotary movement of the contactors 50, I have provided upturn ears 84 projecting out of the central terminal 74, which ears are disposed adjacent the terminal 70 of the resistor and in the path of the contactor 51 as it rides over the resistor. The ears 84 serve as stops to limit the rotation of the contactors.

The electrical circuit through the unit 3 of the volume control may include a complete circuit from terminal 70 through the resistor 40 through the other terminal 70 with the rider arm 51 connected through the bushing 6 and the shell 5 and the rivet 76 to the central contact 73 from which the external circuit may extend. If the unit is mounted on a metallic panel 11 and no insulation is used between the shell and the panel, the rider 51 of the unit 3 will be connected to the panel which in turn may be grounded. The unit 4 is similarly connected but since the shell 25 of the unit is electrically insulated from the panel, this unit may be completely electrically insulated from ground and connected into the electrical circuit at the most opportune point.

In Figure 9, I have shown a slightly modified form of my invention, which form may perhaps be termed the preferred form of the invention.

In this modification of the invention, the volume control comprises the two units 100 and 101 which are constructed in the hereinbefore explained manner, except that the insulators 21 and 29 which line the flanges 6 and 25 of the shell shown in Figure 1, are replaced each by two insulators 102 and 103 in the unit 100, and 104 and 105 in the unit 101. In the unit 100, the insulator 103 disposed next to the wall 86 of the flange is a narrow strip of insulating material whose width is less than the height of the flange. The insulator 102 fits inside of this insulator 103 and between it and the resistor 87. The insulator 102 is a wide insulator whose width is approximately twice the height of the flange 86 of the shell 100.

In the unit 101, a wide insulator 105 is disposed next to the flange 88 and a narrow insulator 104 disposed within it and between the insulator 105 and the resistor unit 89.

When the units 100 and 101 are fitted together in the manner shown in Figure 9, the wide insulator 105 of the unit 101 fits on the outside of the wide insulator 102 of the unit 100, the insulator 105 fitting into an angular pocket formed between the outside of the insulator 102 and the inside of the flange 86 of the unit 100. Similarly the wide insulator 102 fits into an angular pocket formed

inside of the wide insulator 105 of the unit 101 and outside of the resistor 89 of that unit.

The insulator 105 is provided with a plurality of circular openings 90 which are so spaced as to lie approximately midway between the two units when these two units are assembled together in the manner shown in Figure 9.

To hold the units 100 and 101 in this position, I place a drop of suitable cement or cementitious material in the hole 90, that material adhering to the outside surface of the inner insulator 102 and to the periphery of the opening 90, and forms a seal for rigidly holding the two units 100 and 101 together. The contactors, not shown, of these units are joined together by a coupling member such as is shown at 82 in Figure 1.

This improved telescopic cylinder construction shown in Figure 9 produces a rigid volume control unit of greater mechanical strength than is possible with the projecting ears shown in Figure 1, and also the working parts and resistors are practically completely encased and therefore protected from injury and from dust by the telescopic cylindrical insulators 104 and 102. The terminals, indicated generally at 91 and 92 in Figure 9, are connected to the resistors and to the contactor in the hereinbefore explained manner and projected radially outward from their respective units through an opening formed between the ends of the insulators 102 and 104. The unit so constructed is capable of withstanding severe mechanical stresses without being crushed out of shape, and since its working parts are adequately protected from the entrance of grit and dirt, the life of the unit is consequently long.

The unit 100 may be provided with a mounting guide plate such as the plate 13 in Figure 1, which has been omitted from Figure 9 as unnecessary. The volume control comprising units 100 and 101 is mounted in the hereinbefore explained manner and operated by a single dial or knob attached to the shaft 93.

While I have chosen to show my invention by illustrating a preferred embodiment of it, I have done so by way of example only and am not to be limited by the disclosure as I am aware there are many modifications and adaptations which can be made by one skilled in the art without departing from the teachings of the invention.

Having thus complied with the statutes and shown and described a preferred embodiment of my invention, what I consider new and desire to have protected by Letters Patent is pointed out in the appended claims.

1. The method of assembling a resistance unit in a cup-like shell which includes the following operations, lining the shell with insulation, placing a resistance strip within the shell against the insulation, inserting terminals between the strip and insulation, and shrinking the shell to bind the strip terminals, and insulation in place in it.

2. In a rheostat of the wire wound high resistance type, a strip of insulation having generally rectangular cross section with transverse grooves in its edges which are also slightly rounded, a resistance wire wound on said strip and laid in said grooves to prevent its slipping on the strip, and a contact arm engaging said wire at points where it emerges from said grooves.

3. In a rheostat of the wire wound high resistance type, a strip of insulation having generally rectangular cross section with transverse grooves in its edges which are also slightly rounded, a resistance wire wound on said strip and laid in said grooves to prevent its slipping on the strip, and a movable contact arm having an arcuate member engaging said wire where it emerges from said grooves and at an angle to the face of said strip.

4. In a rheostat of the wire wound high resistance type, a strip of insulation having generally rectangular cross section with transverse grooves in its edges which are also slightly rounded, a resistance wire wound on said strip and laid in said grooves to prevent its slipping on the strip, and a contact arm having an arcuate member engaging said wire where it emerges from said grooves and tensioned to bear against the wire at an angle to the face of the strip.

5. In a tandem resistance unit, a pair of cup-like shells each having a resistance element disposed within it, an insulating strip disposed between the walls of each of said cups and said elements, ears on said strips projecting outward from the cup with the ears of one strip registering with the ears of the other and rivets projected through said ears to hold said cups together.

6. In a tandem resistance unit, a pair of cup-like shells each having a resistance element disposed within it, relatively thin flexible insulation, means projecting outward from the open end of one of said shells and registering with a similar means of the other, and means for connecting the means of one shell to the means of the other to rigidly fasten the two together.

7. In a tandem resistance unit, a pair of cup-like shells each having a resistance element disposed within it, a plurality of ears projecting outward from the open ends of said shells with the ears of one shell registering with the ears of the other, means for connecting the ears of one shell to the ears of the other to rigidly fasten the two together, a contacting arm in each shell electrically engaging the resistance element, and an insulating member flexibly connecting said arms to cause them to be moved synchronously.

8. In a tandem resistance unit, a pair of cup-like shells each having a resistance element disposed within it, a plurality of ears projecting outward from the open ends of said shells with the ears of one shell registering with the ears of the other, means for connecting the ears of one shell to the ears of the other to rigidly fasten the two together, a contacting arm in each shell electrically engaging the resistance element, each of said arms having slots into which the ears of a connecting link fit to connect the arms together for synchronous movement.

9. In a tandem resistance unit, a pair of cup-like shells each having a resistance element disposed within it, a plurality of ears projecting outward from the open ends of said shells with the ears of one shell registering with the ears of the other, means for connecting the ears of one shell to the ears of the other to rigidly fasten the two together, a slotted contacting arm in each shell electrically engaging the resistance element, and an insulating link, ears on said link engaging the slots in said arms to connect the arms mechanically for synchronous movement.

10. In a tandem rheostat, a pair of cup-like metallic shells each containing a resistance element, insulating strips interposed between said elements and shells, said strips extending beyond the open end of the cup and registering with each other, and means for connecting the strips to mount one shell upon the other.

11. In a tandem rheostat, a pair of cup like metallic shells, each containing a resistance element, insulating strips interposed between said elements and shells, said strips extending beyond the open end of the cup and registering with each other, and means including rivets projected through the projecting edges of said strip for mounting one shell upon the other.

12. A rheostat comprising a metallic cup member, a resistance element wound on a strip and disposed within the cup, insulators between the element and cup, a pair of terminals disposed between said element and said insulators at the ends of the element, said terminals having serrated edges biting into said insulators to hold the terminal against lateral and endwise movement, and means for clamping said element, insulators and terminals in said cup.

13. A rheostat comprising a metallic cup member, a resistance element wound on a strip and disposed within the cup, insulators between the element and cup, a pair of terminals disposed between said element and said insulators at the ends of the element, and held against lateral and endwise movement, and a terminal including a plate disposed on the opposite side of the element from said first terminals and riveted through the strip to the cup.

14. A rheostat comprising a metallic cup member, a resistance element wound on a strip and disposed within the cup, insulators between the element and cup, a pair of terminals disposed between said element and said insulators at the ends of the element, and held against lateral and endwise movement, and means including an arcuate plate disposed against said element but insulated therefrom and projecting over said terminals on the opposite side of the element and riveted through the strip to the cup.

15. The combination with a rheostat comprising a metallic cup having a resistance element disposed within it and insulated from it, of a bushing centrally located in said cup and having a threaded projecting end for mounting the rheostat, and a positioning plate fastened to said cup around said bushing and having an integral ear for positioning the rheostat and for holding it against turning.

16. In a volume control of the wire wound tandem type, a pair of cup-like shells, a resistance element in each of said shells, a pair of insulating strips between the elements and shell, the outside strip of the first and the inside strip of the second being narrower than said elements and the inside strip of the first and outside strip of the second being wider than said elements, said wide strips overlapping and secured together to hold the shells in tandem.

17. In a volume control of the wire wound tandem type, a pair of cup-like shells, a resistance element in each of said shells, a pair of insulating strips between the elements and shell, the outside strip of the first and the inside strip of the second being narrower than said elements and the inside strip of the first and outside strip of the second being wider than said elements, said wide strips overlapping and secured together with their free edges registering with the free edges of said narrow strips to hold the shells in tandem.

18. In combination, a metallic cup-shaped shell having a substantially cylindrical flange and an end wall, a resistance element comprising a wire wound insulating strip of a width slightly in excess of the depth of the flange disposed in said cup and bent into substantially cylindrical shape, a lining of insulation interposed between the outer cylindrical side of the element and the flange of the cup and also interposed between the inner edge of the element and the end wall of the cup, and sheet metal terminal members having contacting portions disposed between the element and the cylindrical part of the lining and contacting with the end turns of the winding of the element, the insulating strip of the element being placed under endwise compression to cause it to be firmly gripped with the flange of the shell.

19. In combination, a generally cup-shaped

member, a resistance element comprising an insulating strip having a wire wound thereon, said element being disposed within said member and the insulating strip of said element being placed under endwise compression to cause it to be firmly gripped with said cup-shaped member and terminal means for the winding of the element.

20. In combination, a pair of electrical circuit controlling devices having operating shafts journaled for rotation, means for mounting said devices with the shafts adjacent to each other and substantially in endwise alignment, a member on one of said shafts, a thin, flat plate-like coupling member having connection with the other shaft, one of said thin members having a slot therein and means on the other of said members having engagement in said slot between thin edges of the slotted member, the engagement of said last means in said slot and with the thin edges of the other member along the slot coupling the shafts together for rotary motion and permitting universal freedom therebetween.

21. In combination, a pair of rheostats comprising bases which are connected together, circularly disposed resistance elements mounted on said bases, shafts journaled in said bases substantially in axial alignment, a thin contact member engaging one of the rheostats and mounted on the end of one of the shafts, a thin, flat plate-like insulating coupling member having connection with the other shaft, a thin contact member mounted on said other shaft and engaging the adjacent rheostat, one of said thin members having a slot therein, and means on one of the other of said thin members having engagement in said slot between thin edges of the slotted member, the engagement of said last means in said slot and with the thin edges of the slotted member along the slot coupling the shafts together for rotary motion and permitting universal freedom therebetween.

22. In combination, a pair of electrical circuit controlling devices having operating shafts journaled for rotation, means for mounting said devices with the shafts adjacent to each other and substantially in endwise alignment, members on the ends of said shafts, said thin members having diametrically disposed narrow parallel sided slots with thin edges along said slots, and a coupling member comprising a thin plate provided with pairs of ears at each end, said ears extending into said slots and cooperable with the thin edges of the thin members along said slots for coupling the shafts together for rotary motion and permitting universal freedom.

23. In combination, a pair of electrical circuit controlling devices having operating shafts journaled for rotation and restrained against endwise freedom, means for mounting said devices with the shafts adjacent to each other and substantially in endwise alignment, thin plate-like members on the ends of said shafts, said thin plate-like members having diametrically disposed narrow parallel sided slots with thin edges along said slots, and a coupling member comprising a thin plate provided with pairs of ears at each end, said ears extending into said slots and cooperable with the thin edges of the plate-like members along said slots for coupling the shafts together for rotary motion and permitting universal freedom, said plate and said plate-like members having interacting shoulders for preventing radial displacement of the plate with respect to the slots.

24. In combination, a pair of rheostats having cup-shaped shells each having a substantially cylindrical flange and provided with an end wall, a resistance element substantially circularly disposed within the flange of each of said shells, and means for mounting said rheostats with the open ends of said shells adjacent to each other and substantially in alignment, said last means comprising insulating strips secured between the resistance elements and the flanges of the respective shells and secured together.

25. In combination, a pair of rheostats having cup-shaped shells each having a substantially cylindrical flange and provided with an end wall, a resistance element substantially circularly disposed within the flange of each of said shells, and means for mounting said rheostats with the open ends of said shells adjacent to each other and substantially in alignment, said means comprising thin flexible insulating strip means connected together and secured directly to the respective shells.

26. In combination, a pair of rheostats having cup-shaped shells each having a substantially cylindrical flange and provided with an end wall, a resistance element substantially circularly disposed within the flange of each of said shells, and thin flexible insulating strip means extending between the open ends of said shells and at its opposite ends within the flanges of said shells.

27. In combination, a cup-shaped shell having a substantially cylindrical flange open at one end and provided with an end wall at the opposite end, a resistance element comprising a wire wound insulating strip of a width slightly in excess of the depth of the flange disposed in said cup with one edge projecting from the open end thereof, said resistance element being bent into substantially cylindrical shape with the width of the strip disposed substantially parallel the axis of the shell, the projecting edge of the strip being grooved and of generally rounded form and the wire being laid in said grooves to prevent its slipping on the strip and a movable contact member engaging the wire where it

emerges from said grooves whereby substantially the full thickness of the wire holds the contact member out of engagement with the insulating strip and at the same time displacement of the wire by movement of the contact member is prevented.

28. In combination, a resistance element comprising a wire wound insulating strip bent into substantially cylindrical shape with the width of the strip disposed substantially parallel to the axis thereof, said strip having an edge which is grooved and of generally rounded form and the wire being laid in said grooves to prevent its slipping on the strip, and a movable contact member engaging the wire where it emerges from the grooves whereby the wire holds the contact member out of engagement with the insulating strip and at the same time displacement of the wire by the movement of the contact member is prevented.

29. In combination, a resistance unit comprising a base, a resistance element mounted on the base, a rider movably engaging said resistance unit, a shaft for moving said rider, a hub for mounting the rider on the shaft, a pair of radial slots in said hub, a second and similar unit mounted with its resistance element adjacent the element of the first unit and with its shaft in alignment with the shaft of the first unit, said second unit being insulated from said first unit, and an H-shaped coupling means engaging the slots in said hubs and between thin edges along the slots in said hubs and connecting said riders to enable the second to be moved by movement of the first.

In witness whereof, I hereunto subscribe my name this 28th day of December, 1929.

NEWTON C. SCHELLENGER.

## CERTIFICATE OF CORRECTION.

**Patent No. 1,833,042.** **Granted November 24, 1931, to**

**NEWTON C. SCHELLENGER.**

**It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 7, line 14, claim 20, before the word "member" and line 51, claim 22, before the word "members" insert the word thin; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.**

**Signed and sealed this 9th day of February, A. D. 1932.**

**M. J. Moore,**
**Acting Commissioner of Patents.**

**(Seal)**