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H. J. WIEGAND

POTENTIAL CONTROL APPARATUS

Filed March 1, 1923

Fig. 1.

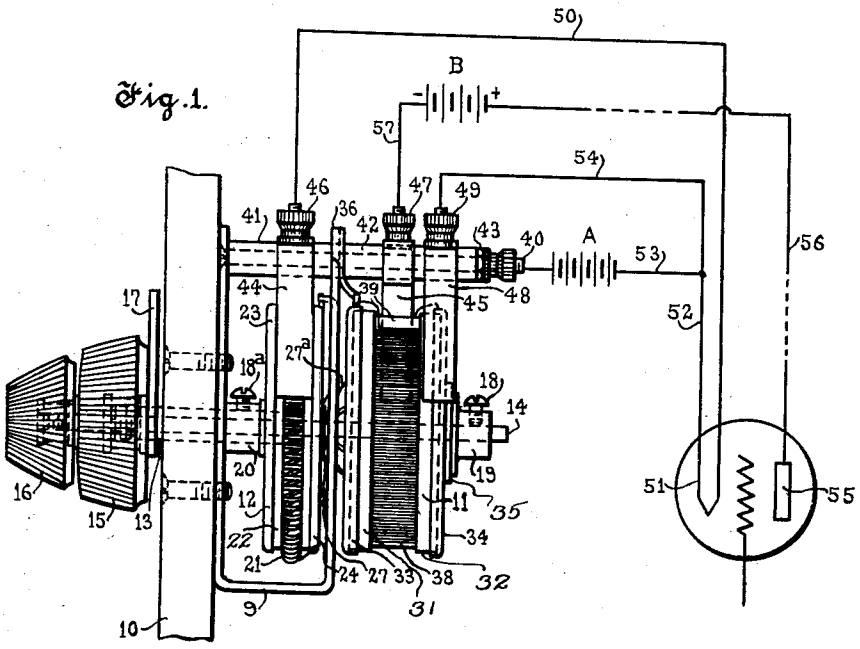
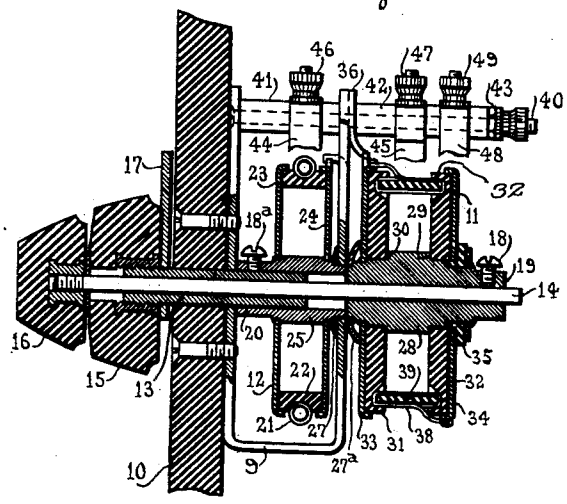


Fig. 2.



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UNITED STATES PATENT OFFICE.

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POTENTIAL-CONTROL APPARATUS.

Application filed March 1, 1923. Serial No. 622,078.

This invention relates to potential control apparatus and is particularly applicable in controlling the output voltage of audion valves and the like.

As is well known, the current flowing in an audion valve output circuit is a function not only of the voltage impressed thereon, but also of the temperature of the heated filament and of the grid potential, whereas, particularly if the audion or the like has an appreciable gas content, relatively minute changes in any of the aforementioned factors may produce relatively a very large change in such output current.

Therefore in control systems employing such audion valves or the like wherever fine regulation of such output current is required it is necessary to provide for fine gradation of the voltage impressed upon the filament and also of the voltage impressed upon the plate circuit.

Also in radio communication and in other special applications of the audion valve, exceedingly close regulation of the filament and plate voltages is essential although for a somewhat different immediate purpose.

The present invention relates to improved and simplified apparatus providing for so regulating these voltages either jointly or individually.

More particularly the invention has as an object that of providing apparatus comprising in a single structure all elements necessary or desirable for close regulation of both the aforementioned factors.

Another object is that of providing apparatus enabling accurate regulation of the filament and plate voltages either individually or jointly at will.

Another object is that of minimizing the number of elements and space requirements of apparatus for performing said functions.

Another object is that of minimizing the number of circuit terminals and lead wires and also simplifying the operation of installing and wiring such apparatus.

Another object is that of improving and simplifying generally the construction of such apparatus and of the individual elements thereof.

Other objects and advantages will hereinafter appear.

In the accompanying drawing wherein is illustrated a preferred embodiment of the invention,

Fig. 1 is a side elevational view of the herein contemplated apparatus, certain proposed or preferred circuit connections therefor being also illustrated diagrammatically, while;

Fig. 2 is a vertical sectional view illustrating more fully certain details of the apparatus illustrated in Fig. 1.

The apparatus so illustrated is adapted to use in conjunction with an audion valve in controlling the output of generators, motors, or the like, also in radio or other communication and generally wherever the operation of an audion valve or the like, particularly one having an appreciable gas content, is to be controlled.

Referring to the drawing, the same illustrates a substantially U-shaped frame member 9, preferably composed of metal, to be permanenty secured upon an insulating control base or panel 10 and adapted to support a plurality of variable resistance devices 11 and 12 together with suitable circuit terminals and control or operating means therefor, the latter preferably including concentric shafts 13 and 14 penetrating the control panel 10 and provided upon the opposite side thereof with individual operating means which may comprise knobs 15 and 16. The indicator 17 is preferably fixed to the shaft 13 for indicating the setting of the element 12, whereas, obviously if desired, the shaft 14 may also be provided with a similar or analogous indicator for a like purpose.

In practice the elements 11 and 12 are secured respectively upon the aforementioned shafts 14 and 13 for rotation therewith, the element 12 being located preferably within the frame 9 and the element 11 being preferably supported by its operating shaft 14 outside said frame. The aforementioned securement of said elements to their respective shafts may be conveniently effected by means of set screws 18 and 18[a] acting through and upon projecting hub portions

19 and 20 of the respective elements 11 and 12. Obviously the aforedescribed construction serves to facilitate mounting, assembly and adjustment of the device.

The element 12 comprises generally a resistor coil 21 wrapped about and supported by an annulus 22 of insulating material, the latter being preferably externally grooved as illustrated for accurate and permanent location of said resistor element. Flanged end caps 23 and 24 are adapted to fit snugly upon and about the circular end portions of said annulus 22, said end caps preferably comprising metal stampings. A hub member 25 having a bore to fit the shaft 13 is located within concentric axial openings of said end caps, said hub member having outwardly facing annular shoulders to be abutted by the end caps and being riveted or spun over the external faces of said end caps to thereby provide for securing the aforementioned elements in suitably spaced and assembled relation. The aforementioned hub extension 20 carrying set screw 18^a is preferably formed integral with said hub member.

The resistor element in practice is spaced and insulated from said end caps by the annulus 22 at all points. However, a terminal portion of the resistor element is brought over and soldered to the end cap 24 as illustrated. A suitable spring washer 27 is preferably interposed between the end cap 24 and the adjacent portion of the frame 9 when the device is assembled. Further details of the element 12 are disclosed and claimed in my copending application, Serial No. 561,136 filed May 15, 1922, and hence further description herein of this element per se is deemed unnecessary.

The element 11 similarly comprises a hub 28 having an axial bore of suitable dimensions to fit the shaft 14, said hub having outwardly facing annular shoulders 29 and 30. Insulating discs 31 and 32 are mounted upon said hub in a relation to abut the shoulders 30 and 29 respectively, whereas flanged end caps 33 and 34, which may preferably comprise metal stampings, similar to and standard with those of the element 12 aforedescribed, are also mounted upon said hub member outside said insulating discs. The end cap 33 may be preferably arranged in mechanical and electrical contact with the hub 28 as shown, whereas the end cap 34 is insulated from said hub by means of the shouldered insulating washer 35 illustrated. The hub extension 19 is also preferably formed integral with the hub 28 to take the aforedescribed set screw 18. In practice the hub 28, like the aforedescribed hub 25, is preferably formed with projecting annular rims or flanges which after assemblage of the aforementioned parts are preferably riveted, swaged or spun over for holding the parts in such assembled relation. The respective insulating discs 31 and 32 are provided upon their adjacent faces and adjacent the respective peripheries thereof with inwardly facing annular grooves to receive the resistor element proper now to be described.

In practice said resistor element may preferably comprise a coil 38 involving a relatively large number of turns of fine resistance wire, said wire being preferably wound upon a flexible strip 39 of fibre or other suitable insulating material and terminally anchored thereto. Said strip 39 having the resistor element 38 coiled thereon is thereafter bent or bowed and sprung within the adjacent grooves of the insulating discs 31 and 32 prior to assembly thereof in the fixed relation aforedescribed.

By the foregoing construction and arrangement obviously the insulating discs and particularly the grooves thereof serve not only to hold the curved insulating strip firmly and permanently in position but also to hold the various turns of the resistor element against shifting with reference to the other parts.

Here it is to be observed that in practice the hub 28 is so swaged, riveted or the like as to place the parts embraced thereby under a very appreciable compression, the aforedescribed structure and arrangement being such as to afford permanence and rigidity to the assembly for positive retention of the element 38 as aforedescribed, while also enabling employment for the various insulating elements of fibre or other readily machinable insulating material, any tendency of such material to undergo warping, contraction, expansion or other distortion being obviated or compensated by such construction and arrangement.

The element 38 is terminally connected by soldering or otherwise to the respective end caps 33 and 34 as shown, whereas a spring washer 27^a, similar to the element 27 aforedescribed, provides positive and resilient electrical connection between said end cap 33 and the frame 9. Said cap 33 and frame 9 are further provided with coacting lugs or stops for limiting movement of the element 11 relative to said frame.

In practice the fixed stop may comprise a channeled member 36 clamped to a suitable portion of frame 9, which may comprise a standard rheostat frame as disclosed in my copending application aforementioned. The movable stop may likewise comprise an outstruck portion of the end cap 33, said end cap being thus of the standard form also described in said copending application.

The open ends of the frame 9 are provided with aligned openings to receive an elongated clamping bolt 40, whereas insulating sleeves 41 and 42 are strung upon said bolt

respectively within and without said frame, a nut 43 serving to clamp the aforementioned elements in position for lending support and rigidity to the structure. Said bolt is further preferably of sufficient length to receive also a terminal nut beyond the nut 43 aforedescribed thereby providing one of the terminals for the device.

Contact fingers 44 and 45 preferably constructed substantially as illustrated and provided respectively with terminal devices 46 and 47 are clamped about the insulating sleeves 41 and 42 respectively for making contact respectively with resistor elements 21 and 38.

Here it should be observed that the projecting annular portions of the respective discs 31 and 32 serve to reduce possible lateral shifting of the contact finger 45 and to prevent the latter from accidentally engaging either of the end caps 33 and 34.

An additional contact finger 48 having an associated terminal 49 is similarly clamped about the insulating sleeve 42 and adapted to make positive engagement preferably with a peripheral portion of the end cap 34 as illustrated. Said end cap is, as aforedescribed, insulated from the frame 9, whereas the end cap 33 is electrically connected with said frame 9 as by the spring washer 27^a aforedescribed.

The aforedescribed terminal arrangement provides for a potentiometer connection of the element 38, the element 21 on the other hand being connected in the manner of a simple variable resistance.

Referring more particularly to Fig. 1, the circuits to be controlled by the aforedescribed elements may be traced as follows. Beginning at the left hand end of the filament battery A to terminal 43 thence through bolt 40 and frame 9 to the end cap 24 which as aforestated is in electrical contact with the resistor 21 and through a portion of said resistor determined by the setting to contact finger 44 and terminal 46 and thence by conductor 50 through the audion filament 51 and by conductors 52 and 53 to the right hand end of the filament battery A.

The resistor element 38 is connected in its entirety across said filament battery A by connections extending from the left hand end of said battery to the frame 9 as formerly traced thence to end cap 33 and through the entire length of said element 38 to end cap 34, then through contact 48 and terminal 49 and by conductors 54 and 53 to the right hand end of battery A shunting the audion filament 51.

The plate circuit may be traced from plate 55 by conductor 56 to the plus side of the plate battery indicated at B, thence by conductor 57 to terminal 47 and through contact finger 45 to the resistance element 38 at a point of the latter determined by the setting. It is thus apparent that a true potentiometer connection of said element 38 is effected.

It is to be observed that the aforedescribed arrangement requires the use of but four circuit terminals, that is to say, one more than the number positively required by the standard potentiometer connection.

Also by the foregoing construction and arrangement the external circuits are greatly simplified and reduced in number, whereas obviously the space requirements of the device are minimized.

The illustrated breaks in continuity of the plate circuit are of course for purposes of indicating possible or desirable locations of various controlled devices such for example as one or more transformers or dynamo machine field coils, or if employed in radio service, suitable tuning coils and receiving or transforming apparatus may be included at the points indicated.

It should be further noted that when necessary or desirable the resistance varying element 12 may be provided with an additional fine adjustment or vernier device which in practice may preferably assume the form, construction and arrangement set forth in my copending application aforementioned.

What I claim as new and desire to secure by Letters Patent is:

1. In apparatus for potential control of a plurality of associated circuits, the combination with a plurality of independently operable resistance varying devices including a potentiometer, each of said devices comprising relatively movable resistor and cooperating fixed contactor elements, a common conductive support, means for unitary mounting of said devices upon said support, and common terminal means for said circuits and said devices carried by said support.

2. In apparatus for potential control of a plurality of associated circuits, the combination with a plurality of independently operable resistance varying devices including a potentiometer, each of said devices comprising relatively movable resistance and cooperating fixed contactor elements, a common conductive support, means for unitary mounting of said devices upon said support, terminals, including a terminal common to said circuits, carried by said support, and means for effecting resilient electrical connection of certain of the cooperating elements of each of said devices with said support and said terminal.

3. In apparatus for potential control of a plurality of associated circuits, the combination with a plurality of independently operable resistance varying devices, each comprising relatively movable resistance and cooperating fixed contactor elements, a common support, means for unitary mounting

of said devices upon said support, circuit terminals carried by said support, means for connecting corresponding elements of said devices to a common circuit terminal and means for connecting other elements of said devices to individual circuit terminals, said last mentioned means comprising means providing a potentiometer connection for certain of said devices.

4. In apparatus for potential control of a plurality of associated circuits, the combination with a unitary supporting frame and concentrically arranged operating shafts carried thereby, of resistors carried by the respective shafts, certain of said resistors being located within said frame, a conductive rod carried by said frame and electrically connected with said resistors and insulated contactors carried by said rod and arranged to provide therewith for circuit connection of said resistors including potentiometer connection of certain thereof.

5. In apparatus for potential control of a plurality of associated circuits, the combination with a unitary supporting frame and concentrically arranged operating shafts carried thereby, of resistors carried by the respective shafts, certain of said resistors being located within said frame, a conductive rod carried by said frame and electrically connected with said resistors and insulated contactors carried by said rod and arranged to provide therewith for circuit connection of said resistors including potentiometer connection of certain thereof, the number of said contactors being not in excess of the number required by a standard potentiometer connection by more than the number of said resistors decreased by two.

6. In apparatus for potential control of a plurality of associated circuits, the combination with a unitary supporting frame and concentrically arranged operating shafts carried thereby, of resistors carried by the respective shafts, certain of said resistors being located within said frame, a conductive rod carried by said frame and electrically connected with said resistors and insulated contactors carried by said rod and arranged to provide therewith for circuit connection of said resistors including potentiometer connection of certain thereof, the number of said contactors being not in excess of the number of said resistors by more than one.

7. In apparatus for potential control of a plurality of associated circuits, the combination with a unitary supporting frame and concentrically arranged operating shafts carried thereby, of resistors carried by the respective shafts, certain of said resistors being located within said frame, a conductive rod carried by said frame and electrically connected with said resistors and insulated contactors carried by said rod and arranged to provide therewith for circuit connection of said resistors including potentiometer connection of certain thereof and individual circuit terminals for said rod and said contactors, the number of said terminals being not in excess of the number of said resistors by more than two.

8. In apparatus for potential control of a plurality of associated circuits, the combination with a unitary supporting frame and concentrically arranged operating shafts carried thereby, of resistors carried by the respective shafts, a certain of said resistors being located within said frame, a conductive rod carried by said frame and electrically connected with said resistors and insulated contactors carried by said rod and arranged to provide therewith for circuit connection of said resistors including potentiometer connection of certain thereof and individual circuit terminals for said rod and said contactors, the number of said terminals being not in excess of the number required for a standard potentiometer connection by more than the number of said resistors decreased by one.

9. In a potential controller, the combination with an insulating support, of a resistor element coiled thereon, spaced insulating members having opposed recesses to receive said resistor and support therebetween and mounting means for said parts comprising reinforcing elements assembled about said insulating parts and a connecting member having outwardly facing shoulders for spacing said recessed members and also having parts expanded about said reinforcing members for holding and permanently compressing said insulating parts between the latter to thereby prevent distortion of said insulating parts and also to prevent relative shifting of said resistor element.

10. A potential controller comprising two spaced disk-shaped relatively rigid insulating members having concentric annular recesses formed respectively in the adjacent faces thereof, concentric dished conducting end caps arranged to receive and hold said members therebetween, a circularly arranged internally reinforced resistor element supported between said members by engagement of its opposite sides within said recesses, a contactor in engagement with said resistor element between said members, said resistor element and contactor being relatively rotatable, the two ends of said resistor being respectively connected to said end caps, and three terminals respectively in permanent electrical connection with said two end caps and said contactor.

11. A device for use in connection with wireless apparatus comprising, in a single structure, an independently operable filament rheostat consisting of a resistor element, a contactor adapted to make contact at various points thereon and two terminal

connectors in electrical connection respectively with one end of said resistor element and with said contactor, and an independently operable potentiometer consisting of a resistor element, a contactor adapted to make contact at various points thereon and three terminal connectors in electrical connection respectively with both ends of said resistor element and with said contactor, and a common terminal connector in electrical connection with one end of the rheostat resistor element and with one end of the potentiometer resistor element whereby the whole device comprises not more than four terminal connectors.

12. A device for use in connection with wireless apparatus comprising, in a single structure, an independently operable filament rheostat consisting of a resistor element, a contactor adapted to make contact at various points thereon and two terminal connectors in electrical connection respectively with one end of said resistor element and with said contactor, and an independently operable potentiometer consisting of a resistor element, a contactor adapted to make contact at various points thereon and three terminal connectors in electrical connection respectively with both ends of said resistor element and with said contactor, a common terminal connector in electrical connection with one end of the rheostat resistor element and with one end of the potentiometer resistor element whereby the whole device comprises not more than four terminal connectors, said rheostat and said potentiometer being carried by a common conductive support and said common terminal connector being connected to the two resistor elements through said common conductive support.

13. A device for use in connection with wireless apparatus comprising, in a single structure, an independently operable filament rheostat consisting of a resistor element, a contactor adapted to make contact at various points thereon and two terminal connectors in electrical connection respectively with one end of said resistor element and with said contactor, an independently operable potentiometer consisting of a resistor element, a contactor adapted to make contact at various points thereon and three terminal connectors in electrical connection respectively with both ends of said resistor element and with said contactor, a common terminal connector in electrical connection with one end of the rheostat resistor element and with one end of the potentiometer resistor element whereby the whole device comprises not more than four terminal connectors, said rheostat and said potentiometer being carried by a common conductive support, the resistor elements of said rheostat and said potentiometer being arranged around the circumferential peripheries of a pair of drums which are independently rotatable with respect to said support and said contactors, and said support being electrically connected to the respective ends of the two resistor elements through the medium of circular end plates respectively carried by said drums and electrically connected to said support.

14. A device for use in connection with wireless apparatus comprising, in a single structure, an independently operable filament rheostat consisting of a resistor element, a contactor adapted to make contact at various points thereon and two terminal connectors in electrical connection respectively with one end of said resistor element and with said contactor, and an independently operable potentiometer consisting of a resistor element, a contactor adapted to make contact at various points thereon and three terminal connectors in electrical connection respectively with both ends of said resistor element and with said contactor, a common terminal connector in electrical connection with one end of the rheostat resistor element and with one end of the potentiometer resistor element whereby the whole device comprises not more than four terminal connectors, said rheostat and said potentiometer being carried by a common conductive support, the resistor elements of said rheostat and said potentiometer being arranged around the circumferential peripheries of a pair of drums which are independently rotatable with respect to said support and said contactors, said support being electrically connected to the respective ends of the two resistor elements through the medium of circular end plates respectively carried by said drums and electrically connected to said support, and said conductive support including a conductive rod, said common terminal connector being mounted on said rod in conducting relation thereto and the other terminal connectors being mounted on said rod but insulated therefrom.

In witness whereof, I have hereunto subscribed my name.

HENRY J. WIEGAND.