Aug. 27, 1935. D. D. ISRAEL 2,012,392

VOLUME CONTROL METHOD AND APPARATUS

Filed Sept. 13, 1929

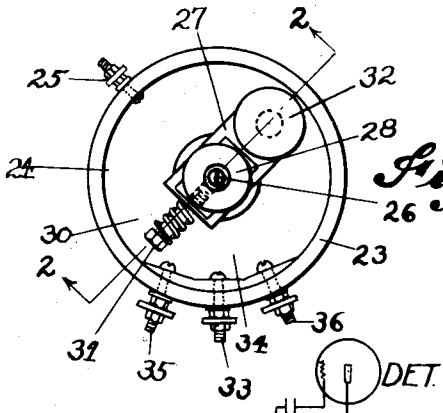


Fig. 1

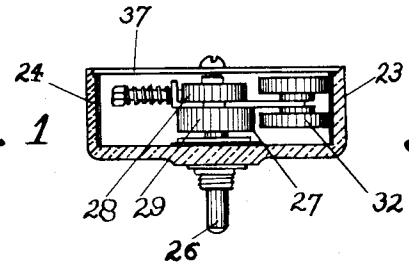


Fig. 2

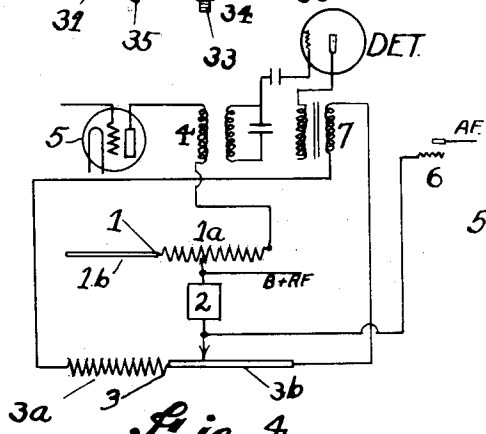


Fig. 4

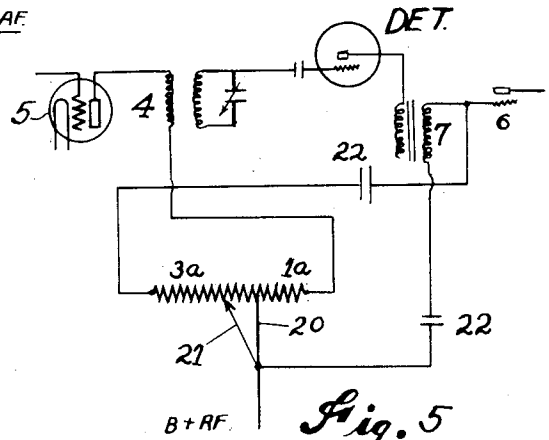


Fig. 5

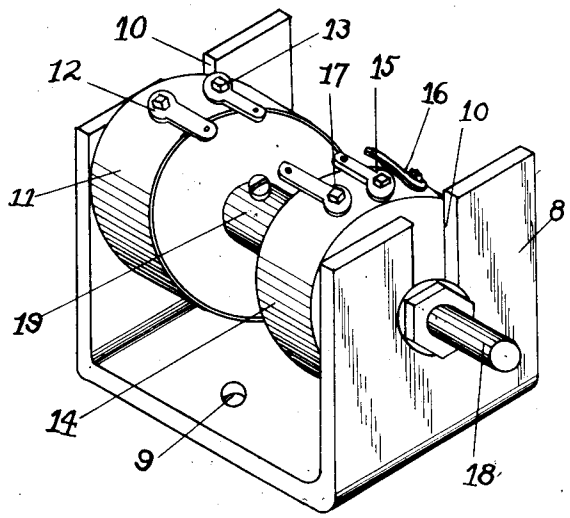


Fig. 3

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Patented Aug. 27, 1935 2,012,392

UNITED STATES PATENT OFFICE

2,012,392

VOLUME CONTROL METHOD AND APPARATUS

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Application September 13, 1929, Serial No. 392,463

11 Claims. (Cl. 250—20)

It is an object of my invention to provide a way of controlling the volume of signals in a radio reception device which will do away with the hum or the blurring incident to volume control by ordinary methods, chief of which is the varying of the intensity of the plate current. It is my further object to prevent oscillation while controlling volume by my method, and to this end to provide, in one aspect, a double resistor device which is operated from a single control, and in another aspect a single resistor device of novel construction which simultaneously accomplishes both purposes. Other ancillary objects will be pointed out in the ensuing disclosure or will be apparent to one skilled in the art upon reading these specifications.

Volume control with an A. C. set, particularly when the filament style of amplifier tubes are used, presents a very serious problem. It is impossible to use any volume control which reduces the plate voltage and consequently the plate current to any extent. It has been found, for instance, that the UX 226 tube shows a minimum of ripple at about 3 milliamperes on the plate. This is also the most stable and efficient operating condition for this tube. But if the plate current is decreased, the ripple rises rapidly, while if it is increased the ripple rises also, but not quite so fast. Ripple must of course be avoided both in audio and in radio frequency tubes. In audio frequency tubes, the ripple causes an actual audible hum. In the radio frequency circuit, a ripple has the effect of breaking up the modulation so that it is blurred, particularly on loud signals.

Volume has been controlled with battery operated sets in both the audio frequency and the radio frequency sections. A desirable audio frequency control is a potentiometer or variable resistance of about 500,000 ohms across the secondary of the first audio transformer. The usual radio frequency control for battery operated sets is a resistance in series with the plate supply of the radio frequency tubes. Now, while the radio frequency control is quite satisfactory on battery operated sets, the audio control is unsatisfactory on loud signals because it has no effect on the detector and a strong signal will therefore overload the detector and cause a distortion which cannot be eliminated. As hereinbefore pointed out, these controls are not very satisfactory on A. C. operated sets.

Furthermore there is present in all A. C. sets a certain amount of hum in the loud speaker. On a loud signal, if the volume is reduced by a volume control, it is preferable that the loud speaker hum be reduced also. If this is not done the illusion to the ear is that the hum is increasing in volume. This is due, of course, to the fact that the signal is decreasing and the hum by comparison seems louder.

My volume control, which is satisfactory for battery sets and has none of the disadvantages just enumerated when used on A. C. sets, is accomplished by that circuit, construction and arrangement of parts of which I shall now describe preferred embodiments, reference being made to the drawing which accompanies this specification.

In the drawing:—

Figure 1 is a top plan view of one of my resistors.

Figure 2 is a section thereof along the line 2—2 in Figure 1.

Figure 3 is a perspective of one of my tandem controls comprising two resistors.

Figure 4 is a circuit employing the tandem control.

Figure 5 is a circuit employing the resistor of Figure 1.

Referring now to Figure 4, I have shown a variable resistor comprising two parts, a variable low resistance 1*a* and a metallic segment 1*b*. The resistance will be of the order of 5,000 ohms, and it comprises as an example $\frac{7}{16}$ of the total length of the resistance unit 1. This unit may be thought of as straight, with a slider 2, for the purpose of this diagrammatic illustration, but in actual use is preferably of the round type controlled from a knob on a dial. This construction I shall hereinafter describe more fully. When the slider or other contact device 2 is furthest to the right the resistance 1*a* is completely cut out, while as the contact moves toward the left, the resistance increases to a maximum, whereupon a further movement of the contact will not result in an increase of the resistance because the contact is moving along the metal segment 1*b*.

At 3, I have shown a relatively high resistance potentiometer the resistance portion of which, 3*a*, has a value of from 250,000 to 500,000 ohms. This resistance is effective for, let us say 7/16 of the total length of the potentiometer, and the remaining 9/16 of that length is made up by a metallic segment 3*b*. The slider member 2 is common both to the resistor 1 and the potentiometer 3, but the actual contacts of the two devices are insulated from each other. It will be noted, that whereas the metallic segment of the resistor is to the left, the metallic segment of the potentiometer is to the right. A movement of the

slider, therefore, from left to right, will result in causing the resistor to increase its effective resistance from zero to the maximum through a distance of travel of 7/16 of the slider path, and to hold the resistance at the maximum throughout the remainder of that path of travel. Meanwhile the resistance of the potentiometer circuits remains the same through 9/16 of the path of travel of the slider, and then through the remaining 7/16 to decrease the resistance in the left hand circuit and increase it in the right.

The resistor 1 is connected in series with the primary of a transformer 4 and the plate of a radio frequency tube 5. It will now be plain that, starting at the point of maximum volume, if the slider or contact 2 is moved to reduce the volume, a small amount of resistance is inserted in series with the plate of the radio frequency tube. This cuts down the volume initially; but the resistance is so low that it does not reduce the plate current materially. Long before an unfavorable reduction in plate current can take place the resistance of the unit 1 has reached its maximum, for example, 5,000 ohms at 7/16 of the contact travel path. This small resistance does, however, stop oscillation. When all of the resistance 1a is in circuit oscillation has completely stopped. But it will be noted that at 7/16 of the travel path of the tandem unit comprising resistor 1 and potentiometer 3, the potentiometer circuits have not changed at all.

Now it may be that at this point the volume on near-by stations is still too loud. For further volume decrease, I work upon the audio circuit. It will be observed that the potentiometer contact of the slider 2 is connected to the grid 6 of an audio-frequency tube. The other terminals of the potentiometer span the secondary of the first audio-frequency transformer 7. If, therefore, the slider 2 is moved still further to the left, the audio control comes into play at 9/16 of the travel distance, and as the movement continues the signal diminishes until at the extreme left hand position it is entirely gone.

The diagrammatic Figure 4 contemplates a tandem unit of resistor and potentiometer actuated by a common control or slider 2. A device for the commercial embodiment of this concept is illustrated in Figure 3. A metallic yoke 8, having screw holes 9 for attachment to the base of the set, is slotted as at 10, 10 to accommodate the shafts of the units. 11 is a casing containing a resistor of the circular type. If this is to be made like the resistor 1 of Figure 4, the first 7/16 of the circular resistor length will have a resistance value of 5,000 ohms, while the remaining length of the circular element will be of negligible resistance. This can be effected in many ways known to the art. It may be done by providing a circular insulating core, and winding 7/16 of its length with resistance wire, joining this to a metallic strip which follows the core for the remainder of the distance. Or the entire core may be wound with wire, and 9/16 of it covered with a metal strip, or plated upon until it presents a solid metallic, low-resistance surface. The contact device may be any of a number well known in the art. It is connected to the terminal 12, while the resistance is connected with the terminal 13.

14 represents a casing containing a potentiometer, with a contact terminal 15, and resistance terminals 16 and 17. If the resistor 11 has been constructed as described, the potentiometer will be constructed thus: Over the first 9/16 of the circular core the resistance will be negligible, while over the remaining 7/16 the total resistance will be from 250,000 to 500,000 ohms. The modes of construction described above may be followed here. The resistor and potentiometer are actuated by central shafts. The potentiometer shaft is shown at 18 and is adapted for the attachment of an actuating knob. At 19 is shown an insulating sleeve which connects the shaft of the potentiometer to the shaft of the resistor so that they move together. This will be readily understood. The two devices are so assembled that the negligible resistance segments are opposite each other, i. e., so that in turning the shaft 18 from full volume position to zero volume position, the value of the resistance of the resistor 11 will increase to its maximum while the potentiometer circuits remain unchanged, and then hold that maximum while the potentiometer varies. The manner in which the tandem device is connected into a radio circuit is shown in Figure 4.

I have now illustrated and described my volume control utilizing separate resistor and potentiometer tandem operated, which is to say, mechanically coupled. I shall now describe another unit which combines the function of the two. This gives, of course, a cheaper and more effective construction. The circuit is shown in Figure 5. Here resistance units corresponding to 1a and 3a of Figure 4 are combined in a single resistor. A tap 20 is led out from the juncture of the two resistances and is permanently connected to the slider or contact member 21. The resistance 1a is again connected in series with the plate of a radio frequency tube 5 through the primary of a radio frequency transformer 4. The resistance 3a is shunted, through the tap and an end connection as shown, across the secondary of the audio frequency transformer 7. Condensers 22 are inserted in series with the leads. Again the resistances will be unequal, 1a being, let us say, of the order of 5,000 ohms, while 3a is of the order of 250,000 to 500,000 ohms. In operation, starting at the position of maximum volume, with the contact 21 furthest to the right, and moving it to diminish volume, it will be clear that resistance is again inserted into the plate circuit of the radio frequency tube until the tap is reached. Thereafter the radio frequency circuit remains fixed, but a short-circuiting resistance 3a is gradually decreased across the grid of the first audio frequency tube. When the extreme left hand position is reached the tube is short-circuited out, and the volume is zero.

I shall now describe an apparatus which will serve as a commercial embodiment of the device diagrammatically represented in Figure 5. Broadly it comprises a circular resistance element with a portion wound for low resistance, and the remainder prepared for high resistance, a tap where the two resistance elements join, a rotary slider or contact member, the tap connected permanently with the slider, and appropriate terminals. In Figure 1, I have shown a casing 23, bearing within a circular resistance element 24. This may comprise a core wound with different sizes of wire; but it may be conveniently made with a wire winding for the low resistance portion, and a coating over the core of high resistance material for the high resistance portion. A tap 25 may be made through the casing to the resistance element where the high and low resistance portions join. A shaft 26 is the operating device for the resistor, and it will preferably project through a panel and be fitted with the ordi-

nary knob. It bears a rider 27 held in place by collars 28, 29 and controlled by a spring 30, which is held by the bolt 31 screwed into the collar 28. The rider bears a contact roller 32 which is adapted to make moving contact with the resistance element without abrading it. This construction is shown in section in Figure 2. I do not claim the contact-making device and actuating means as novel. It is capable of wide variation; a number of satisfactory types of contact making devices being currently used. A terminal 33 connects with the contact device through a bar 34. Terminals 35 and 36 connect with the respective ends of the resistance element. The casing may be closed by an insulating plate 37. I have shown the tap terminal 25 arranged for external contact with the terminal of the slider 33; but if desired permanent connection may be made in the device, as by continuing the bar 34 and fastening it to the terminal 25.

The device which I have just described is a satisfactory commercial embodiment of my invention; but my invention is not restricted to the specific mechanism which I have described, since obviously many styles of variable resistances are adapted by modification to be fitted for use as I have indicated. Furthermore, instead of applying the radio and audio frequency volume control to a plate and grid circuit respectively, it can be applied to other circuits in which it is customary to control volume by an added resistance.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is: —

1. In a volume control apparatus, devices operative in a definite order, the first device to operate diminishing volume by inserting a resistance in the plate circuit of a radio-frequency tube, and the device next to operate adapted for diminishing volume in the audio-frequency circuit, and comprising a potentiometer in the grid circuit of an audio-frequency tube.

2. In a volume control apparatus, devices operative in a definite order, the first device to operate diminishing volume in the radio-frequency circuit, said device first to operate comprising a variable resistance in the plate circuit of a radio frequency tube, said resistance being of a magnitude sufficient to stop oscillation without producing ripple, and the device next to operate adapted for diminishing volume in the audio-frequency circuit sufficiently to complete the total desired variation.

3. In a volume control apparatus, devices operative in a definite order, the first device to operate diminishing volume in the radio-frequency circuit, said device first to operate comprising a variable resistance in the plate circuit of a radio-frequency tube, said resistance being of a magnitude sufficient to stop oscillation without producing ripple, and the device next to operate adapted for diminishing volume in the audio-frequency circuit sufficiently to complete the total desired variation, said last mentioned device comprising a short-circuiting variable resistance in the grid circuit of an audio-frequency tube.

4. In a volume control apparatus, devices operative in a definite order, the first device to operate diminishing volume in the radio frequency circuit, said device first to operate comprising a variable resistance of the order of 5000 ohms in the plate circuit of a radio-frequency tube, and the device next to operate adapted for diminishing the volume in the audio-frequency circuit sufficiently to complete the total desired variation, said means comprising a variable short-circuiting resistance in the grid circuit of an audio frequency tube, said resistance being of the order of 250,000 to 500,000 ohms.

5. In a volume control apparatus, devices operative in a definite order, the first device to operate diminishing volume in the radio frequency circuit, said device first to operate comprising a variable resistance of the order of 5000 ohms in the plate circuit of a radio-frequency tube, and the device next to operate adapted for diminishing the volume in the audio-frequency circuit sufficiently to complete the total desired variation, said means comprising a variable short-circuiting resistance in the grid circuit of an audio frequency tube, said resistance being of the order of 250,000 to 500,000 ohms, the specified operation of said device progressively first increasing said radio-frequency resistance from zero to maximum, and thereafter decreasing said audio-frequency resistance from maximum to minimum.

6. In a volume control apparatus, a resistance device comprising a low resistance portion and a high resistance portion, said low resistance portion connected in the plate circuit of a radio-frequency tube, and said high resistance portion short-circuiting the grid of an audio-frequency tube, and means operative for short-circuiting both resistance portions, said means being commonly operative for both portions, in a single movement, to short-circuit said resistance portions in the order named.

7. In a volume control apparatus, a resistance element comprising a low resistance portion and a high resistance portion, said low resistance portion connected in the plate circuit of a radio-frequency tube, said high resistance portion short-circuiting the grid of an audio-frequency tube, and means operative for short-circuiting both resistance portions in a definite order of succession, said means arranged in a progressive movement, and in the first stage of said movement to increase said low resistance portion from zero to maximum and thereafter to decrease said high resistance portion from maximum to zero and vice versa.

8. In a volume control apparatus, a resistance element comprising a low resistance portion and a high resistance portion, said low resistance portion connected in the plate circuit of a radio-frequency tube, said high resistance portion short-circuiting the grid of an audio-frequency tube, and means operative for short-circuiting both resistance portions in a definite order of succession, said means arranged in a progressive movement, and in the first stage of said movement to increase said low resistance portion from zero to maximum and thereafter to decrease said high resistance portion from maximum to zero and vice versa, said means comprising a common contact member electrically connected to said resistance element at the juncture of the high and low resistance portions.

9. In a volume control, a resistance in the plate circuit of the plate of a radio-frequency tube, said resistance having a portion of maximum resistance sufficient to produce a diminution of volume and prevent oscillation but insufficient to produce ripple, and a portion of negligible resistance, and a contact member, so arranged that a movement in one direction will increase said resistance to a maximum and then maintain said resistance at said maximum during a further movement, and a short-circuiting resistance in the grid circuit of an audio-frequency tube in the

same radio set, said resistance having a portion of negligible resistance and a portion of a resistance high enough to permit said audio-frequency tube to function, and a contact member, so arranged that a movement in the same direction will, for a distance, make no change in said circuit, and upon further movement will decrease said resistance from maximum to zero, and means for simultaneously moving said contact members in the same direction.

10. In a volume control, a variable resistance in the plate circuit of a radio-frequency tube of the order of 5000 ohms having a segment of negligible resistance, and a contact member, and a variable resistance of the order of 250,000 to 500,000 ohms short-circuiting the grid of an audio-frequency tube in the same radio set, and having a segment of negligible resistance, and a contact member, and means for moving said contact members simultaneously, whereby said radio-frequency resistance may be increased from zero to maximum while no change occurs in said audio-frequency resistance, and maintained at said maximum while said audio-frequency resistance is decreased from maximum to zero and vice versa.

11. The method of controlling volume in a radio receiving set which consists in diminishing volume in the radio-frequency circuit of said set in minimum proportion, from its most stable and efficient operating condition, and diminishing volume in the audio-frequency circuit of said set in the substantially greater proportion to effect the aggregate desired variation in volume of the set, for the purposes set forth.

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