Oct. 1. 1929. W. J. BROWN 1,729,983

AMPLIFIER SYSTEM

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Fig. 1.

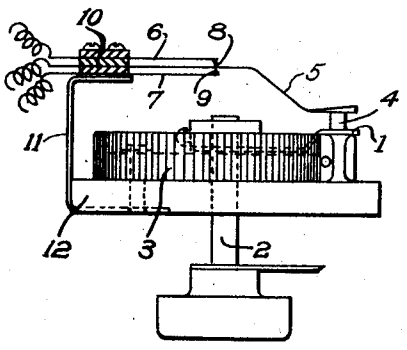


Fig. 2.

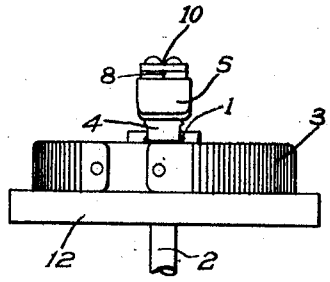
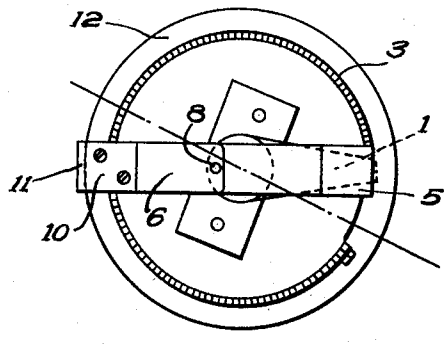


Fig. 3.



WITNESSES:

A. G. Schiefelbein

H. D. Hemeline

INVENTOR

Walter John Brown.

BY

Wesley G. Carr

ATTORNEY

Oct. 1, 1929. W. J. BROWN 1,729,983

AMPLIFIER SYSTEM

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Fig. 4.

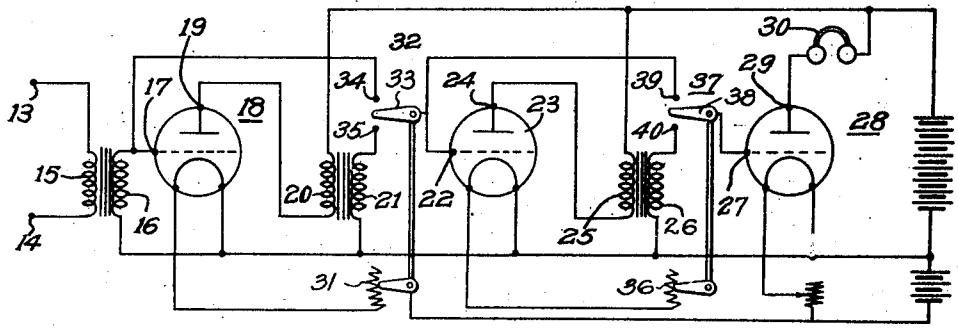


Fig. 5.

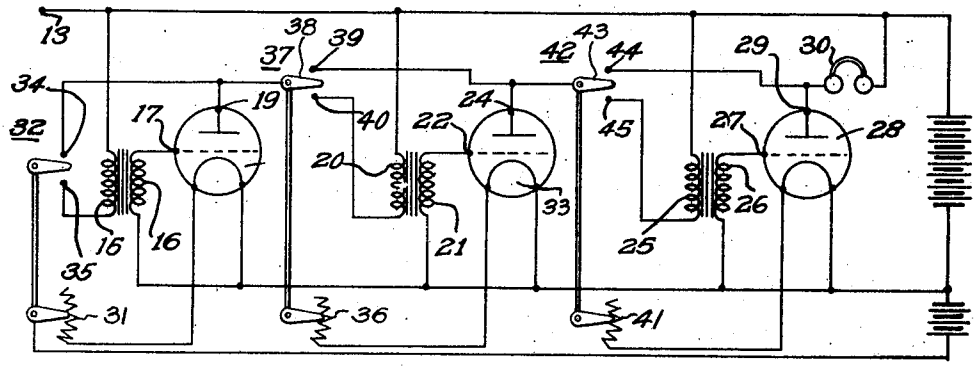
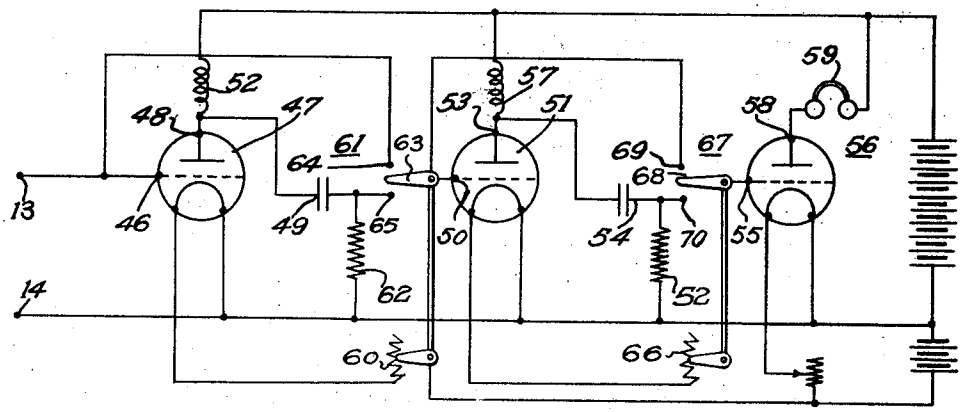


Fig. 6.



WITNESSES:

C. J. Schiefelbein.

H. D. Hineline

INVENTOR

Walter John Brown.

BY

Wesley G. Carr

ATTORNEY

Oct. 1, 1929. W. J. BROWN 1,729,983

AMPLIFIER SYSTEM

Filed June 2, 1924 3 Sheets-Sheet 3

Fig. 7.

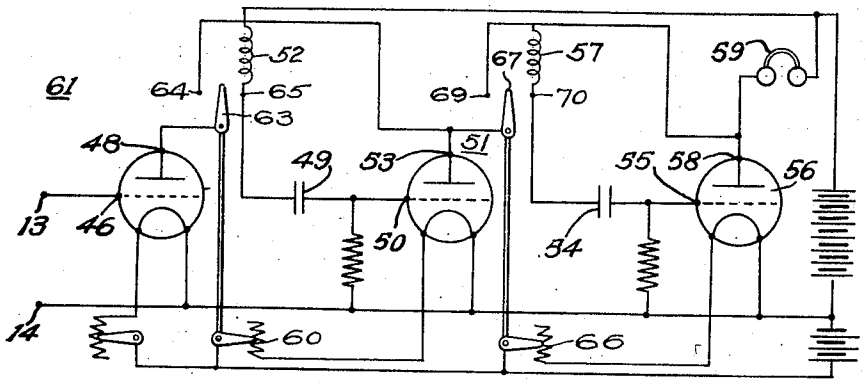


Fig. 8

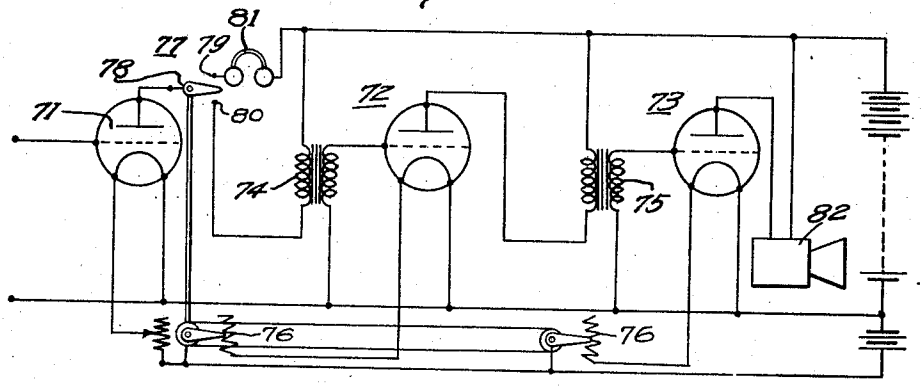
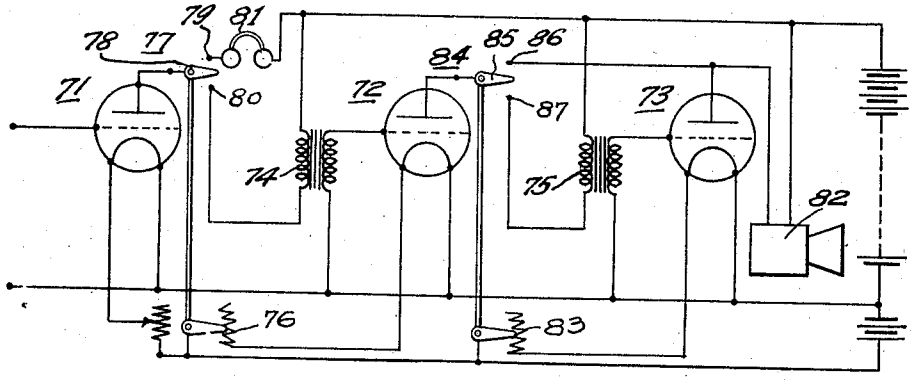


Fig. 9.



WITNESSES:

A. G. Schiefelbein.

H. D. Hinckley

INVENTOR

Walter John Brown.

BY

Wesley G. Carr

ATTORNEY

Patented Oct. 1, 1929 1,729,983

UNITED STATES PATENT OFFICE

WALTER JOHN BROWN, OF EVERSLEY, ENGLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ASSOCIATED ELECTRICAL INDUSTRIES LIMITED, A BRITISH JOINT-STOCK COMPANY

AMPLIFIER SYSTEM

Application filed June 2, 1924, Serial No. 717,247, and in Great Britain June 9, 1923.

My invention relates to signal amplifying systems and particularly to amplifier systems having means for adjusting the degree of amplification.

One object of my invention is to produce a signal receiving system having adjustable amplification means.

Another object of my invention is to produce a signal receiving system having an amplifier means, the degree of amplification produced by which is controlled by switching means cooperating with a rheostat.

Another object of my invention is to produce a rheostatically controlled amplifier system in which switching elements are actuated by the rheostat controlling means.

Another object of my invention is to produce a multi-stage amplifier system in which the various stages may be rendered inoperative by switching means cooperating with a cathode current rheostat.

Another object of my invention is to provide a simple and improved switching arrangement whereby, in a multi-stage triode electron device amplifier, one or more of the triode electron devices may be rendered inoperative according to the degree of amplification required.

In the prior art of the operation of multi-stage triode electron discharge device amplifiers, it has been found possible to provide switching means for rendering inoperative various stages of the amplification means. This switching apparatus has, however, been found complicated and inconvenient to operate.

According to the present invention, two-way switches are provided for cutting out the triodes and these switches are automatically operated to cut out a predetermined number of triodes by means of an adjustable filament rheostat when a movable member of the latter is moved to a predetermined position.

The filament rheostat may be arranged to operate the arm of the throw-over switch in any desired manner. For example, it may be provided with an insulating extension, which, when the rheostat contact arm is moved beyond the position of maximum resistance to its "off" position, will operate the throw-over switch either by direct engagement thereof or indirectly through an insulating link or other mechanism. The switch arm may be positively operated from one contact to the other or may be normally retained by means of a spring in the position wherein the triode valve which it controls, is operative. The throw-over switches are preferably of such construction that the capacity between the parts thereof is reduced to a minimum.

In a convenient application of the invention to a transformer coupled electron discharge device amplifier operating at either high or low frequency, the two-way switch may have its arm connected to the grid of a triode valve while one contact of the switch is connected through the secondary winding of the transformer to the filament circuit, and the other terminal is connected to the grid of the preceding valve. The filament rheostat of a valve which may be cut out operates the switch arm connected with the grid of the succeeding valve.

Alternatively, the arm of the switch may be connected to the anode of one valve, one contact member of the switch being connected to the primary of the intervalve transformer and the other contact thereof to the anode of the succeeding valve. In this case, the filament rheostat operates the switch which controls the input circuit of the valve which is to be cut out, that is to say, the switch connected to the anode of the preceding valve.

In applying the invention to a high or low frequency amplifier employing resistance-capacity, inductance-capacity, or tuned anode couplings between the several amplifying valves, the grid of each valve succeeding that which it is desired to cut out of circuit may be connected to the arm of the two-way switch. One contact thereof is connected to the grid leak, and, through the grid condenser, to the anode of the preceding valve, while the other contact is connected to the grid of the preceding valve. The filament rheostat of a valve which may be cut out of circuit operates the switch arm which is connected to the grid of the succeeding valve.

Alternatively, the arm of the two-way switch may be connected to the anode of the

valve preceding the valve which it is desired to cut out. One of the contacts of the said switch may be connected to the anode end of the anode inductance coil or resistance, and to the grid condenser, while the other contact of said switch is connected by a conductor to the anode of the valve which it is desired to cut out. In this case, the filament rheostat of the valve which is to be cut out of circuit operates the switch arm which is connected to the preceding valve.

Other objects and structural details of my invention will be apparent from the following description and the accompanying drawings wherein:

Figure 1 is a side view of a rheostat and switching means suitable for use in my invention,

Fig. 2 is a view in elevation at right angles to Fig. 1,

Fig. 3 is a plan view of the device of Figs. 1 and 2,

Fig. 4 is a diagrammatic view of circuits and apparatus embodying my invention,

Fig. 5 is a diagrammatic view of a modification thereof,

Fig. 6 is a diagrammatic view of a further modification thereof,

Fig. 7 is a diagrammatic view of a further modification thereof,

Fig. 8 is a diagrammatic view of a further modification thereof, and

Fig. 9 is a diagrammatic view of a further modification thereof.

Referring to Figs. 1, 2 and 3, the rheostat shown by way of example is of the type in which a contact arm 1 connected to a rotatable spindle 2 is adapted to make contact on a coil of resistance wire 3 wound on a core and bent into the form of a circle. The contact arm 1 carries a block 4, of insulating material, which engages with a resilient metallic conductor 5 when the contact arm 1 is in the "off" position. This conductor 5 may make contact with either of the two conductors 6 and 7 through contact points 8 and 9. The arm 5 is normally in engagement with the contact point 9 but when forced upwards by means of the block of insulating material 4 carried on the arm 1, it makes contact with the conductor 6 and breaks contact with the conductor 7. These three conductors 5, 6 and 7 are insulated from each other by layers of insulating material shown at 10, and the three are clamped together to a support 11 which is carried on the insulating base 12 of the rheostat.

According to the position of the arm 5, in contact with either the conductor 6 or conductor 7, one or the other of two corresponding circuits is energized. In a convenient arrangment, the normal position of the arm 5 is that in which it is in contact with the conductor 7, that is, when the block 4 on the contact arm of the rheostat is not in engagement with it. It may be biased to this position by a spring or by reason of its natural elasticity.

In Fig. 4, an arrangement is shown in which the invention is applied to a three-stage low frequency amplifier with transformer coupling between the stages, in which the switching occurs in the grid circuits of the valves. In the normal three-stage system, the low frequency input to the amplifier, which may be from a detector, is obtained from the terminals 13 and 14 through the primary 15 of a transformer having windings 15 and 16. The secondary 16 is connected to the grid 17 of the first valve 18. From the anode 19 thereof, amplified currents are led through the primary 20 of a transformer having windings 20 and 21, and from the secondary 21 to the grid 22 of the second valve 23.

From the anode 24 of this valve, correspondingly amplified currents are led through a transformer having windings 25 and 26 to the grid 27 of the third valve 28, and the low frequency signals are received by the telephone 30 in the anode circuit of this valve. In order that stages of amplification can be cut out as desired, the valves 18 and 23 are provided with rheostat-operated switches according to the invention. The rheostat 31 of the valve 18 is adapted to cooperate with the two-way switch 32, the contact arm 33 of which, may engage with either of two contacts 34 and 35.

When the rheostat contact arm is moved to its off position the arm 33 engages with the contact 34 which is connected to the grid of the bulb 18, which is then automatically removed from the circuit. In a corresponding manner, the rheostat 36 of the second valve 23 is adapted to operate the two-way switch 37, the arm 38 of which can make engagement with either of the contacts 39 and 40. When the rheostat 36 is moved to its off position, the arm 38 engages the arm 39, which is connected back to the grid terminal 22 of the valve 23, so that this valve is then automatically removed from the circuit. Normally, of course, when the filaments of the valves 16 and 23 are energized, the switch arms 33 and 38 are in engagement with contacts 35 and 40 respectively and all the stages are operative.

In Fig. 5, a similar arrangement is shown in which the switching is arranged to take place in the anode circuits of the valves. The rheostat 31 of the valve 18 is adapted to operate the switch 32, and the rheostat 36 of the valve 23 to operate the switch 37. An additional switch 42 may also be provided and operated by the rheostat 41 of the last valve 28 if desired. In this case, when the rheostat 41 is moved to its off position the contact arm 43 of the switch 42 engages with the contact 44, whereby the low frequency signals are received in the telephone

30 directly from the input circuit without amplification.

In Fig. 6, an arrangement is shown in which the invention is applied to a three-stage low frequency amplifier with inductance-capacity coupling when all the stages are used. The low frequency input is applied to the grid 46 of the first valve 47, and the potential variation in a coil 52 connected in the anode circuit of this valve is applied through a condenser 49 to the grid 50 of the second valve 51. The grid of this valve is of course connected either to the filament or to earth through a high resistance 62 in order to prevent building up of charge on the grid. In a similar way, potential variations in a coil 57 connected to the anode 53 of this valve 51 are applied through a condenser 54 to the grid 55 of the third valve 56. The low frequency signals are received in a telephone 59 connected in the anode circuit of this valve 56. In order that as many of the stages of amplification as desired can be used, the valves 47 and 51 are provided with switch-rheostats according to the invention. Thus the rheostat 60 operates the two-way switch 61 and the arm 63 of which can engage with either of two contacts 64 or 65. When the contact arm is moved to its off position, the contact arm 63 engages with the contact 64 which is connected back to the grid of the first valve 47, which is thus automatically cut out and the arrangement becomes a two-stage amplifier. In a similar manner, movement of the contact arm of the rheostat 66 to its off position causes the arm 68 of the switch 67 to engage with the contact 69, which is connected back to the grid of the second valve 51, which thus in a similar manner is removed from the circuit and a one-stage amplifier obtained. When the filaments of either of the valves 47 and 51 are energized the contact arms 63 and 68 are respectively in engagement with the contacts 65 and 70. The method of operation is the same if resistance-capacity, or tuned anode coupling is used. The coils 52 and 57 can be replaced by high resistances or by adjustable oscillation circuits.

In Fig. 7, a similar arrangement is shown for a three-stage inductance-capacity coupled low frequency amplifier in which the switching takes place in the anode circuits of the valves. In this arrangement, the rheostat 60 of the second valve 51 is adapted to operate the switch 61 in the anode circuit of the first valve and the rheostat 66 of the third valve 56 to operate the switch 67 in the anode circuit of the second valve. In this manner, when the contact arms of the rheostats 60 and 66 are moved to their respective off positions, a one-stage amplifier, utilizing the first valve only, is obtained.

In Fig. 8, a convenient arrangement is shown in which low frequency signals are first received in the telephone 81, and then switched as desired through a two-stage amplifier with transformer coupling to a loud speaker 82. When the loud speaker is in operation, the low frequency input is applied to the grid of the first valve 71 and thence to the next two valves 72 and 73 through the low frequency transformers 74 and 75 in the usual manner. The rheostats 76 of the two valves are mechanically coupled and are adapted to operate the two-way switch 77, the contact arm 78 of which can engage with either of two contact members 79 and 80. Alternatively, a single rheostat is used to control the filaments of both valves, which is similarly adapted to operate the two-way switch 77. When the rheostats are moved to their off positions, the arm 78 is in engagement with the contact 79 and the telephone 81 only receives the signal. When the filaments of valves 72 and 73 are energized the contact arm 78 engages with the contact member 80 and the two-stage amplifier circuit is utilized to operate the loud speaker.

In Fig. 9, a similar arrangement is shown by means of which a loud speaker may be operated using either one or two stages of low frequency amplification. In this arrangement, the contact arm of the rheostat 76 operates the two-way switch 77, and the contact arm of the rheostat 83 operates the switch 84. When both the rheostats are in their off positions, the arms 78 and 85 of the switches 77 and 84 engage with their respective contacts 79 and 86, and the telephone 81 only is energized. When the filament of the valve 72 is energized, the contact arm 78 engages the contact member 80 and the loud speaker 82 receives amplified energy from the valve 72. When the filament of the valve 73 is energized, the contact arm 85 engages the contact member 87 whereby the transformer 75 is energized and the loud speaker 82 receives amplified energy from both the valves 72 and 73.

It will be apparent, from the foregoing description, that my invention enables the construction of an amplifying system wherein satisfactory volume-control is accomplished through the medium of switching means having minimum complexity.

While I have shown several embodiments of my invention, it is to be understood that it is capable of still other modifications without departing from the spirit thereof and it is desired, therefore, that only such limitations shall be imposed thereon as are indicated in the prior art or in the appended claims.

I claim as my invention:

1. In an amplifying system, a plurality of three-electrode vacuum tubes in cascade relation, cathode-rheostats, one for each tube, switches, one controlled by each rheostat and each moved to a characteristic position by the movement of the corresponding rheostat to cut-off position and connections established

by the said characteristic position of each switch between an electrode of the deenergized tube and a like electrode of another tube.

2. In an amplifying system, a plurality of three-electrode vacuum tubes in cascade relation, cathode-rheostats, one for each tube, switches, one controlled by each rheostat and each moved to a characteristic position by the movement of the corresponding rheostat to cut-off position and connections established by the said characteristic position of each switch between an electrode of the deenergized tube and a like electrode of the next tube.

3. In an amplifying system, a plurality of three-electrode vacuum tubes in cascade relation, cathode-rheostats, one for each tube, switches, one controlled by each rheostat and each moved to a characteristic position by the movement of the corresponding rheostat to cut-off position and to an alternative position by movement of the rheostat to current-passing position, amplifiers and a translating device excluded from the said cascade relation when said switches are in the characteristic position and connections cooperating with said switches when in the alternative position to include said amplifiers and translating device in said cascade relation.

4. In a multi-stage amplifier comprising a plurality of thermionic discharge devices each having a cathode and a plurality of other electrodes, a cathode-rheostat associated with the cathode of at least one of said devices, means controlled by the rheostat and moved to a characteristic position by the movement of said rheostat to deenergize the cathode circuit corresponding thereto, and means whereby connections are established between an electrode of the deenergized device and a corresponding electrode of another of said devices by the movement of said first mentioned means to said characteristic position.

In testimony whereof, I have hereunto subscribed my name this 9th day of May, 1924.

WALTER JOHN BROWN.