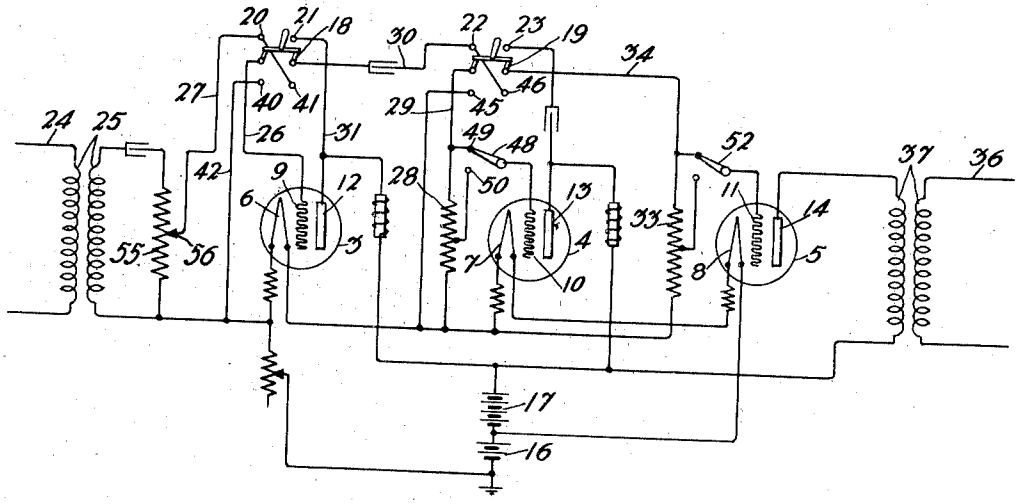
A. HADDOCK.

VACUUM TUBE CIRCUITS.

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1,396,745.

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Inventor:
Arthur Haddock
by J. H. Roberts Atty

UNITED STATES PATENT OFFICE.

ARTHUR HADDOCK, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

VACUUM-TUBE CIRCUITS.

1,396,745. Specification of Letters Patent. Patented Nov. 15, 1921.

Application filed May 19, 1919. Serial No. 298,069.

To all whom it may concern:

Be it known that I, ARTHUR HADDOCK, a citizen of the United States, residing at East Orange, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Vacuum-Tube Circuits, of which the following is a full, clear, concise, and exact description.

This invention relates to vacuum tube circuits and more particularly it relates to multi-stage amplifier circuits in which vacuum tubes are employed in the various stages.

One of the objects of this invention is to provide means for regulating the degree of amplification of a multi-stage amplifier set for signals impressed thereon.

As it is well known in the art, weak currents or signals may be amplified to any desired degree by impressing them on a plurality of vacuum tube amplifiers arranged to work in to each other by suitable circuit connections. In employing such a multi-stage amplifier set for amplifying weak currents, it is frequently found undesirable to use the total amplification of the set before impressing the amplified currents on the outgoing line or the receiving instrument, since the degree of amplification desired for each particular case will depend largely upon the strength of the incoming currents and on the electrical conditions in the output circuit into which the amplifiers work. It is also frequently desirable to cut down the degree of amplification to prevent overloading the last stages of the set.

In accordance with this invention, switching means are provided for cutting in or out, one or more of the stages of a set in order to vary by relatively large steps, the amplifications produced. Means are also provided for adjusting the amount of the voltage impressed on the input circuit of one amplifier from the output circuit of the preceding amplifier so as to obtain a more accurate regulation of the total amplification of the set and also to prevent succeeding stages of the set from being overloaded.

This invention will be better understood by reference to the following detailed description, taken in connection with the accompanying drawing which illustrates the invention applied to a three-stage amplifier set.

Referring to the drawing 3, 4 and 5 are vacuum tube amplifiers containing cathodes, 6, 7, 8 control electrodes, 9, 10, 11 and anodes 12, 13 and 14 respectively. The three filaments, 6, 7 and 8 are heated by battery 16; and a source of voltage 17 is provided for the output circuits of the three tubes.

With the double pole double-throw switches 18 and 19 thrown so as to make connections with contacts 20, 21 and 22, 23 respectively, currents from the incoming line 24 will be impressed through transformer 25 through the wire 27, contact 20 and wire 26 upon the control electrode 9 of the vacuum tube 3. The amplified currents from the tube 3 will be impressed on control electrode 10 of amplifier 4 since its control electrode 10 is connected to resistance 28, which is included in the output circuit of tube 3 through wire 29, switch 19, contact 22, wire 30, switch 18, contact 21 and wire 31. Similarly the resistance 33 is connected in the output circuit of tube 4 through wire 34, switch 19 and contact 23. The amplified currents in the output circuit of tube 4 will then be impressed on the control electrode 11 of tube 5 for further amplification, before being impressed on the outgoing line 36 by transformer 37. As thus described, all the amplifiers are employed and the set delivers its maximum amount of amplification.

If now it is desired to cut out one of the stages, switch 18 may be moved to contacts 40, 41 while switch 19 is allowed to remain connected to points 22 and 23. With such an arrangement, the input circuit of tube 3 is short-circuited through wire 26, switch 18 and wire 42 thereby preventing the tube from functioning. The incoming currents, instead of being impressed on tube 3, will be impressed on control electrode 10 of tube 4 by wire 27, contact 20, contact 41, switch 18, wire 30, switch 19 and wire 29. The amplified currents in the output circuit of tube 4 will be further amplified by tube 5 so that with this arrangement, two stages of amplification are employed.

In the case just described, tube 3 was cut out and tubes 4 and 5 employed, but it is obvious that if desired tubes 3 and 5 may be employed for two stage amplification, tube 4 being cut out by throwing switch 19 on contacts 45 and 46 thereby connecting resistance 33 in the output circuit of tube 3. The amplified currents from tube 3 would

then be impressed directly on tube 5 without the intermediary of tube 4.

If it is desired to employ only one stage of amplification for the incoming currents, the switch 18 should be thrown to contacts 40, 41 and switch 19 should be thrown to contacts 45, 46, thereby short-circuiting the input circuits of both tube 3 and tube 4 and impressing the incoming currents from line 24, by wire 27, switch 18, wire 30, switch 19 and wire 34 upon the control electrode 11 of tube 5. The incoming currents, therefore, would be amplified by only one stage of the set before being impressed on the outgoing line 36.

However, it may be desired in some instances to obtain a more accurate adjustment of the degree of amplification of the set than is obtainable by cutting in or out one or more of the amplifiers. One way in which this may be accomplished is to provide a means for varying the amount of impedances common to the output circuit of one tube and the input circuit of the succeeding tube. Switch 48, for example, when on the contact 49 connects all of resistance 28 in the input circuit of tube 4, but when the switch is moved to contact 50 only a portion of resistance 28 is included in the input circuit of tube 4. The switch 48 therefore in its second position on contact 50 serves to considerably diminish the strength of the signals impressed on tube 4 from tube 3, thereby cutting down the effective amplification of tube 3 and also preventing tube 4 from being overloaded in cases where the output current of tube 3 becomes unusually large. Similarly a switch 52 is provided for regulating the amount of potential impressed on tube 5 from tube 4 through resistance 33. In some instances it may also be desirable to regulate the strength of the signals impressed on the first amplifier. For this purpose a high resistance 55 may be connected across the terminals of the secondary of transformer 25 and the grid 9 connected to this resistance by an adjustable contact 56.

It is, therefore, apparent that with the combined or individual action of switches 18, 19, 48, 52 and 56, a very wide range in the degree of amplification of the set may be obtained to adapt the set for various values of the incoming current. From the above description it is apparent that this invention is not limited in its application to a three-stage amplifier set, but may be employed with sets having any desired number of stages. It is also to be understood that this invention is not limited to the particular means shown for associating the output circuit of one tube with the input circuit of the adjacent tube.

In the following claims, wherein it is specified that the tubes repeat incoming signals without distortion, this is to be interpreted as differentiating between rectification on the one hand and amplification on the other hand, and is to be interpreted as being descriptive of the operation of an ordinary amplifier set.

What is claimed is:

1. A vacuum tube system comprising an incoming line, an outgoing line, a plurality of vacuum tubes therebetween, each having an input circuit and an output circuit, switching means for varying the number of effective tubes between said lines, and switching means for varying the connection of the input circuit of one tube with the output circuit of the preceding tube.

2. A vacuum tube system comprising an incoming line, an outgoing line, a plurality of vacuum tubes connected in tandem therebetween, switching means for rendering one of said tubes temporarily inoperative without affecting the operation of any remaining tube between said lines, and means for varying the connection of the input circuit of one tube with the output circuit of a preceding tube.

3. A vacuum tube system comprising a plurality of vacuum tubes, each having an input circuit and an output circuit, an incoming line, means for associating the input circuit of either one of a plurality of said tubes with said line, and means for varying the impedance relation of the tube so associated and a succeeding tube.

4. A vacuum tube system comprising a plurality of vacuum tubes, each having an input circuit and an output circuit, an input transformer, means for connecting the secondary of said transformer in the input circuit of either one of a plurality of said tubes, and means for varying the impedance relation of two adjacent tubes.

5. A multi-stage amplifier system comprising an incoming line, an outgoing line, a plurality of vacuum tubes connected in tandem therebetween, each of said tubes having an input circuit and an output circuit, switching means for varying the number of effective stages between said lines, and switching means for varying the connection of the input circuit of one tube with the output circuit of a preceding tube.

6. A vacuum tube system comprising a plurality of vacuum tubes, each having an input circuit and an output circuit, an input transformer, switching means for connecting the secondary of said transformer in the input circuit of either one of a plurality of said tubes, an impedance element in the output circuit of one of said tubes, and means for varying the amount of said impedance associated with the input circuit of a following tube.

7. A multi-stage amplifier system comprising a plurality of vacuum tubes con-

nected in tandem, each of said tubes having an input circuit and an output circuit, an incoming line, switching means for associating said line with the input circuit of either one of a plurality of said tubes, a resistance in the output circuit of one of said tubes, and switching means for varying the amount of said resistance which is connected in the input circuit of the succeeding tube.

8. A vacuum tube system comprising an incoming line, an outgoing line, a plurality of vacuum tubes therebetween and adapted to repeat incoming signals without distortion each of said tubes having an input circuit and an output circuit, switching means for varying the number of effective tubes between said lines, an element across which impulses to be transmitted are impressed, and means for connecting the input electrode of one of said tubes to an adjustable portion of said element.

9. A vacuum tube system comprising an incoming line, an outgoing line, a plurality of vacuum tubes connected in tandem therebetween, each having electrodes, switching means for rendering ineffective one of said tubes while maintaining an electrical connection between an electrode of the ineffective tube and an electrode of another of said tubes, a potential regulating element between said incoming line and one of said tubes, and switching means for varying the effective value of said element.

10. A vacuum tube system comprising an incoming line, an outgoing line, a plurality of vacuum tubes therebetween and adapted to repeat incoming signals without distortion, each of said tubes having input and output electrodes, switching means for varying the number of effective tubes between said lines, a regulating element between said incoming line and one of said tubes, and switching means for varying the effective value of said element.

11. A vacuum tube system comprising an incoming line, an outgoing line, a plurality of vacuum tubes connected in tandem therebetween, each having an input and an output circuit, switching means for rendering ineffective a tube subsequent to the first of said tubes, and a potential regulating element between said incoming line and one of said tubes.

In witness whereof, I hereunto subscribe my name this 12th day of May A. D., 1919.

ARTHUR HADDOCK.