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VACUUM TUBE CIRCUITS

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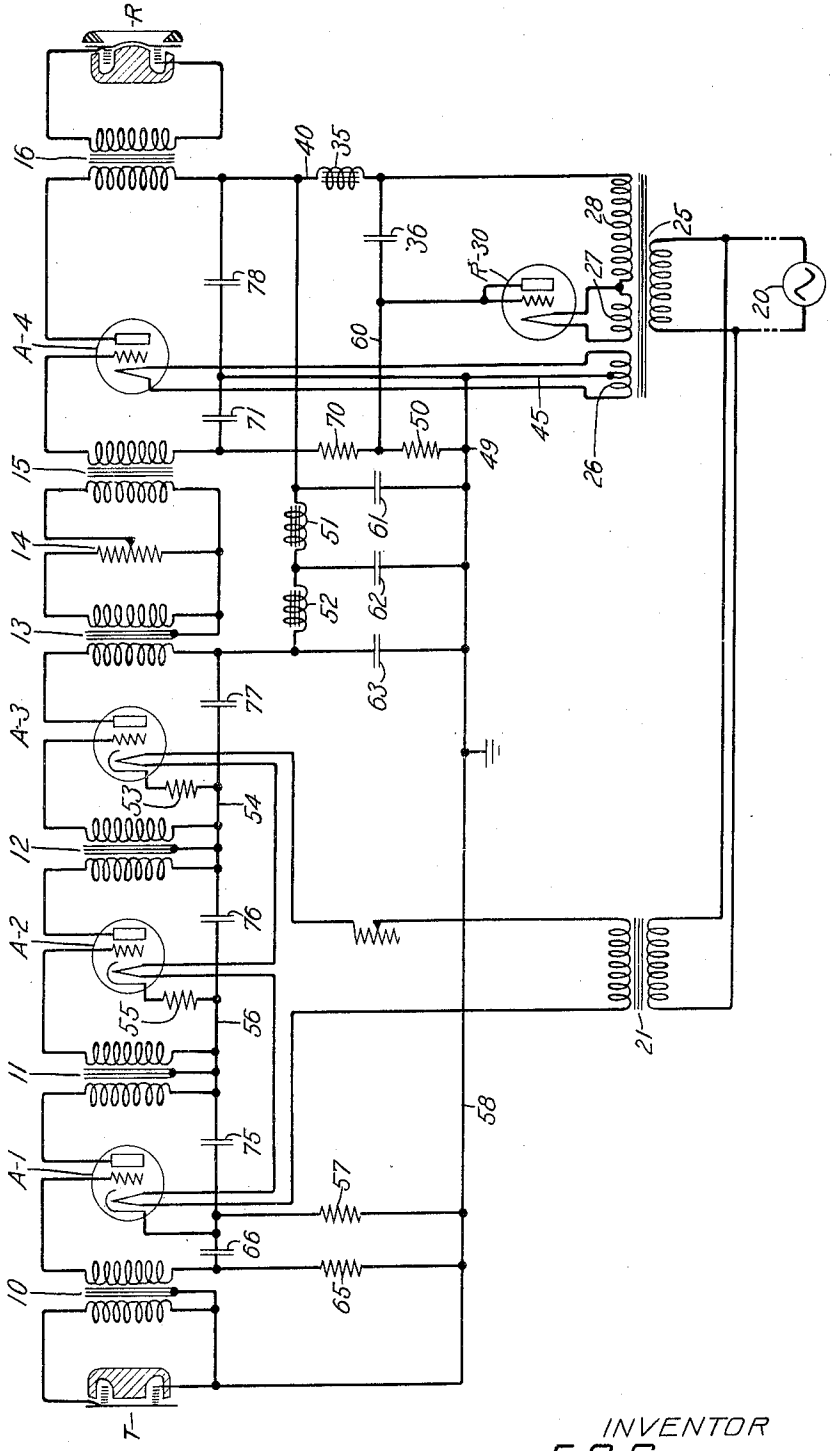

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VACUUM TUBE CIRCUITS

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This invention relates to circuits for electric space discharge devices.

Objects of the invention are to simplify such circuits and to improve their operation.

In one specific aspect the invention is an amplifier, for example a high quality, high gain amplifier for use in audiphones, which comprises a power stage fed by a plurality of homopotential cathode tubes in tandem connection, with a rectifier for supplying direct current to the space current paths of the homopotential cathode tubes in series with each other and for supplying direct current to the space current path of the power stage in parallel with the series connected space current paths of the homopotential cathode tubes.

The D. C. plate circuits of the tubes which feed the power stage can be thus operated in series from the rectifier which feeds the power stage, even though, at the current drain to which the rectifier would be subjected were the plate circuits connected to it in parallel, the voltage regulation of the rectifier would be so poor that the amplifier would not operate. With the D. C. plate circuits in series, then, the rectifier operates satisfactorily and all of the amplifier tubes receive the proper plate current and voltage.

Moreover, in this amplifier the first stage is electrically further from the last stage than in a parallel plate amplifier in which all stages are connected in parallel across a common impedance. This feature tends to stabilize the amplifier from the standpoint of feed-back action.

Further, the series connection of the space current paths tends to stabilize the plate current. If desired, grid biasing potentials for the tubes can be obtained by a voltage drop in the plate circuit of each tube. Upon applying plate potential to the series circuit, the current reaches a value determined by the summation of the voltage drops in all tubes in that circuit but no matter what the variation in the parameters of the tubes, the plate current through them all must remain the same unless radical changes occur. Likewise, the grid biasing voltages must remain proportional to the resistances from across which they are obtained.

By using the homopotential or heater type cathodes for the tubes that have D. C. supplied to their space current paths in series, the cathodes of those tubes can be energized from a common A. C. or D. C. source although they are at different D. C. potentials; for the heater elements of the cathodes are electrically insulated from the thermionically active portions of the cathodes, and need not be at different potentials.

As indicated above, deaf sets or audiphones are one important field of application of the invention. Its application is not restricted to that field. It is applicable to amplifier circuits and vacuum tube circuits generally.

Other objects, aspects, and advantages of the invention will be apparent from the following description and claims.

The single figure of the drawing shows an audiphone circuit embodying the specific form of the invention referred to above.

In the drawing, a telephone transmitter T responsive to sound waves (e. g. speech waves) delivers corresponding electrical waves to a four-stage amplifier comprising vacuum tubes A—1, A—2, A—3 and A—4. The amplifier amplifies the waves and delivers them to a telephone receiver R.

The transmitter T and the receiver R may be of any suitable type, e. g. the moving coil type disclosed in the copending application of E. C. Wente, Serial No. 275,542, May 5, 1928 patented June 24, 1930, No. 1,766,473, or the moving coil type disclosed in E. C. Wente Patent No. 1,707,545, April 2, 1929.

The first three stages of the amplifier, comprising tubes A—1, A—2 and A—3, are shown as tubes of the unipotential cathode type, e. g. homopotential cathode tubes having thermionic cathodes electrically insulated from filaments that serve as heater elements for the cathodes. These tubes may be, for example, Western Electric Company type 244-A vacuum tubes. The last stage of the amplifier, comprising tube A—4, is a power stage. Tube A—4 may be, for example, a Western Electric Company type 205-D vacuum tube. Transformer 10 couples transmitter T to tube A—1. Tubes A—1 and A—2 are coupled by transformer 11; tubes A—2 and A—3 by transformer 12; and tubes A—3 and A—4 by transformer 13, gain or volume control potentiometer 14 and transformer 15. Transformer 16 couples tube A—4 to the receiver R.

A transformer 21 is energized from a source of alternating voltage 20, which may be, for example, a 60 cycle, 110 volt source, for heating the filaments of tubes A—1, A—2 and A—3 to energize the cathodes of those tubes. The source 20 also energizes transformer 25 which has three secondary windings, 26, 27 and 28. Winding 27 supplies current for energizing the filament of a rectifier tube R—30, which may be of the same type as the tube A—4. Winding 26 supplies cur-

rent for energizing the filament of tube A—4. Winding 28 in conjunction with tube R—30 supplies rectified current for two D. C. circuits in parallel relation, one comprising the space discharge path of tube A—4 and the other comprising the space discharge paths of tubes A—1, A—2 and A—3 in series. Choke coil 35 and condenser 36 tend to prevent fluctuations in the rectified current supplied to these two parallel circuits. The first of these circuits extends from the upper terminal of choke coil 35 through conductor 40, primary winding of transformer 16, space discharge path of tube A—4, filament of tube A—4, winding 26, and conductor 45 which connects the grounded midpoint of winding 26 to the lower terminal 49 of resistance 50. The second of the two parallel circuits extends from conductor 40, through choke coils 51 and 52, primary winding of transformer 13, space discharge path of tube A—3, resistance 53, conductor 54, primary winding of transformer 12, space discharge path of tube A—2, resistance 55, conductor 56, primary winding of transformer 11, space discharge path of tube A—1, resistance 57 and conductor 58 to terminal 49. The rectified currents through these two parallel paths pass from terminal 49 through resistance 50 and conductor 60 to the anode of rectifier tube R—30. The choke coils 51 and 52 in conjunction with condensers 61, 62 and 63 tend to prevent fluctuations in the rectified current supplied to the space discharge paths of tubes A—1, A—2 and A—3.

Biasing potentials for the grids of tubes A—1, A—2 and A—3 are obtained from the voltage drops in resistances 57, 55 and 53 respectively.

Biasing potential for the grid of tube A—4 is supplied from the voltage drop in resistance 50, through resistance 70 which in conjunction with condenser 71 tends to prevent voltage fluctuations across resistance 50 from appearing on that grid.

Condensers 66 and 71 afford paths of negligibly low impedance to the signal waves in the input circuits of tubes A—1 and A—4 respectively. Condensers 75, 76, 77 and 78 afford paths of negligibly low impedance to the signal waves in the output circuits of tubes A—1, A—2, A—3 and A—4 respectively.

What is claimed is:

1. A wave translating system comprising electric space discharge devices each including a space current path, means connecting one of said devices to amplify waves that have been amplified by another of said devices, an alternating current output circuit individual to said one device in said means, means for supplying direct current to said paths in series, each of said devices having a control element for controlling said direct current, and means for insuring that each of said control elements controls substantially all of said direct current in response to changes in said direct current.

2. A wave translating system comprising vacuum tubes, a source of electromotive force for supplying direct current to the space paths of said tubes in series, separate alternating current output circuits for the respective tubes, and means for supplying to a grid of each of said tubes a voltage which controls substantially all of said direct current in response to changes in said direct current.

3. A wave translating system comprising vacuum tubes, a source of electromotive force for supplying direct current to the space paths of said tubes in series, separate alternating current output circuits for the respective tubes, and means for supplying to a grid of each of said tubes a voltage which controls substantially all of said direct current in response to changes in said direct current and in response to the alternating current output of the tube.

4. A multi-stage vacuum tube amplifier comprising a source of voltage for supplying direct current to the space paths of the stages in series, separate alternating current output circuits for the respective stages, impedances in series with said space paths and said source, means for supplying to a grid of one of said stages a voltage from across one of said impedances, and means for supplying to a grid of another of said stages a voltage from across another of said impedances.

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