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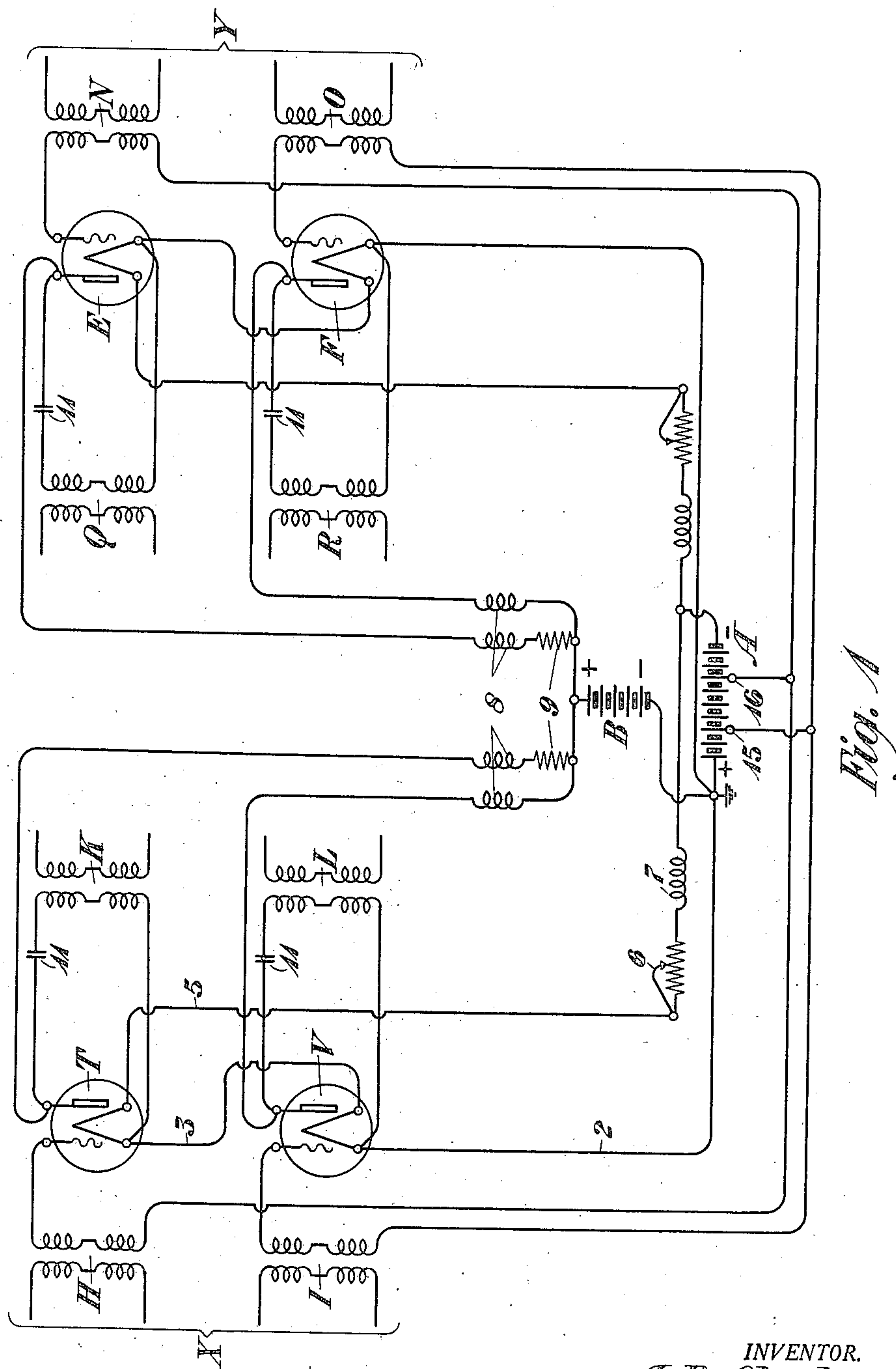
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GRID CIRCUIT FOR ELECTRON TUBES

Filed May 20, 1919

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

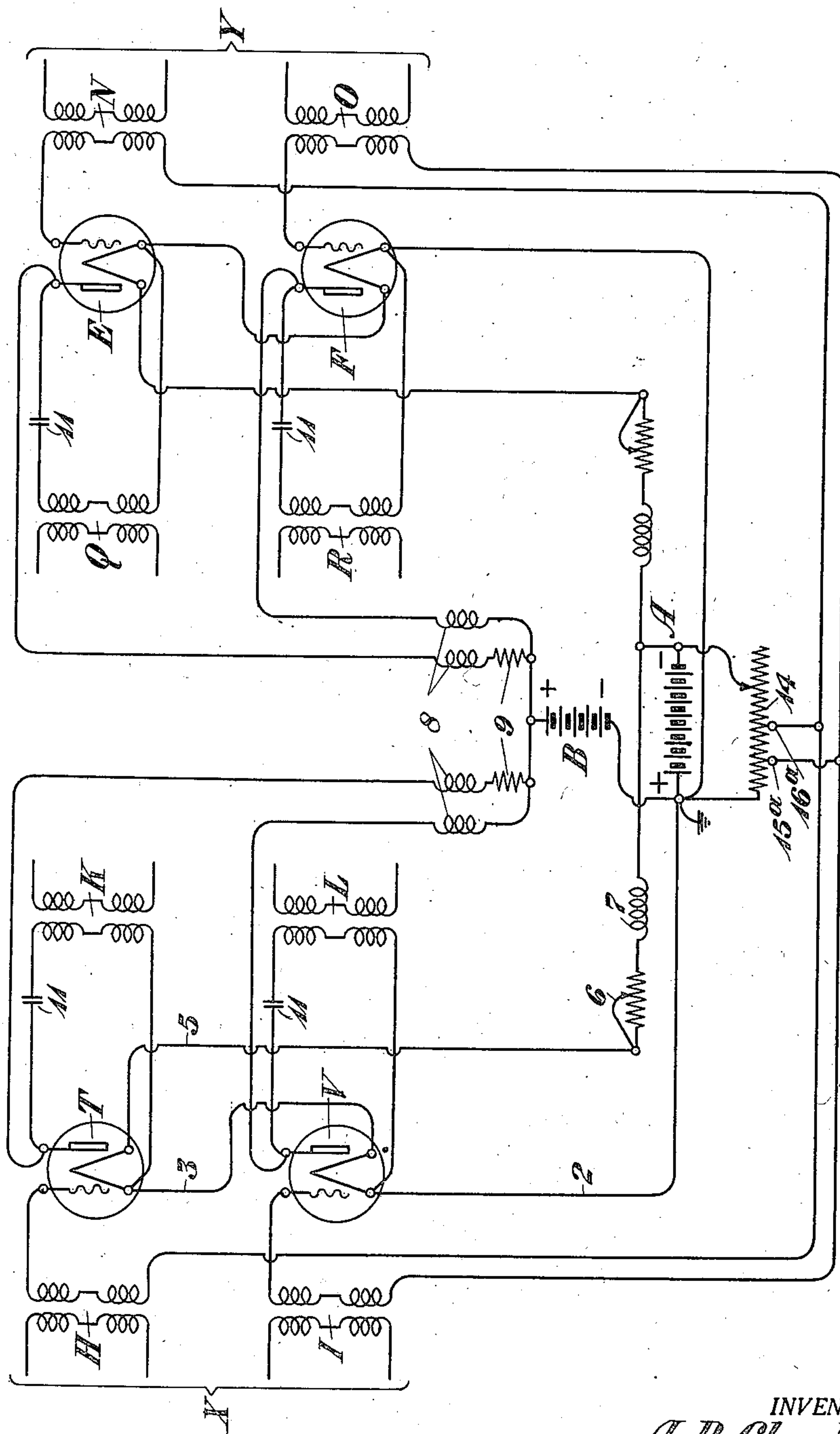


Fig. 2

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GRID CIRCUIT FOR ELECTRON TUBES.

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This invention relates to improvements in circuits and other means for impressing upon the grids of electron tubes a potential, negative with respect to the filaments.

When electron tubes are used as amplifying elements in telephone repeaters the grid of each tube is usually maintained at negative potential with respect to the filament, so that practically no electrons may pass from the filament to the grid and substantially no current flows in the input circuit of the tube, which circuit is connected between the filament and the grid. Heretofore the negative potential on the grid was ordinarily obtained by a small battery, usually composed of dry cells, connected in the input circuit of the tube, a separate battery being used for each grid. It will readily be seen, however, that the necessarily large number of cells in large repeater installations are, however, not only troublesome to maintain but also exceedingly expensive in both first cost and maintenance cost.

It is an object of the present invention to avoid this trouble and expense; and this object is attained by imparting the requisite negative potential to the grids of all the repeater tubes of an installation from a common source. No observable cross-talk results from such connection of the grids since substantially no current flows in the grid circuits, so that there can be no disturbance of one grid by another through the common source of potential even though said source has a fairly large impedance.

According to the present invention the source of filament heating current is likewise utilized as the common source of grid potential. In one form of the invention this source is provided with a plurality of terminals to which the grids are connected, and in a modification thereof this source is bridged by a variable resistance with which the grids are connected.

A better understanding of the invention may be had by reference to the accompanying drawings, Fig. 1 of which is a diagrammatic view showing an arrangement of circuits for electron tube repeaters in which the potential of the grids is derived from terminals on the filament heating battery, Fig. 2 being a view similar to Fig. 1, except that the potential of the grids is derived from a resistance bridged across the filament heating battery.

Similar reference characters refer to similar parts in each of the views.

The apparatus shown in Fig. 1 comprises two groups, X and Y, of telephone repeaters or amplifiers for telephone circuits, each group comprising two independent talking circuits not shown in their entirety, but indicated merely by input transformers H, I and N, O and output transformers K, L and Q, R. The talking circuits are associated with electron tube amplifying elements, designated respectively T, V and E, F. It is to be understood, however, that the number of talking circuits and electron tubes for each repeater group is merely illustrative and the present invention is not limited thereby.

The tubes of each repeater group have their filaments connected in series with each other, and are supplied with current by a filament heating battery A, common to both repeater groups. For example, tubes, T and V are supplied with current through a circuit extending from the positive terminal of battery A, through wire 2, filament of tube V, wire 3 filament of tube T, wire 5, resistance 6 and inductance coil 7, to battery A. Resistance 6 is variable, so that the filament current may be held constant and the coil 7 is highly inductive and thus prevents the disturbances on battery A from being transmitted to the talking circuits. For reasons apparent further below it should here be noted that because of the series connection of the filaments the filament potential decreases from tube to tube. For example, if each tube has a filament of such resistance that there is a six volt drop in each filament, the lowest potentials in the filaments of tubes V and T are, respectively, -6 and -12 volts. The filaments of tubes E and F, are connected to battery A in similar manner. Although only two groups of repeaters are shown, any number of groups may be associated with the same sources of current and potential.

The plate or space current for each tube is supplied from a battery B which has its negative end connected to ground and its positive end connected to the plates of the tubes of both repeaters. In the latter connections there are provided inductance coils 8 to prevent the flow of voice currents there-through. Resistances 9 are inserted into the

plate circuits of tubes T and E, so that the potentials on these plates are lower than the potentials on the plates of tubes V and F, the difference in the plate potentials being the same as the difference in the filament potentials. For example, in tubes having six volt drops in the filaments, resistances 9 are of such value that the potentials on the plates differ also by six volts, and consequently the difference in potential between the plate and filament is the same for each tube. Condensers 11 are provided to prevent the flow of direct current from the battery B through the windings of the output transformers, but to permit the passage of voice currents.

Potential for each grid is furnished by the battery A, which for this purpose is provided with intermediate terminals 15 and 16 which are connected to the grids of the tubes and impress thereon negative potential. Terminals 15 and 16 are so chosen on the battery that in each tube the grid bears the same negative potential with respect to the filament. For example, where six volt filaments are used and a 9-volt difference of potential is required between the grid and the filament, the terminals to which the grids of tubes V and T are connected have respectively potentials of -15 and -21 volts. Similar connections are made from battery A to the grids of the other repeaters.

The modification shown in Fig. 2 differs from the arrangement of Fig. 1 only in that a resistance 14 is bridged across battery A, this resistance being variable so that the current therein may be held constant regardless of the variations in battery potential. The grids of the electron tubes are connected to terminal 15^a and 16^a on this resistance, these terminals being so chosen that their potentials bear the desired relation with respect to the filaments.

The operation of the electron tubes is too well known to need explanation herein. For the present purpose it is sufficient merely to explain that the connection of grids to a common source of potential does not give rise to cross-talk. It is readily understood that the flow of electrons from the filaments to the negative grids is negligible, so that for all practical purposes the grid or input circuits may be considered open. When therefore the voice currents flow through the input transformers they cause merely variations in the grid potentials, but practically no flow of current in the grid circuits. Consequently there is no way in which one grid circuit can disturb another through the common source of potential, nor can there be any inductive action between the leads connecting the input transformers with the source. Without either of these there can be no cross-talk, due to the use of the common source.

Although only two forms of the invention are shown and described herein, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of the invention.

What is claimed is:

1. In combination, a plurality of electron tubes, filament circuits and input circuits therefor, respective output circuits, a source of current common to said filament circuits with a plurality of respective filaments in series to said source, and an impedance connected in parallel to said source and tapped at respectively different points for imparting potential to said input circuits.

2. In combination, a plurality of electron tubes, a circuit for connecting the filaments of said tubes in series, a source of current for said circuit, an impedance element connected across said source, means for retaining the current in said impedance element constant, connections from the grids of said tubes to said impedance, and respective output circuits connected with the plates of said tubes.

3. In combination, a plurality of electron tubes, a circuit connecting the filaments of said tubes in series, said circuit comprising a resistance and a source of current, a variable resistance connected in parallel to said source and having points of potential thereon negative with respect to said filaments, means for connecting the grids of said tubes to said resistance at said points of negative potential, and respective output circuits connected with the plates of said tubes.

4. In combination, a plurality of telephone repeater groups, each group comprising a plurality of electron tubes having independent input circuits and independent output circuits, a filament heating circuit for each repeater group, comprising the filaments of the corresponding electron tubes connected in series, a source of current common to said filament heating circuits and means for holding the grid of each tube at a predetermined negative potential with respect to the filament, said means comprising a resistance bridged across said source of current, a variable contact for holding the current in said resistance constant, a plurality of terminals on said resistance of predetermined negative potential with respect to said filaments and connections from the grids of said electron tubes to the corresponding terminals on said resistance.

5. In combination, a plurality of telephone repeater groups, each group comprising a plurality of electron tubes having respective input circuits and respective output circuits, a filament heating circuit for each group, comprising the filaments of the corresponding electron tubes connected in series, a source of current common to said

filament heating circuits and means for holding the grid of each tube at a predetermined negative potential with respect to the filament, said means comprising a plurality of terminals on said source of current of predetermined negative potential with respect to said filaments and connections from the grids of said electron tubes to the corresponding terminals on said source.

6. In combination, a plurality of electron tubes, a battery, a resistance in series with said battery and connected to the negative end thereof, a circuit connecting the filaments of said tubes in series between said resistance and the positive terminal of said battery, a resistance in parallel with said battery, a variable contact thereon for regulating the current therein, a plurality of terminals on said resistance, and respective input circuits for said tubes, each circuit comprising a connection to said resistance

at a terminal thereon having substantially the same negative difference of potential with respect to the filament.

7. In combination, a plurality of electron tubes with respective filaments, grids and plates, respective input circuit connected with said grids, respective output circuits connected with said plates, a source of current adapted to serve also as a source of potential, said filaments being connected to receive current in series from said source and said grids being connected to receive potentials from said source, said connections comprising adjustable means by which the potential of each grid with respect to its filament may be made the same for all the tubes.

In testimony whereof, I have signed my name to this specification this 16th day of May, 1919.

ALVA B. CLARK.