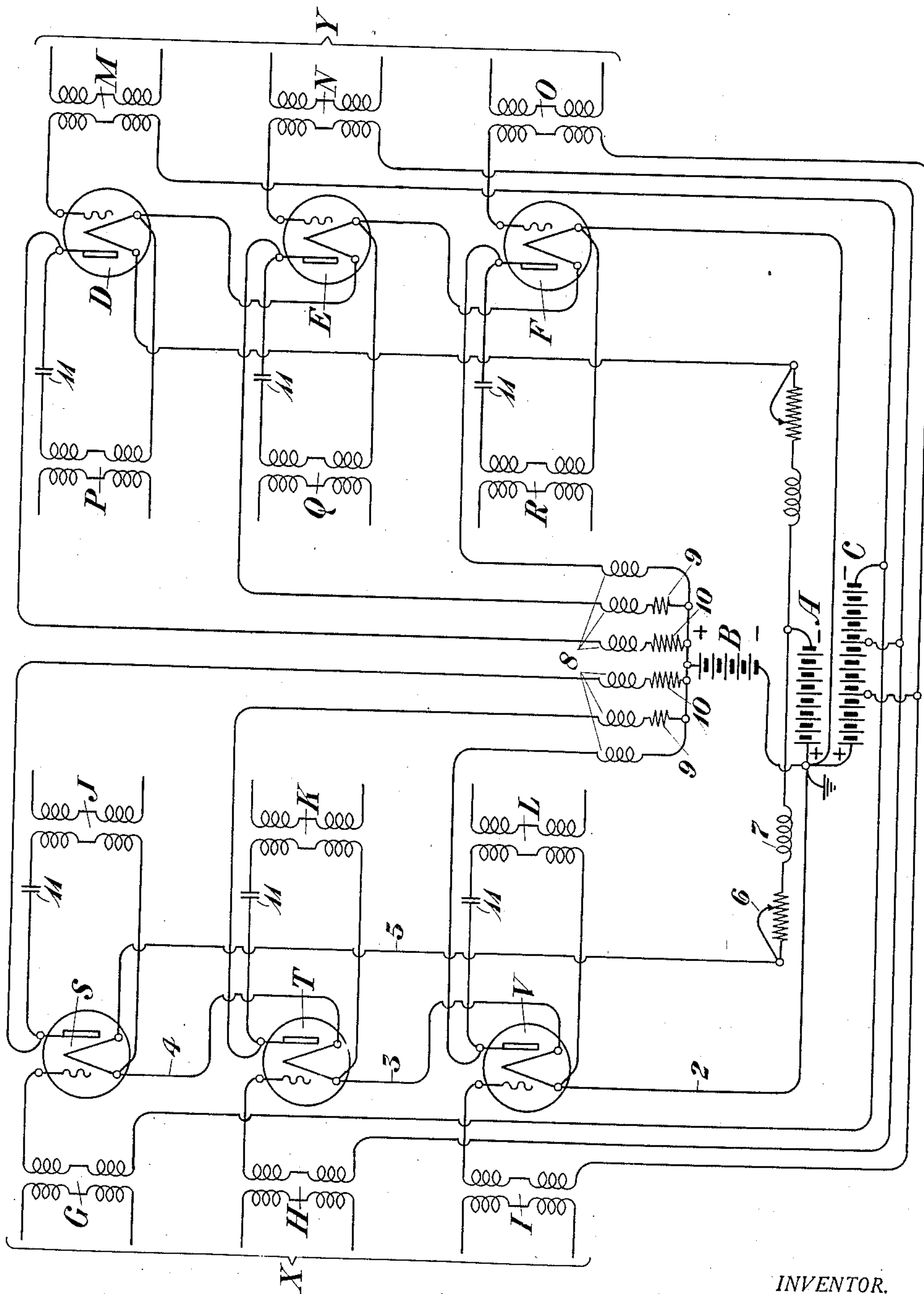


A. B. CLARK.
 GRID CIRCUITS FOR ELECTRON TUBES.
 APPLICATION FILED MAY 20, 1919.

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GRID-CIRCUITS FOR ELECTRON-TUBES.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, ALVA B. CLARK, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Grid-Circuits for Electron-Tubes, of which the following is a specification.

This invention relates to improvements in circuits 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 substantially 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 has ordinarily been 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. The necessarily large number of cells in large repeater installations are, however, not only troublesome to maintain, but also exceedingly expensive in first cost, as well as in maintenance cost.

It is an object of the present invention to avoid this trouble and expense; and such object is attained by exciting the grids of all the repeater tubes of an installation from a common battery, this battery being distinct from the sources of current for the other circuits associated with the repeater tubes. No 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.

A good understanding of the invention may be had by considering the following detailed description, with reference to the accompanying drawing, which in diagrammatic form shows an arrangement of circuits for electron tube repeaters in which a common C battery supplies potential to the grids.

The apparatus shown in the drawing comprises two groups, X and Y, of repeaters or amplifiers for telephone circuits, each group comprising three independent talking circuits not shown in their entirety, but indi-

cated merely by input transformers G, H, I and M, N, O and output transformers J, K, L and P, Q, R. The talking circuits are associated with electron tubes, designated respectively S, T, V and D, 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 S, 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 4, filament of tube S, 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 which will be apparent it should here be noted that because of the series connection of the filaments the filament potential decreases from tube to tube due to the filament resistance, and if, for example, there is a six volt drop in each filament the lowest potential in the filaments of tubes V, T and S are, respectively, -6, -12, and -18 volts. The filaments of tubes D, E, 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 all repeaters. In the latter connections there are provided inductance coils 8 to prevent the flow of voice current there-through. The connections to the plates of tubes S and T are provided with resistances, 9 and 10 respectively, which when traversed by current from the B battery cause such drop in voltage in their respective circuits that the resultant potential on the plate of the tube S is less than that on the plate of tube T, which in turn is less than the potential on the plate of tube V. In tubes having a six volt drop in the filaments, re-

sistances 9 and 10 are of such value that the potentials on the plates differ by six volts, so that the difference in potential between the plate and filament is the same for each tube. Like resistances are inserted in the plate circuits of tubes D and E for the same reasons. The 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 a battery C which for this purpose is provided with four terminals. The positive terminal is connected to ground and therefore has zero potential and the remaining terminals are connected to the grids of the tubes and impress thereon negative potential. The negative terminals 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, T, and S, are connected have respectively potentials of - 15, - 21 and - 27 volts. Similar connections are made to battery C from the grids of the other repeater.

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 the 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 practically zero, 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 C battery, nor can there be any inductive action between the leads connecting the input transformers with the C battery. Without either of these there can be no cross talk due to the use of the common C battery.

Although only one form of the invention is 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, a battery having terminals of negative potential with respect to the filaments of said tubes and respective independent input circuits and translating devices for said tubes connected to said terminals.

2. In combination, a plurality of electron tubes, a battery for supplying current to the filaments of the tubes, a second battery having its positive terminal associated with the positive terminal of the first battery, and a respective independent input circuit and translating device for each tube connected at one end to the grid of the tube and at the other end directly to said battery at a point thereon of negative potential with respect to the filament.

3. In combination, a plurality of electron tubes, respective input translating devices associated with the grids of said tubes, a circuit connecting the filaments of said tubes in series, a source of current therefor, a grid battery having its positive terminal associated with said source, said battery having a plurality of points of negative potential with respect to the filaments, circuits connecting the grids of said tubes to said battery, each circuit comprising a respective translating device and being connected to said battery at a point thereon of negative potential with respect to the filament of the corresponding tube.

4. In combination, a plurality of electron tubes, each tube comprising a grid, a filament and a plate, a series circuit for supplying heating current to said filaments, a source of plate current, connections from said source to said plates, and arranged so that the potential difference between the plate and filament of each tube is substantially the same, a grid battery, and connections from said grids to points on said battery of such potential that the grid of each tube is negative with respect to the filament and the potential difference between the grid and filament of each tube is substantially the same.

5. 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 a source of filament of current and the filaments of the corresponding electron tubes connected in series, and means for holding the grid of each tube at a predetermined negative potential with respect to the filament, said means comprising a grid battery having its positive terminal connected to the positive terminal of said source of filament current, a plurality of negative terminals on said grid battery of predetermined potential with respect to said filaments, and connections from the grids of said electron tubes to the corresponding terminals on said battery.

6. In combination, a plurality of electron tubes, a source of potential having terminals of graded negative potential with respect to the filaments of said tubes, respective inde-

pendent input translating devices for the tubes, and circuits connecting said input translating devices with the respective grids, said circuits being connected to the respective terminals of said source of potential.

7. In combination, a plurality of electron tubes, respective independent input translating devices therefor, respective input circuits comprising said translating devices and the grids of said tubes, a device adapted to give graded potentials, a filament heating circuit comprising the filaments of said tubes the said input circuits to the grids being connected to said device at various points thereof so as to apply proper potentials to the grids.

8. In combination, a plurality of electron tubes, with their filaments at different potentials, respective independent output trans-

lating devices connected with the plates of said tubes, a battery to which the plate circuits are connected in multiple, and means to equalize the potential differences between the plates and the respective filaments.

9. In combination, a plurality of electron tubes with their filaments in series on a common circuit, respective independent output translating devices connected with the plates of said tubes, a battery to which the plate circuits are connected in multiple, and resistances in said circuits to absorb the potential drop therein and equalize the potential differences between the plates and the respective filaments.

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

ALVA B. CLARK.