March 2, 1926. 1,574,807

D. K. GANNETT

MEANS FOR REGULATING VOLTAGES

Filed Sept. 21, 1923 2 Sheets-Sheet 1

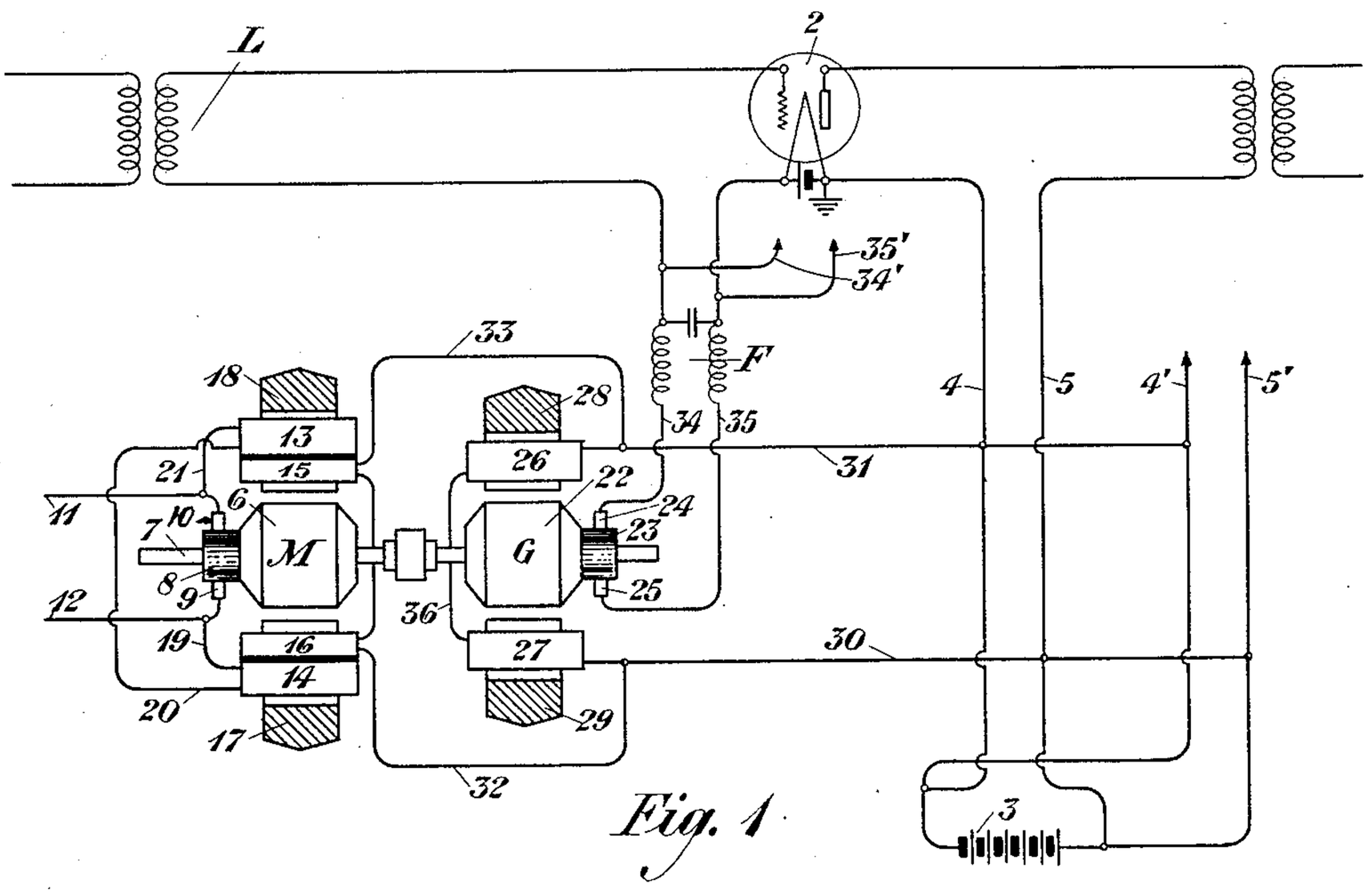

Fig. 1

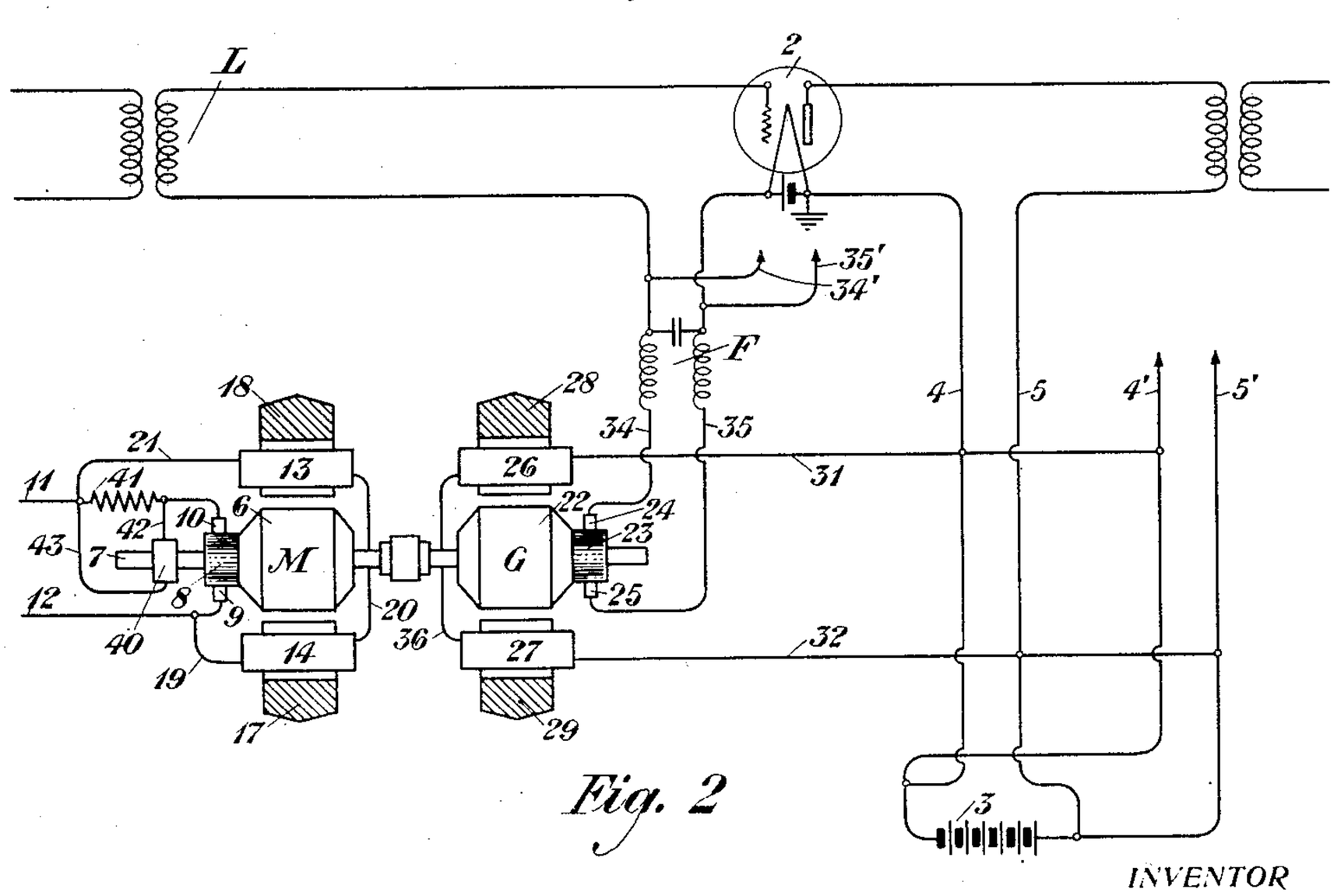

Fig. 2

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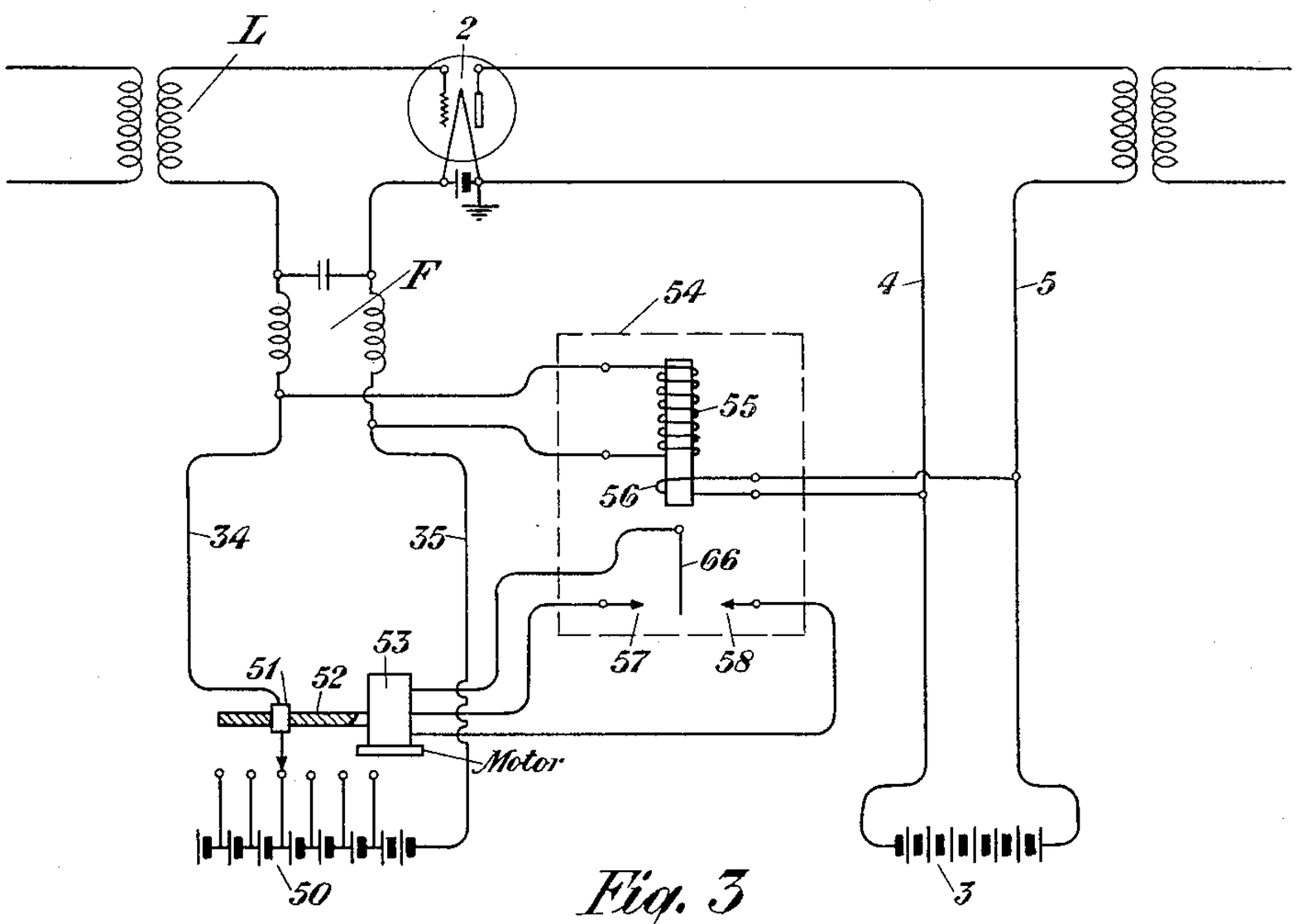

Fig. 3

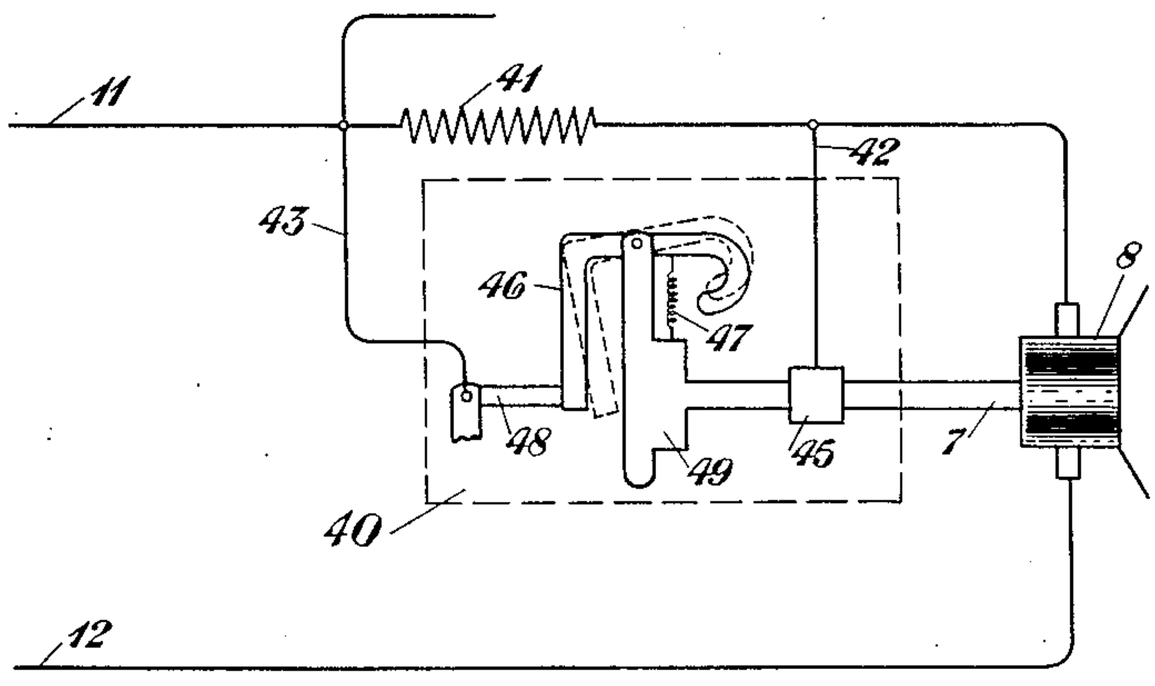

Fig. 4

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UNITED STATES PATENT OFFICE.

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MEANS FOR REGULATING VOLTAGES.

Application filed September 21, 1923. Serial No. 664,065.

To all whom it may concern:

Be it known that I, DANFORTH K. GANNETT, residing at Elmhurst, in the county of Queens and State of New York, have invented certain Improvements in Means for Regulating Voltages, of which the following is a specification.

This invention relates to improvements in amplifiers of the well known vacuum tube type and more particularly to arrangements for counteracting the effects of voltage fluctuations in the battery circuits of such tubes.

It is well known that the amount of amplification which a vacuum tube will give in any circuit depends upon the voltage amplification constant of the tube and upon the relation between the impedances of the tube and the impedances of the circuits to which it is connected. The output impedance of the tube (the plate-filament impedance) is a function of $(E_b+\mu E_c)$, where E_b and E_c are the plate and grid voltages, respectively, measured to the negative end of the filament and μ is the voltage amplification constant of the tube. It is evident, therefore, that if either E_b or E_c varies, the output impedance of the tube varies and the effective amplification of the tube is changed. However, it is also evident that when one of the voltages varies, it is possible to so vary the other as to maintain the quantity $(E_b+\mu E_c)$ and, therefore the tube impedance, constant. This invention discloses automatic means for thus avoiding variations in the amplification of a tube when the battery voltages fluctuate.

An example of the application of this invention may be found in telephone repeaters, in the case of which it is particularly desirable to avoid variations in amplification. In the past it has been the custom where a battery having a variable voltage must be used to supply the plate potential for telephone repeaters, to inert a stabilizing resistance in series with the output circuit of the vacuum tube. This decreases the effect of variations in tube impedance but also causes a considerable reduction in the amplification. This is objectionable because it reduces the maximum amplification which is obtainable and also the maximum power which the repeater will handle. The use of the present invention in such a case would reduce the amplification variations to nearly zero without decreasing either the maximum gain which may be obtained or the maximum power output. In the arrangements of the invention the desired compensation may be accomplished by supplying the grid potentials from a motor generator set and so designing and connecting the motor generator set with the plate battery that any flutuations in potential therein will cause the output potential of the motor generator set to vary so as to compensate for the plate battery fluctuations. Other features and objects of the invention will appear more fully from the detailed description hereinafter given.

The invention may be more fully understood from the accompanying drawing in the Figures 1, 2, 3 and 4, of which the invention is illustrated. In Fig. 1 is illustrated a sectional view of the motor generator set and the circuit arrangements thereof. Figs. 2 and 3 show modifications of the invention and Fig. 4 shows the details of the governing mechanism of Fig. 2. Similar reference characters have been utilized to denote like parts in all of the figures.

In Fig. 1 is shown a line L including a vacuum tube amplifier 2 having grid, plate, and filament elements. The plate circuit of the tube is supplied with potential by means of conductors 4 and 5 connected to the plate battery 3. The grid potential is supplied by means of a motor generator set M G. The motor M comprises an armature 6 mounted on a shaft 7 together with a commutator 8 and the brushes 9 and 10. These brushes are connected to a power circuit 11, 12. The motor also comprises the pole pieces 17 and 18 and the field windings 13 and 14. The current for the field windings is supplied from the power circuit by means of conductors 19, 20 and 21. The motor is also provided with an auxiliary set of field coils 15 and 16. These field coils are connected so as to oppose the magnetic field of the motor for purposes which will be pointed out hereinafter. The auxiliary field coils are connected over conductors 33 and 31 and 32 and 30 to conductors 4 and 5 leading to the plate battery 3. The generator G comprises an armature 22 mounted on the shaft 7 together with the commutator 23 and the brushes 24 and 25. The generator also comprises the pole pieces 28 and 29 and

the field windings 26 and 27. The field windings 26 and 27 are connected by conductors 30 and 31 to conductors 4 and 5 leading to the plate battery 3. The magnetic circuit of the generator is designed so that it is magnetically saturated so that the field flux does not vary perceptibly with variations in the potential across the terminals of the field coils 26 and 27. The grid circuit of the tube 2 is connected by means of conductors 34 and 35 to the brushes 24 and 25 of the generator.

As has been previously pointed out the auxiliary field windings 15 and 16 of the motor M are so connected as to oppose the magnetic field of the motor. Accordingly any increase in the voltage of plate battery 3 would tend to weaken the magnetic field of the motor and cause it to run faster so as to cause the generator to supply a greater negative potential to the grid circuit to compensate for the potential increase in the plate circuit. A decrease in the voltage of plate battery 3 would in like manner cause the motor to lessen its speed and cause the generator to decrease the voltage supplied to the grid circuit.

A filter F has been shown associated with conductors 34 and 35 to prevent machine harmonics from being transmitted to the line L. Other grid circuits may be connected to the machine generator by the conductors 34′ and 35′ and other plate circuits may also be connected to the battery 3 by conductors 4′ and 5′ as shown.

In Fig. 2 the motor M only has one set of field coils 13 and 14 which are supplied with current from the power circuit 11, 12 by means of conductors 19, 20 and 21. The motor is driven at a constant speed by means of the governor 40. The field coils of the generator G are connected as in Fig. 1 to the plate battery. The magnetic structure of the generator, however, is such that it operates considerably below the saturation point. Accordingly, any variation in the voltage of battery 3 will cause a corresponding variation in the field flux of the generator, which in turn will cause a corresponding variation in the output voltage of the generator. In other words the generated grid voltage will always remain proportional to the plate voltage and the fluctuations of the latter will always be compensated for automatically. A filter F is also shown between the grid circuits and the generator to eliminate machine harmonics.

In Fig. 4 are shown the details of the governor shown as 40 in Fig. 2 for driving the motor M at a constant speed. It is understood that any other desirable form of governor might equally well be utilized. Mounted on the shaft 7 is a bearing 45 to which is connected conductor 42, which is in turn connected to conductor 11 of the power circuit. Pivotally connected to the head 49 of shaft 7 is the contact arm 46 normally held in the position shown by the spring 47. Bearing against the lower extremity of contact arm 46 is the fixed contact arm to which is connected the conductor 43. Conductor 43 is connected to conductor 11 of the power circuit. Normally the following short circuit exists around resistance 41 in the power circuit,—from conductor 11, conductor 43, contact arms 48 and 46, shaft 7, bearing 45, and over conductor 42, to conductor 11. If the speed of the motor increases the shaft 7 will rotate faster and the centrifugal force will cause the pivotal contact arm 46 to assume the dotted position, thus breaking contact with contact 48 and opening the short circuit around resistance 41 which will be included in the power circuit until the motor slows down.

In Fig. 3 is shown a modified form of the invention in which the grid voltage is caused to automatically vary in accordance with the .plate voltage by means of a voltmeter relay which associates the two sources of potential with each other. The voltmeter relay has two windings. Winding 55 is connected over conductors 34 and 35 to the source 50 of grid potential. Winding 56 is connected over conductors 4 and 5 to the source 3 of plate potential. These windings are arranged so as to oppose each other and the ratio of the number of turns of winding 55 to winding 56 is equal to the amplifying constant of the tubes. For purposes of illustration it will be assumed that this ratio is six. The grid battery has a series of contacts cooperating with a pointer 51 controlled by a rotary shaft 52 and a motor 53 in such a manner that it may be moved either to the left or right. The voltmeter relay will have a movable contact 66 and the fixed contacts 57 and 58. The connections to the motor from contacts 57 and 58 are such that the motor rotates in one direction when contact 66 touches contact 57 and in the other direction when it touches contact 58. The grid battery for purposes of illustration may be assumed to be composed of 2 volt cells. Under these conditions contacts 57 and 58 of the voltmeter relay are adjusted so that the distance between them corresponds to a movement of the contact 66 caused by slightly more than 12 volts change in the plate battery 3. If the voltage of the plate battery 3 fluctuates more than ± 6 volts from its normal value, then the relay contact 66 makes contact with either contacts 57 or 58 and the pointer 51 operates to cut in or out additional cells of the battery 50 until equilibrum is reestablished. The filter F is provided to prevent creating a noise in the circuit L because of the transients produced by these changes. The arrangement of Fig. 3 just described compensates not

only for changes in the voltage of the plate battery 3 but also for variations in the voltage of the grid battery 50. That this is true is seen from the fact that the position of the moving contact 66 is determined by both the plate and grid battery and a change in the voltage of either causes that contact to move, actuating the motor 53 and readjusting contact 51 to compensate for the change as just described.

The arrangements of the invention might obviously be utilized to supply potentials, which have a proportionate variation, to devices other than vacuum tubes. Accordingly, while the invention has been illustrated in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A vacuum tube having grid and plate circuits, a source for supplying potential to said plate circuit, a motor generator set for supplying potential to said grid circuit, means for connecting said motor generator set with said source, and means in said motor generator set responsive to the variations in potential of said source for controlling the output potential of said motor generator set.

2. A source of potential, a work circuit therefor, a second source of potential, said second source of potential comprising a motor generator set, a separate work circuit therefor, means for connecting said motor generator set with said first source of potential, and means in said motor generator set responsive to the variations in potential of said first source for controlling the output potential in the work circuit of said motor generator set.

3. A source of potential, a work circuit therefor, a second source of potential comprising a motor generator set, a separate work circuit therefor, means for connecting the field coils of said generator to said first source of potential, the magnetic circuit of said generator being so designed that it is magnetically saturated whereby the field flux will not vary perceptibly with variations in the potential across the terminals of its field coils, means for connecting said first source of potential to said motor, and means in said motor controlled by said last mentioned means for controlling the speed of said motor.

4. A source of potential, a work circuit therefor, a second source of potential comprising a motor generator set, a separate work circuit therefor, means for connecting the field coils of said generator to said first source of potential, the magnetic circuit of said generator being so designed that it is magnetically saturated whereby the field flux will not vary perceptibly with variations in the potential across the terminals of its field coils, an auxiliary set of field coils for said motor, said auxiliary field coils being designed to oppose the magnetic field of said motor, and means for connecting said auxiliary field coils to said first mentioned source of potential.

5. A vacuum tube having grid and plate circuits, a source for applying potential to said plate circuit, a motor generator set for applying potential to said grid circuit, said motor generator set comprising a generator driven by a motor, means for connecting the field coils of said generator to said first source of potential, the magnetic circuit of said generator being so designed that it is magnetically saturated whereby the field flux will not vary perceptibly with variations in the potential across the terminals of its field coils, an auxiliary set of field coils for said motor, said auxiliary field coils being designed to oppose the magnetic field of said motor, and means for connecting said auxiliary field coils to said first mentioned source of potential.

In testimony whereof, I have signed my name to this specification this 20th day of September, 1923.

DANFORTH K. GANNETT.