May 3, 1932. H. M. STOLLER 1,856,666

FILTER CIRCUITS

Filed May 6, 1925

Fig. 1

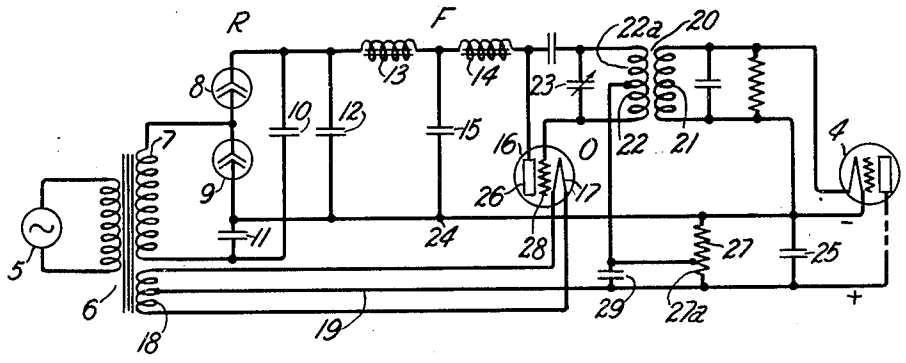


Fig. 2

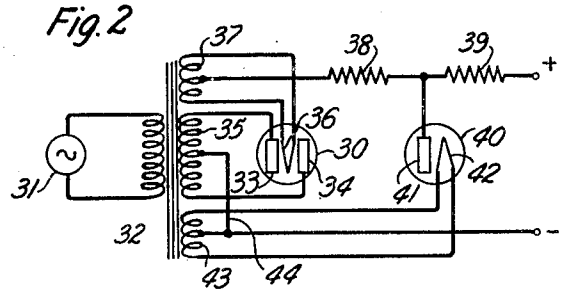
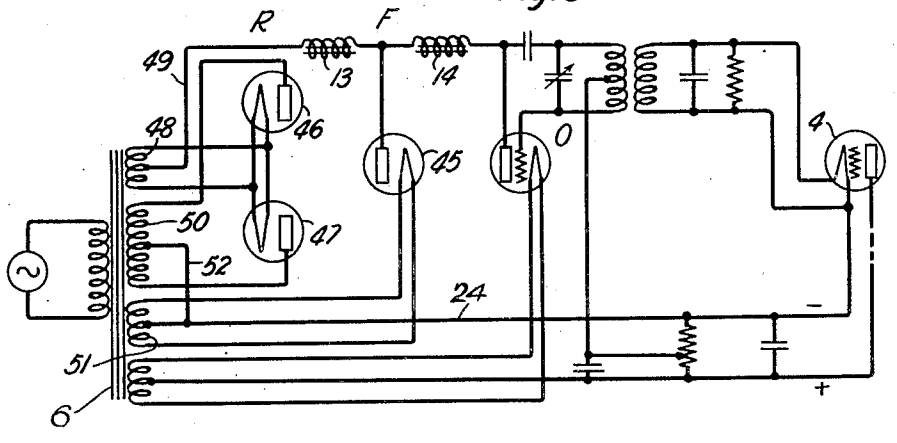


Fig. 3



Inventor:
Hugh M. Stoller
by E. W. Adams Att'y.

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UNITED STATES PATENT OFFICE

HUGH M. STOLLER, OF MOUNTAIN LAKES, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTERN ELECTRIC COMPANY, INCORPORATED, A CORPORATION OF NEW YORK

FILTER CIRCUITS

Application filed May 6, 1925. Serial No. 28,304.

This invention relates to electric filters, and particularly to filters of the type used for suppressing low frequencies such as may be present in the output of rectifiers, for example; and to combination rectifier-filter circuits.

One object of this invention is to provide a cheap and effective filter for suppressing currents of low frequency.

It is well known that inductance condenser and resistance condenser filters may be connected in the output of rectifiers for eliminating the fluctuations in the rectified current. However, it has been found that in order to effectively filter low voltage currents, it is necessary to use a high capacity condenser even of the order of 1000 mf. or more. Such condensers are necessarily expensive and bulky.

It is a particular object of this invention to provide a suitable filter for purifying rectified power for low voltage circuits.

One feature of this invention consists in arranging a rectifier and filter to supply power to two or more low voltage circuits in series; for example the space current circuits of two space discharge devices. In this way, it is possible to increase the voltage across the filter, thus giving better filter action and decreasing the cost of the filter. Such a circuit arrangement not only makes it possible to use more simple condensers, but also reduces the value of the series inductances required to keep the voltage fluctuation below a definite value.

Another feature of this invention consists in the use of a gas-filled discharge tube as the shunt element of a filter. The voltage drop in a gas-filled tube is practically independent of the current throughout a wide range of current and dependent primarily on the nature and pressure of the gas and the size and spacing of the electrodes. It has also been found that such a tube will absorb pulsations in the current without developing corresponding changes in the voltage across the tube, that is, it offers a low resistance to superimposed alternating current. Such a tube, therefore, can be used as a shunt element in a filter and by the proper arrangement of the electrodes and the proper choice of gas pressure, it is possible to adapt it to a considerably wide range of voltages.

This invention can be more readily understood by reference to the following description in connection with the drawings, in which;

Fig. 1 shows one embodiment of the invention in an inductance condenser filter for energizing a plurality of electron tubes in series;

Fig. 2 shows an embodiment of this invention employing a gas-filled tube as a shunt element of the filter; and

Fig. 3 shows an embodiment of the invention employing a gas-filled tube as a filter element and supplying current to a plurality of circuits connected in series.

Referring first to Fig. 1 which shows a power supply circuit for electron tubes which may be used in an amplifier, for example, one tube 4 is shown, but it is understood that the circuit may be used for supplying a plurality of tubes in the same manner. Current is supplied from the alternating current source 5, for example a house lighting circuit. Current from this source is rectified by means of the rectifier R, and the rectified current is filtered by a filter F, and is used for supplying space current to the tubes 4 and to an oscillator circuit O. This oscillator circuit generates a superaudible frequency which is employed for supplying filament heating current to the tubes 4 as is described in my copending application Serial No. 680,172, filed December 12, 1923.

Current is supplied from the source 5 to the primary of the transformer 6, one secondary winding 7 of which is connected to the two cold cathode rectifier tubes 8 and 9 which are connected in circuit with condensers 10, 11 and 12 to give a high voltage output. This type of rectifier circuit is described on page 141 of The Thermionic Vacuum Tube by H. J. Van der Bijl (McGraw and Hill, 1920) to which reference is made for a further description. The filter F comprises two series inductances 13 and 14 and a shunt condenser 15.

The oscillator circuit is of the type de-

scribed in U. S. Patent 1,472,470, granted to R. V. L. Hartley, October 30, 1923 to which reference is made for a more detailed description of the operation. The particular form here shown comprises a vacuum tube 16 having a cathode 17 connected to a secondary winding 18 of the transformer 6 for supplying heating current. A mid-tap 19 is brought out from the winding 18 for making the cathode connection. An oscillation transformer 20 is provided having an output coil 21 and primaries 22 and 22*a* connected to the grid and plate circuits, respectively, of the oscillator tube 16. A condenser 23 is connected across the primaries for determining the frequency of the generated oscillations. This is adjusted so that the oscillations generated are in the superaudible range, for example, in the neighborhood of 20,000 cycles per second.

The output of the filter F can be traced from the negative terminal 24 through the space current circuit of the tube 4, which is shunted by the condenser 25 for further filtering the space current, through connection 19 to the cathode 17, through the tube 16 to the anode 26, back to the other terminal of the filter at inductance 14. A resistance 27—27*a* is shunted across the space current circuit of the tube 4. A connection from the grid 28 of the oscillator tube 16 is brought to a point on this resistance so that the grid is maintained at a negative potential with respect to the cathode 17 by the IR drop in the portion 27*a*. Resistance 27—27*a* also serves to complete the circuit to cause sufficient space current to flow in the oscillator for starting.

Fig. 2 shows a balanced rectifier 30 supplied with alternating current from a source 31 through a transformer 32. The rectifier which may be of any of the well-known types comprises two anodes 33 and 34 connected to the two ends of a secondary winding 35 to rectify both halves of the alternating current wave in a manner well known in the art. Cathode 36 is heated by current from an auxiliary secondary 37. The output of the rectifier is filtered by means of a filter comprising two series resistances 38 and 39 and a gas-filled space discharge tube 40 connected in shunt to the rectifier output. The anode 41 of this tube is connected to the positive rectifier lead between the two resistances 38 and 39. Heating current is supplied to the cathode 42 from another secondary winding 43. The cathode is effectively connected to the negative terminal of the rectifier by the connection 44 joining the mid-points of windings 35 and 43. This arrangement may be used for supplying filament heating current or space current to electron tubes.

The commercial gas-filled tubes now used for rectifying comparatively low currents are well adapted for use in low voltage filters such as might be used for supplying filament heating current to electron tubes, but as pointed out above tubes can be designed for use on higher voltage circuits by the proper choice of gas pressure and the proper design and arrangement of electrodes.

Fig. 3 shows a power supply circuit similar to Fig. 1 except that a gas-filled tube 45 is used as the shunt element of the filter. Two rectifier tubes 46 and 47 are shown with their anodes connected to the terminals of a secondary winding 50 for rectifying both halves of the alternating current wave, instead of the rectifier arrangement shown in Fig. 1. The cathodes of these tubes are connected in parallel to a secondary winding 48 of the transformer 6 for supplying heating current. A mid-tap 49 to this winding serves as a positive terminal of the rectifier. Inductances 13 and 14 are connected in this lead as in Fig. 1 and the anode of the tube 45 is connected between them. The cathode of tube 45 receives heating current from the secondary winding 51 the mid-point of which is connected to the mid-point of secondary winding 50 and the negative rectifier lead 24.

This invention is not limited to the particular examples shown, but may be embodied in other forms which will be obvious to those skilled in the art.

What is claimed is:

1. In combination, a rectifier having output terminals, a filtering means connected to said output terminals, a high frequency generator having input and output terminals, a space discharge device having a thermionic cathode, circuit connections from the output terminals of said generator to the cathode of said space discharge device for supplying heating current thereto, and circuit arrangements for supplying space current to said space discharge device and current to the input terminals of said generator in series.

2. In a system including a source of fluctuating direct current to be filtered, leads extending from said source, a filter comprising a plurality of inductance coils in one of said leads and a gas filled space discharge device having an electrode connected between two of said inductances and a second electrode connected to the other of said leads.

3. A peak-suppressing circuit for connection between a source of fluctuating current and a load, said circuit comprising series impedance and a shunt impedance, the latter comprising a gas-filled discharge device having a flat region in its voltampere characteristic extending over the amplitude range of the fluctuations impressed across said device from said source.

4. A smoothing circuit for connection between a source of fluctuating current and a load, said circuit comprising a plurality of series choke coils and a shunt impedance connected across the circuit from a point between said coils to the opposite side of the

circuit, said shunt element comprising a gas-filled hot-cathode discharge device having a flat region in its volt-ampere characteristic extending over the amplitude range of the fluctuations that are to be suppressed, and means for heating the cathode of said device from said source of current.

5. The combination of a source of alternating current, a rectifier, a smoothing circuit and a load to be supplied with direct current voltage of constant value, said smoothing circuit comprising series impedance connected between said rectifier and said load, and comprising further a shunt impedance in the form of a hot-cathode electric discharge device having a flat region in its volt-ampere characteristic extending over the amplitude range of the fluctuations to be suppressed, and a circuit for supplying heating current to the cathode of said device from said source of alternating current, including a transformer with its secondary winding connected to said cathode, one terminal of said load being connected to the mid-point of said secondary winding.

6. In combination, an oscillation generator including a three electrode tube, a power source for said oscillation generator, means for eliminating ripple from power supplied to said generator, a thermionic valve filament circuit electrically connected to said generator whereby the oscillating current heats the filaments, and means for maintaining a negative bias on the oscillation generator tube whether the tube is oscillating or not.

7. In combination, a source of power that may fluctuate, a translating device to be operated from said source, and a network for smoothing out the fluctuations of said power supply including a current stabilizer in series with said translating device and a voltage regulator comprising a glow discharge device in parallel with said translating device and a resistance in series with one of said last two devices.

8. The method of operating translating devices from a source of electric current subjected to variations and fluctuations, consisting of passing such current through a current stabilizing device and shunting by a glow discharge device a portion of said current from said translating device to smooth out said variations.

In witness whereof, I hereunto subscribe my name this 28th day of April A. D., 1925.

HUGH M. STOLLER.