April 12, 1932. B. F. MIESSNER 1,853,217

ELECTRICAL FILTER SYSTEM

Filed Jan. 8, 1929

Fig. 1.

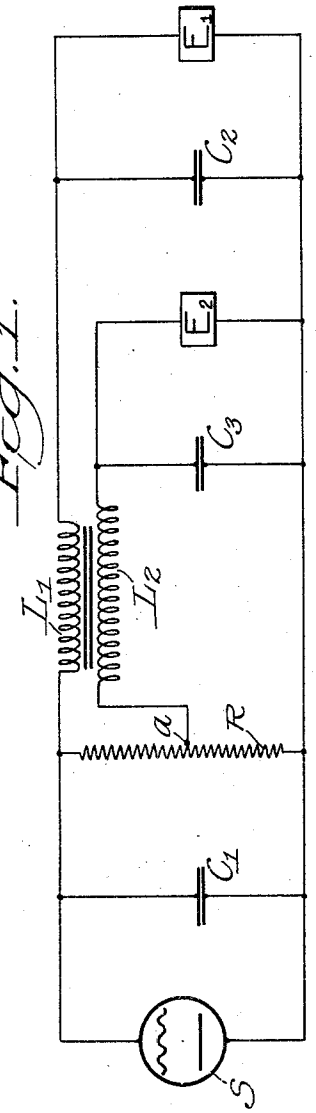
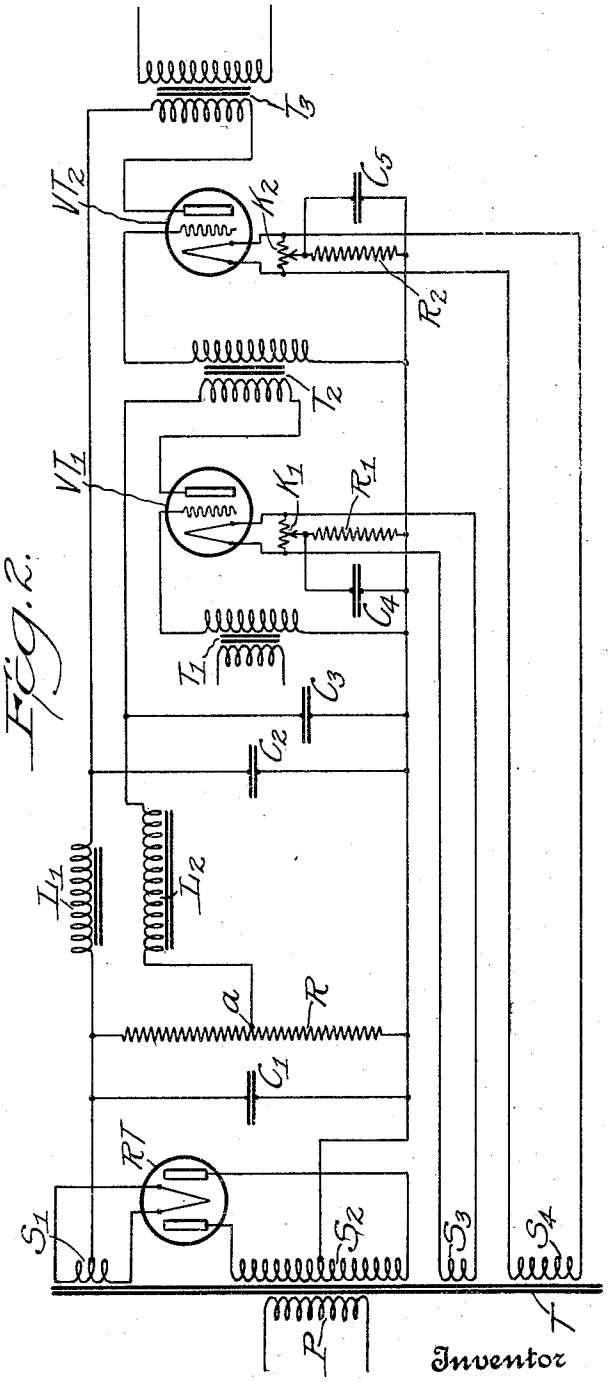


Fig. 2.



WITNESS

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UNITED STATES PATENT OFFICE

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ELECTRICAL FILTER SYSTEM

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The present invention relates to electrical filter systems, and in particular such a system for supplying two or more loads from a single source of supply of periodically fluctuating uni-directional current.

A particular object is to supply the plate circuits of two or more vacuum tubes with filtered uni-directional current from a single rectifier of alternating current at different voltages with the economical use of filter material while keeping hum production low, as is required in commercially acceptable radio broadcast receivers.

It is a feature of my present invention that I divide the rectified or other unsteady current into the number of different components desired for distribution to work circuits before filtration is undertaken. In present practice filtration is accomplished before division takes place. For example, all of the plate current for a radio receiver having a power amplifier requiring say 200 volts, other amplifiers requiring say 100 volts, and a detector requiring say 40 volts, is first filtered and then divided, as by a tapped resistor termed a "voltage divider" shunted across the output of the filter circuit, for distribution to the plate circuits of the several vacuum tubes. This practice requires a large amount of filter apparatus and results in a loss of some of the expensively filtered current by way of the shunted voltage divider. Since it is well known that the more current passing through a filter or, in other words, the greater the load thereon, the less complete is the filtration by reason of the loss of current through the voltage divider, so that the residual alternating current component after filtration is large, thus increasing hum. In addition the voltage divider placed after the filter increases coupling effects between tubes and circuits at different amplification levels in the system, making oscillation prevention more difficult.

Other features of the invention will be apparent from the description to follow in connection with the figures of the drawings, in which like reference characters represent like parts so far as possible in the two figures.

Fig. 1 diagrammatically illustrates the invention in a generalized form. Fig. 2 illustrates the invention employed as a filter system to supply the plate circuits of three electrode vacuum tubes connected in tandem in an amplifying system from rectified alternating current.

In Fig. 1 the device S is any source of periodically fluctuating uni-directional current, preferably shunted by a condenser C_1 of capacity suitable for energy storage. A shunt resistance R provides for dividing the potential of the source into one or more components of lesser potential than total, as by connection of a circuit to the point *a* in the resistance as shown. The circuit including the inductance L_1 is shown supplying a load E_1 at highest potential, and filtration is had by the inductance of L_1 aided by the capacity of shunt condenser C_2. The circuit including inductance L_2 supplies a load E_2 at lower potential, and the current is filtered by the inductance of L_2 aided by shunt condenser C_3. In this way only current employed for useful work is subjected to a high degree of filtration, the loss current through voltage divider resistance R not encountering the filter elements at all.

The system is also adapted to coupling the coils L_1 and L_2, as by winding in opposite directions on the same core, to cause the alternating current components in the two coils to oppose, to improve filtration by neutralizing the fluctuating effects. At the same time such a winding provides for the magnetic field due to the direct current component in one circuit opposing the magnetic field due to the direct current component in the other circuit, thus aiding in avoiding magnetic saturation in the magnetic core, and aiding maintaining high inductance for filtration of the fluctuating components of the currents.

In Fig. 2 a transformer T supplied from an alternating current source through a primary winding P has secondary winding S_1 for heating the filament of a full wave rectifier tube RT, whose anodes are energized by secondary winding S_2, the rectified current being supplied to the filter system across

storage condenser C_1 and voltage divider resistance R as in the case of Fig. 1. The system supplies the plate circuits of three-electrode vacuum tubes VT_1 and VT_2 connected in cascade through audio transformer T_2 as loads corresponding to E_2 and E_1 respectively in Fig. 1. Transformer T_1 indicates an audio frequency input to the cascade amplifier, and transformer T_3 indicates an output, as to a loud speaker or other translating device. It is of course understood that the amplifying system may be extended, as by including a detector and one or more stages of radio frequency amplification for a usual type of radio receiver.

Secondary windings S_3 and S_4 are shown to supply the filaments of tubes VT_1 and VT_2 respectively with raw alternating current for heating in accordance with general practice, but any form of filament heating may be used, this not being a feature of the present invention. Resistances R_1 and R_2, connected to cross-connected filament resistances K_1 and K_2 respectively, provide for developing grid bias potentials for tubes VT_1 and VT_2 respectively, and are further shown to have signal-shunting condensers C_4 and C_5, all in accordance with general practice, and not directly forming features of the present invention, so that other arrangements suitable for accomplishing the same results may be substituted.

Tube VT_2 may be a power amplifier and thus supplied with high and full potential current through coil L_1, filtration of coil L_1 being aided by shunt condenser C_2. Tube VT_2 is shown supplied with current at lesser potential through connection of coil L_2 to point *a* on resistance R, filtration being accomplished by coil L_2 with the aid of shunt condenser C_3. Thus the loss current through voltage divider resistance R does not enter the filter system and, at the same time, the filter condensers C_2 and C_3 provide low impedance paths for the signal currents of tubes VT_2 and VT_1 respectively. The impedance of coils L_1 and L_2 cooperate with these condensers to prevent signal currents from reaching resistance R, and therefore located as it is in the present invention this resistance has negligible effect in producing feed-back coupling.

As in the case of Fig. 1 the coils L_1 and L_2 may be coupled to introduce neutralizing effects as between both the alternating and direct current component effects. Since the current in L_1 may be large compared to the current in L_2, L_2 may have more turns in order to more nearly equalize the ampere-turn relation of the two coils. At the same time the values of condensers C_2 and C_3 can be selected to aid in improving the relation of the alternating current ampere turns in the two coils.

It will be further noted that fluctuations in the plate circuit of tube VT_1 will be transferred to tube VT_2 by way of transformer T_2, and amplified before encountering the fluctuations in the plate circuit of VT_2. If transformer T_2 is so poled as to transfer the fluctuations to VT_2 in phase to oppose the fluctuations in the plate circuit of VT_2, further neutralization can be had, but in view of the amplification it is desirable to have the fluctuations in VT_1 less than in VT_2 by a factor substantially equal to the amplification factor of VT_2. For this reason it is desirable to filter the current supplied to the plate of VT_1 to higher degree than that supplied to VT_2, or if poor filtration is had for tube VT_1 to make the filtration for VT_2 correspondingly worse in proportion to the amplification.

The relative degrees of filtration desirable for the two tubes fits in with the ampere-turn relation between the coils L_1 and L_2. A coil L_2 of large number of turns will increase filtration for VT_1 and, at the same time, improve the ampere turn relation for neutralizing as between the two circuits through coupling between the coils.

Having fully described my invention, I claim:

1. In a current supply and filter system the combination of a source of uni-directional periodically fluctuating current, a plurality of work circuits, a resistance in shunt to said source to which said work circuits are connected at points different in potential, means associated with said work circuits including an inductance coil in each circuit for filtering the currents therein independently of the current lost in said resistance, said coils being so inductively related that the fields generated therein by the alternating current components are opposed.

2. In a current supply and filter system the combination of a source of uni-directional periodically fluctuating current, a plurality of work circuits, means for impressing from said source currents at different potentials upon said work circuits, and inductance coils in two of said circuits so inductively related that the fields generated therein by the alternating current components are opposed.

3. In an amplifying system including three electrode vacuum tubes connected in cascade, a current supply and filter system for energizing the plate circuits of said tubes comprising a source of uni-directional periodically fluctuating current, a resistance in shunt to said source to which the plate circuits of said tubes are connected at points different in potential, and means associated with said plate circuits for filtering the currents delivered thereto, said means including inductance coils in two of said circuits so inductively related that the fields generated therein are opposed.

4. In an electrical system, the combination of a source of rectified alternating current, a plurality of work circuits, a storage condenser across said source, a voltage divider resistance connected across said condenser, a plurality of work circuits, a plurality of filter systems, each system including an inductance connected between said resistance and one of said work circuits, and a plurality of condensers connected between the connection of said inductances to said work circuits and the other terminal of said resistance, said inductances being coupled together and so poled that the magnetic flux of each of said inductances due to the direct current flowing therethrough to any work circuit and the alternating current component of the current flowing through one of said inductances is materially reduced.

5. In an amplifying system, a plurality of space discharge devices, a current supply and filter system for energizing the anode circuits of said devices comprising a source of unidirectional fluctuating current, a resistance element shunted across said source to which the anode circuits of said devices are connected at points different in potential and means associated with said anode circuits for filtering the currents delivered thereto, said means including inductance coils in two of said circuits wound around the same core and so inductively related that the fields generated therein are opposed whereby fluctuating current effects in each of said circuits are substantially neutralized and magnetic saturation of said core is substantially prevented.

In witness whereof, I have hereunto subscribed my name this 5th day of January, 1929.

BENJAMIN F. MIESSNER.