Sept. 9, 1924. 1,508,354

E. O. SCRIVEN

ELECTRIC WAVE FILTER

Original Filed July 14, 1917

Fig. 1.

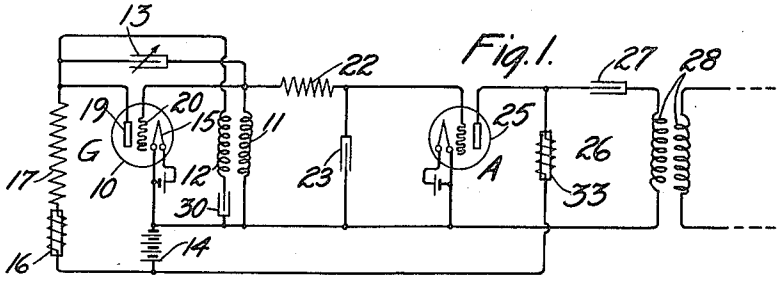


Fig. 2.

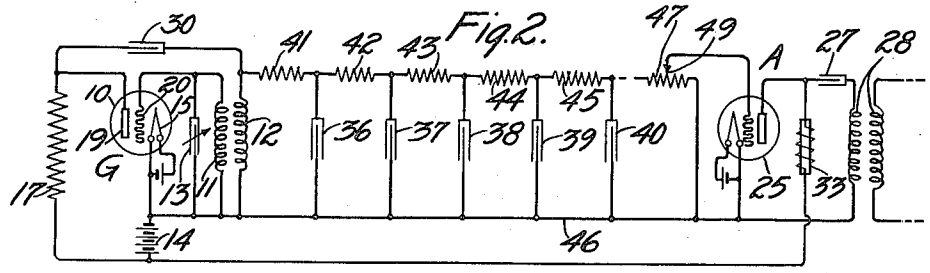


Fig. 3.

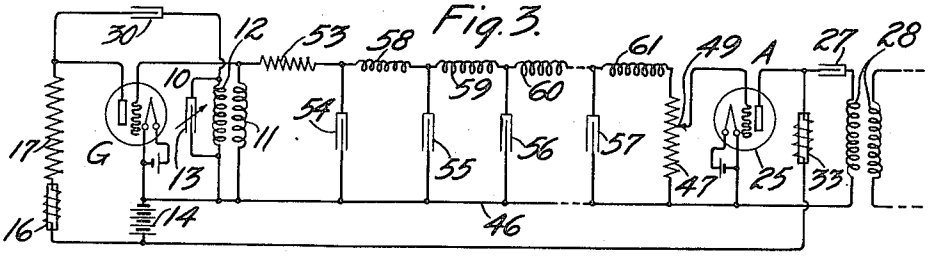


Fig. 4.

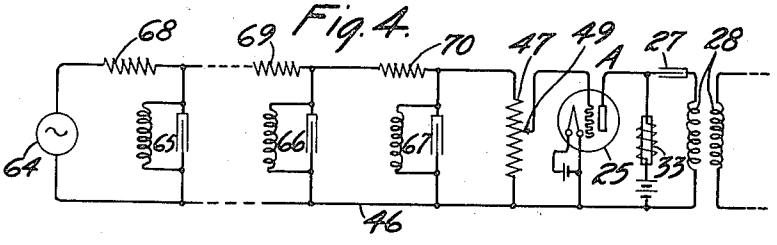
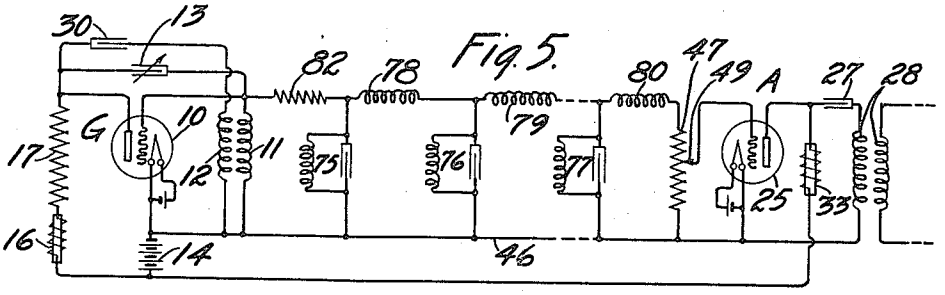


Fig. 5.



Inventor:
Edward O. Scriven.
by W. E. Beatty Atty.

Patented Sept. 9, 1924. 1,508,354

UNITED STATES PATENT OFFICE.

EDWARD O. SCRIVEN, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRIC WAVE FILTER.

Original application filed July 14, 1917, Serial No. 180,589. Divided and this application filed May 16, 1921. Serial No. 469,978.

To all whom it may concern:

Be it known that I, EDWARD O. SCRIVEN, a citizen of the United States, residing at New York, in the county of New York, State of New York, have invented certain new and useful Improvements in Electric Wave Filters, of which the following is a full, clear, concise, and exact description.

This invention relates to improvements in wave filters and has for one of its objects to prevent undesired circulation of electrical energy in a wave filter.

A further object of the invention is to prevent electrical oscillations in one part of a wave filter from reacting on the source of electric waves.

A filter having means for accomplishing the above objects is particularly useful when connected to the output circuit of a vacuum tube oscillator for preventing the transmission of harmonics which are likely to be produced by the oscillator.

A filter embodying this invention comprises in its simplest form a condenser in shunt to the output circuit of an oscillator and having relatively high impedance to the fundamental frequency to be transmitted, but having lower impedance to the harmonics, and a series resistance between the oscillator and the condenser to prevent the filter from affecting the tuning of the oscillator or producing other objectionable distortion. This arrangement, which may be regarded as a filter having a single section, may be used alone or may be used in conjunction with a plurality of similar sections or in conjunction with a wave filter of the type described by Campbell in his United States Patent No. 1,227,113, May 22, 1917. The shunt reactance may also assume other forms, as for example, an inductance and a condenser in parallel. The loop circuit so formed should preferably be tuned to the fundamental oscillations to be transmitted, thereby offering a path of very high impedance to said fundamental oscillations, but a path of low impedance to the harmonics.

The oscillator or other source of electric waves can further be protected from reactions or disturbances in the work circuit by interposing a unidirectional translating device, such as a vacuum tube amplifier between the filter above described and the work circuit.

While a filter comprising this invention is not limited in utility to a position in the output circuit of an oscillation generator, it is shown herein in connection with an oscillation generator in accordance with the showing in my application, Serial No. 180,589, filed July 14, 1917, (now Patent 1,501,729, July 15, 1924) of which this is a division. The oscillator shown is of the type shown in patent to Hartley No. 1,356,763, issued Oct. 26, 1920.

For the better understanding of this invention, reference is made to the following description taken in connection with the accompanying drawings, in which Fig. 1 illustrates one embodiment of this invention in which a filter of one section is employed in connection with an oscillation generator. Figure 2 illustrates an oscillation generator having a plurality of these sections. Figure 3 illustrates this invention in connection with a wave filter of the form described by Campbell in his above-mentioned patent. Figure 4 is a modified form of Fig. 2, and Figure 5 illustrates this invention in connection with a Campbell wave filter adapted to transmit to the outgoing line a certain frequency within a given band of frequencies. Each evacuated vessel in the drawings has a reference character beside it to indicate its function: thus, "A" indicates that the vacuum tube is an amplifier, and "G" indicates that the tube is an oscillation generator.

In Fig. 1, the vacuum tube 10, taken in connection with the induction coils 11 and 12 and capacity 13, constitutes an oscillation generator of the type described by Hartley in his above-mentioned patent. 14 is a source of voltage for said generator, its negative pole being connected to the filament 15, and its positive pole being connected through the choke coil 16 and resistance 17 to the anode 19. Shunted around the coil 11 which is connected between the filament 15 and the grid 20 is one section of the type of filtering device of this invention consisting of the resistance 22 and the capacity 23. The drop of potential across the terminals of the capacity is impressed upon the input terminals of an amplifier 25. The amplified oscilla-

tions in this output circuit 26 may be impressed upon other amplifiers for further amplification, or they may be, as shown, impressed by a transformer 28 upon a suitable outgoing line.

This method of associating the generator with the amplifier 25 prevents, to a considerable extent, the amplifier from receiving the harmonics of the fundamental oscillations. The drop of potential across the terminals of inductance 11 will tend to be emphasized by the harmonics, since the impedance of an inductance increases with increase in frequency. But since the impedance of a condenser decreases with increase in frequency, the condenser 23 may be chosen of such a value that it will offer considerable impedance to the fundamental oscillations, but a relatively small impedance to its harmonics, thereby neutralizing the effect of the inductance 11. What will be impressed upon the input terminals of the amplifier will then be composed chiefly of the oscillations of the fundamental frequency, while the oscillations of higher frequency will be largely shunted through the condenser 23. Since the impedance across the inductance 11 increases with increase in frequency, there is a tendency for the voltage output of the generator to have the same variation, but this variation is prevented by the above-mentioned neutralizing effect of the capacity 23, so that approximately a constant voltage may be obtained from the generator for oscillations of widely different frequencies. Resistance 22 is inserted to prevent the capacity 23 from affecting the tuning of the oscillating circuits. It is preferable that the period of the oscillations should be determined solely by the value of the constants of oscillatory circuit including the adjustable capacity 13.

Condenser 30 (preferably of large capacity) is inserted to prevent the direct current from flowing through the output circuit coil 12. In order to prevent the generated oscillations from passing through that part of the output circuit containing the resistance 17 and the source of voltage 14, a choke coil 16 is inserted. The resistance 17 is of such a value that the direct current flowing therethrough is practically constant and independent of the frequency of the generated oscillations and of slight changes in the source of voltage or in the impedance between the output electrodes or other elements of the vacuum tube circuits. This enables a constant current to be derived from an oscillation generator as has been previously described and claimed by me in my Patent 1,418,739, June 6, 1922.

The source of voltage 14 may also be used as the output battery for the amplifier 25. The choke coil 33 is then preferably inserted to prevent the oscillating currents from passing through the battery circuit. A short circuit for the battery 14 through the primary of transformer 28 is prevented by the insertion of a condenser 27.

In Fig. 2 the adjustable condenser 13, instead of being connected between the anode 19 and the grid 20, is shown shunted around the grid circuit coil 11. The harmonic reducing device is shown to be composed of a plurality of sections, consisting of the capacities 36 to 40 inclusive and resistances 41 to 45 inclusive. These sections are shown to be connected to the output circuit coil 12, although they may be connected, if desired, to the input circuit coil 11, as shown in Fig. 1. The resistances 41 to 45 inclusive are shown to be connected in series with the connecting line 46, while the condensers 36 to 40 inclusive are shunted across said line. Each condenser provides an additional short circuit for the harmonics, so that the voltage across the terminals of the last condenser 40, and consequently the voltage drops across the terminals of resistance 47, is due almost entirely to the oscillations of the fundamental frequency. The voltage impressed on the amplifier 25 is supplied from the voltage drop across the resistance 47. The amount supplied may be regulated by the adjustable contact 49. The values of the resistances 41 to 45 should be such that they prevent the capacities 36 to 40 from reacting upon the oscillation tube. The capacities should be of such values that they supply a path of low impedance for the oscillations desired to be suppressed, and a path of high impedance to the frequencies desired to be transmitted.

In Fig. 3 is shown a filter of the type described by Campbell in his above-mentioned patent which consists of the capacities 54 to 57 inclusive, connected in shunt to the connecting line 46 and inductances 58 to 61 inclusive in series with said line. Between this filter and the oscillation generator is shown a resistance 53 which prevents the filter from reacting upon the generator 10. With such a filter practically pure oscillations are supplied to the outgoing line by the voltage drop across the resistance 47. The filter may be associated with the output terminals of the generator in any suitable manner. Herein it is shown connected to the input circuit coil 11.

In Fig. 4 is illustrated a generator of oscillations having a filtering device, comprising the resistances 68 to 70 in series with the connecting line 46, and tuned-loop circuits 65 to 67 in shunt to said line. These resistances prevent the tuned-loop circuits from reacting upon the source of oscillations 64, which source may be an alternating current generator, or any other suitable source of oscillations from which it is desired to trans-

mit oscillations of a certain frequency while suppressing other frequencies. The tuned-loop circuits should preferably be tuned to the frequency of the oscillations desired to be transmitted to the outgoing line. Such being the case, they will afford a path of approximately infinite impedance to said oscillations, while providing a path of low impedance for oscillations of different frequencies. It follows, therefore, with such a filter, that only oscillations of the desired frequency may be impressed upon the outgoing line.

In Fig. 5 a wave filter of the Campbell type comprising the tuned circuits 75 to 77 inclusive and inductances 78 to 80 is connected to the oscillation generator by the input circuit coil 11. Such a filter is adapted to transmit only a desired band of frequencies so that, providing the fundamental of the oscillations generated is within the transmitted band, the resistance 47 will impress only the fundamental oscillations upon the amplifier 25. The resistance 82 prevents the filter from reacting upon the oscillator.

Various modifications may be made in the circuit arrangements illustrated in the various figures of the drawing without departing from the spirit of this invention. The tuning condenser 13 may be connected between the grid and anode as shown in Figs. 1 and 5, or it may be shunted across the input circuit coil as in Fig. 2, or shunted around the output circuit coil as in Fig. 3. The potentiometer shunt 47 may be inserted if it is desired to regulate the amount of energy supplied to the outgoing line, but its presence is not necessary. In Fig. 1 it has been omitted.

What is claimed is:

1. A filter section comprising input and output terminals, an impedance path connecting one input terminal and one output terminal, an electric path connecting the other input terminal and output terminal, and an impedance path connecting said first two paths, one of said impedance paths consisting of substantially pure resistance, and the other of said impedance paths comprising an inductance and a capacity in parallel.

2. A filter section comprising input and output terminals, an impedance path connecting one input terminal and one output terminal, an electric path connecting the other input terminal and output terminal, and an impedance path connecting said first two paths, said first impedance path consisting of substantially pure resistance, and said second impedance path comprising an inductance and a capacity in parallel.

3. An electric wave filter consisting of a connecting line composed of a plurality of sections, each section having a resistance element in series with the line, and capacity and inductance elements in parallel in shunt across the line, said elements having predetermined values dependent upon the frequency or frequencies to be selectively transmitted, one of said sections being substantially free from series reactance.

4. An electric wave filter consisting of a connecting line composed of a plurality of sections, each section having a resistance element in series with the line, and capacity and inductance elements in parallel in shunt across the line, said elements having predetermined values dependent upon the frequency or frequencies to be selectively transmitted, said filter being substantially free from series inductance.

In witness whereof, I hereunto subscribe my name this 13th day of May, A. D. 1921.

EDWARD O. SCRIVEN.