

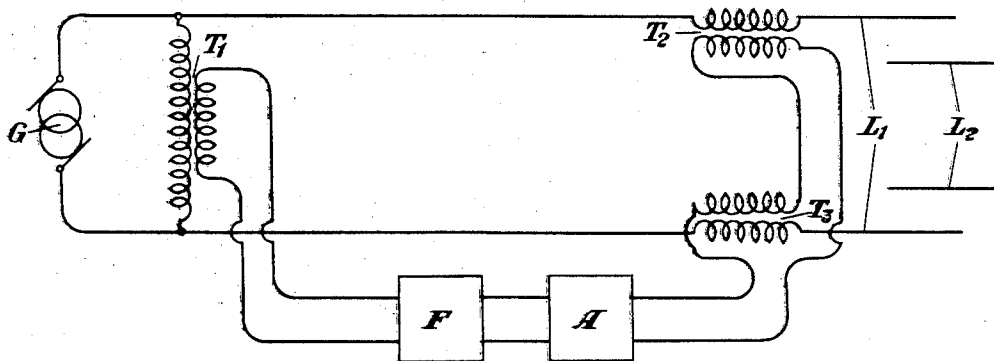
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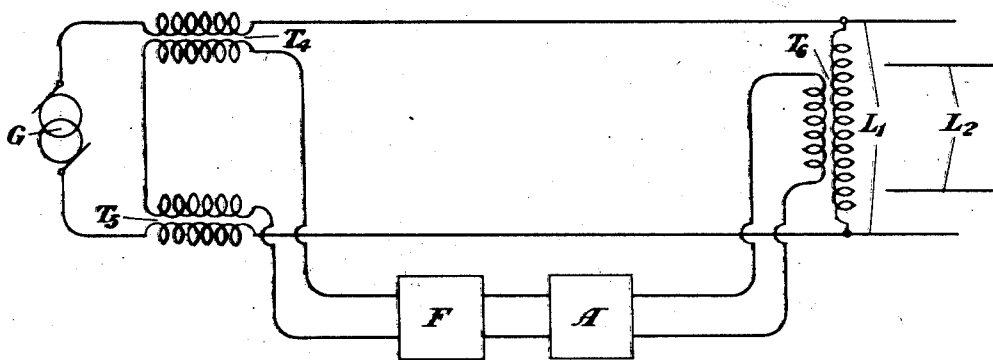
1,773,772

HARMONIC SUPPRESSOR

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*Fig. 1*



*Fig. 2*

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BY

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# UNITED STATES PATENT OFFICE

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## HARMONIC SUPPRESSOR

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This invention relates to transmission systems, and particularly to arrangements in such systems for substantially suppressing the effects of inductive interference from power circuits upon exposed telephone circuits, or the like.

In systems for the transmission of a fundamental frequency of an electrical source over a power circuit, it is often found that harmonics of the fundamental frequency are transmitted to the power circuit, along with the fundamental frequency. These harmonics of the fundamental frequency are introduced into the power circuit and may be caused by the electrical generator or oscillator, which is the source, or by the transformers, etc. These harmonics of the fundamental frequency are essentially undesirable because of their tendency to produce inductive interference in nearby telephone circuits or the like, especially if these telephone circuits are exposed to the power circuits by virtue of their proximity. It seems hardly necessary to state that harmonics introduced into telephone circuits will have detrimental effects, producing, for example, distortion in the signals to be transmitted over the telephone circuits, noise, etc.

Accordingly, it is an object of this invention to provide an arrangement for substantially suppressing the harmonics of a fundamental frequency of a power source so that an exposed telephone circuit will be free from the effects of inductive interference.

It is another object of this invention to associate a local circuit with a transmission line so that when part of the energy of the transmission line is applied to the local circuit, harmonics may be introduced into the transmission line, equal in magnitudes and opposite in phases to those already present therein, whereupon the harmonics will be substantially suppressed.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing, in which Figures 1 and 2

disclose two forms of embodiment of the invention.

Referring to Fig. 1 of the drawing, a source of alternating current, such as an electrical generator or oscillator, is designated by the reference character G. The alternating current generator G supplies current of fundamental frequency to a transmission line or a power line  $L_1$ . For any one of a number of causes, harmonics of the fundamental frequency are also introduced into the line  $L_1$ , which are ordinarily undesirable because of their tendency to produce inductive interference into an exposed telephone line, or the like, such as  $L_2$ , the effect of which is detrimental to the faithful transmission of signals over that telephone line. The primary winding of the transformer  $T_1$  is bridged across the power line. The secondary windings of two transformers  $T_2$  and  $T_3$  are in series with the power line. The secondary winding of the transformer  $T_1$  and the primary windings of the transformers  $T_2$  and  $T_3$  are connected in a local and isolated circuit, together with other apparatus, which will be described hereinafter, so that when energy of the power line is impressed upon this local circuit, harmonics of the fundamental frequency will be introduced into the power line, equal in magnitudes and opposite in phases to those harmonics already present therein. This will be better understood from the description hereinafter following.

The secondary winding of the transformer  $T_1$  is connected to a filter F, which may be of any well known type, preferably of the type described in the patent to G. A. Campbell, No. 1,227,113, dated May 22, 1917. This filter substantially suppresses current of the fundamental frequency, while it freely transmits currents of the harmonics of the fundamental frequency. An amplifier A is connected to the filter to amplify the harmonics of the fundamental frequency to a definite and predetermined level, thus overcoming losses in the local circuit. This amplifier may be of any well known type, preferably of the vacuum tube type. The amplifier A is connected to the primary windings of the trans-

formers  $T_2$  and  $T_3$ , which are in series relationship.

As has already been stated, harmonics of a fundamental frequency present in a power line will, due to inductive effects, interfere with the faithful transmission of signals over a telephone circuit. The object of this invention is to substantially suppress these harmonics in the power circuit so that their effects upon exposed telephone circuits will be substantially nullified. In the embodiment of the invention shown in Fig. 1, a portion of the current or voltage produced by the alternating current generator  $G$  is transmitted through transformer  $T_1$  to the filter  $F$ . This filter  $F$  will therefore receive current of the fundamental frequency of the generator  $G$  as well as currents of the harmonics of the fundamental frequency of the generator. The filter  $F$  substantially suppresses the current of the fundamental frequency while it freely transmits to the amplifier  $A$  currents of the harmonics of the fundamental frequency. The amplifier  $A$  functions to amplify the currents of the harmonics transmitted by the filter  $F$ , so that the transformers  $T_2$  and  $T_3$  may impress upon the power line the currents of these harmonics in magnitudes equal to the magnitudes of the currents of those harmonics already present in the power line. Moreover, the series circuit consisting in part of the primary windings of transformers  $T_2$  and  $T_3$  is so arranged that the harmonics of the fundamental frequency are introduced into the power line, opposite in their phases to those already present therein. Since the currents of the harmonics introduced by the local circuit into the power line are equal in magnitudes and opposite in phases to those which are already present therein, these harmonics will become neutralized so that their effects upon a power line, and consequently upon an exposed telephone line, or the like, will be substantially nullified.

Fig. 2 shows a modification of the embodiment of the invention shown in Fig. 1. In Fig. 2, the transformer  $T_1$  of Fig. 1 has been replaced by the series transformers  $T_4$  and  $T_5$ , and the series transformers  $T_2$  and  $T_3$  of Fig. 1 have been replaced by the transformer  $T_6$ .

It will be understood that if the electrical filter of this invention is of a type which produces, of itself, a phase variation of the harmonics as they are passed therethrough, a phase shifting network of any well known type may be added to the local circuit in order to bring the harmonics back to their initial phase relationship.

While this invention has been described particularly in connection with the suppression of harmonics in power circuits, it is to be understood that the invention is equally applicable to the suppression, not only of har-

monic, but also of any undesirable frequencies in radio circuits, carrier current circuits, and the like, as well as in power circuits.

While this invention has been shown and described in certain particular embodiments, merely for the purpose of illustration, it will be obvious that the general principles of the invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The method of eliminating from a power line the harmonics of a fundamental frequency produced by an electrical generator or oscillator, which consists in applying part of the output of the electrical generator or oscillator to a filter in order to suppress the fundamental frequency and to freely transmit the harmonics of the fundamental frequency, amplifying the harmonics of the fundamental frequency to a definite level, and applying the harmonics of the fundamental frequency to the line so that the magnitudes of the harmonics are equal, and the phases of the harmonics are opposite, to those present in the line.

2. The method of substantially eliminating the inductive interference in a telephone line introduced therein by the harmonics of a fundamental frequency generated by an electrical oscillator connected to a power line, which consists in applying part of the energy of the electrical oscillator to an auxiliary circuit, suppressing the fundamental frequency and freely transmitting through the auxiliary circuit the harmonics of the fundamental frequency, amplifying the transmitted harmonics of the fundamental frequency so that when these harmonics are impressed by the auxiliary circuit upon the power line to which the electrical oscillator is connected, the harmonics will be substantially suppressed due to the presence of these harmonics in phase opposition.

3. A system for eliminating the harmonics of a fundamental frequency generated by an electrical oscillator, comprising a line to which said electrical oscillator is connected, a first transformer and a second transformer associated with said line, a filter, and an amplifier coupled to said filter, the secondary of the first transformer and the primary of the second transformer being connected, respectively, to said filter and said amplifier in a local circuit, said filter suppressing the fundamental frequency of the oscillator and the amplifier amplifying the harmonics of the fundamental frequency transmitted by said filter, whereupon the effect of the harmonics in said line is substantially nullified by virtue of the presence of the harmonics of the fundamental frequency in phase opposition.

4. In combination, a source of fundamental frequency producing harmonics as well as

the fundamental, a line to which said source of fundamental frequency is connected, an auxiliary circuit the input and output of which are inductively coupled to the line, comprising means for suppressing the fundamental frequency of said source and for freely transmitting the harmonics of the fundamental frequency impressed thereon, and an amplifier for amplifying the harmonics of the fundamental frequency so that the harmonics of the fundamental frequency are introduced into the line in two states, which are of equal amplitudes and of opposite phases.

5. The combination of a generator producing current of fundamental frequency and its harmonics, a power line to which said generator of fundamental frequency is connected, a telephone line which is exposed to the power line, and an auxiliary circuit coupled to the power line for impressing upon the power line the harmonics of the fundamental frequency introduced into the power line by said generator so that these harmonics may be neutralized, said auxiliary circuit comprising means for passing part of the energy of the electrical generator, a filter for substantially suppressing the fundamental frequency of the electrical generator while freely transmitting the harmonics of the fundamental frequency, an amplifier for amplifying the harmonics of the fundamental frequency to the energy levels at which they are present in the power line, and means for retransmitting the harmonics of the fundamental frequency to the power line, so that these harmonics become impressed upon the power line in phase opposition, whereby their effects upon the power line and upon the exposed telephone line are substantially nullified.

6. A system for eliminating the harmonics of a fundamental frequency introduced by an electrical generator which is connected to a power line, comprising a filter to which part of the energy of the electrical generator is transmitted so that the fundamental frequency may be substantially suppressed and the harmonics of the fundamental frequency freely transmitted, an amplifier for amplifying the transmitted energy of the harmonics, and means for impressing the harmonics of the fundamental frequency amplified by the amplifier upon the power line in phases opposite to those of the harmonics already present therein, whereupon these harmonics become substantially non-effective.

7. In combination, a power line, a telephone line, an electrical generator connected to the power line, and means coupled to the power line for eliminating from the power line the harmonics of the fundamental frequency transmitted by said electrical generator so that energy of the harmonics is not impressed upon said telephone line, comprising an electrical wave filter to which part of the energy of the electrical generator is

transmitted for substantially suppressing the fundamental frequency of the generator and for freely transmitting the harmonics of the fundamental frequency, an amplifier coupled to said wave filter for amplifying the transmitted energy of the harmonics of the fundamental frequency, and means for introducing into the power line the harmonics of the fundamental frequency after amplification so that the harmonics so introduced into the power line are equal in magnitudes and opposite in phases to the harmonics transmitted to the power line by the electrical generator.

8. The combination of an electrical generator, a power line connected to said electrical generator, and a telephone line which is exposed to the power line, an isolated circuit to which a portion of the energy of the electrical generator is transmitted and from which the harmonics of the fundamental frequency are derived equal in magnitudes and opposite in phases to those harmonics transmitted to the power line by the electrical generator, said isolated circuit including an electrical wave filter for substantially suppressing the fundamental frequency of the electrical oscillator and for freely transmitting the harmonics of the fundamental frequency of the electrical generator, and an amplifier for elevating the magnitudes of the harmonics transmitted by the electrical wave filter to predetermined levels, and means coupling the amplifier in the isolated circuit with the power line.

In testimony whereof, I have signed my name to this specification this 28th day of December 1926.

OSCAR H. BERTHOLD.