March 11, 1941. L. R. WRATHALL 2,234,213

TONE SIGNAL SOURCE FOR TELEPHONE SIGNALING SYSTEMS

Filed March 30, 1940

FIG. 1

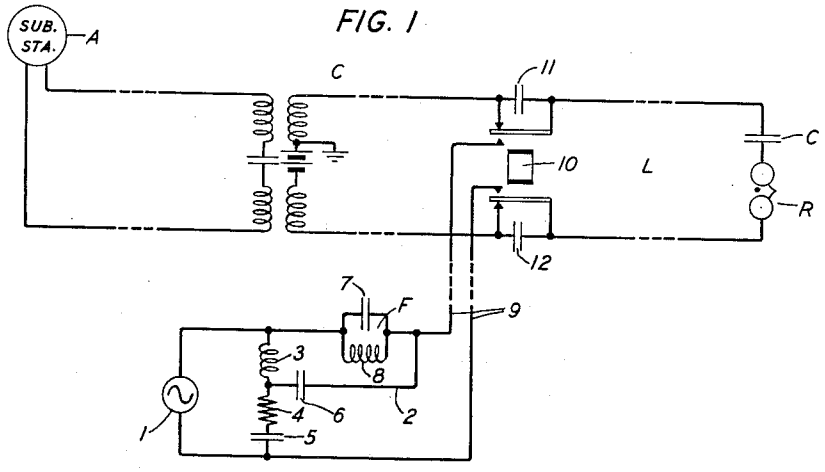


FIG. 2

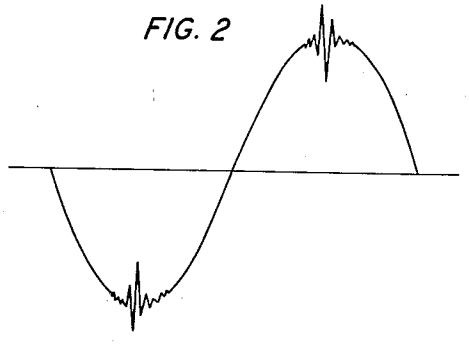
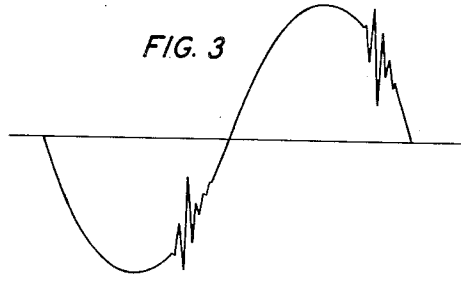


FIG. 3



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TONE SIGNAL SOURCE FOR TELEPHONE SIGNALING SYSTEMS

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3 Claims. (Cl. 179—84)

This invention relates to telephone signaling systems and more particularly to methods and means for transmitting an audible tone signal to a calling subscriber to indicate that a called subscriber's station is being rung.

In large telephone offices alternating current of the order of 425 cycles, and varying in amplitude at a 40-cycle rate, is generated by a tone alternator and superimposed on the 20-cycle ringing current commonly used for ringing. In smaller offices, where tone alternators are not available, the calling subscriber hears the audible frequencies naturally present in the output of the commonly used ringing current generators, which frequencies are caused by what are known as commutator or slot ripples. These effects, however, are not always present in sufficient quantities to furnish a good audible ringing tone.

An object of the present invention is to provide a simple arrangement which will generate from, and introduce in, a substantially pure low frequency ringing current, a tone of the desired audible frequency and amplitude.

Another object is to insure that the maximum voltage of the combined low and audible frequency in the load circuit is not substantially higher than the maximum voltage of the low (20-cycle) frequency alone.

A feature of the invention, whereby the first object is attained, resides in an arrangement comprising a magnetic unpolarized coil of the type disclosed and claimed in United States Patent 2,117,752 to the present applicant, whereby, from a substantially pure fundamental frequency supplied thereto, a plurality of harmonics of said fundamental frequency are obtained, and in a further circuit arrangement for suppressing all but a desired group of said harmonic frequencies and combining them with said fundamental frequency in an output circuit to produce a wave of the fundamental frequency having superimposed thereon a wave of said desired harmonic frequencies.

A further feature, whereby the second object is attained, resides in the provision of means for controlling the phase of the desired harmonic frequencies, with respect to the fundamental, whereby the amplitude of the peaks of the combined wave in the output circuit are not substantially higher than the amplitude of the peaks of the fundamental wave alone.

The invention will be understood from the following description in connection with the accompanying drawing in which:

Fig. 1 is a circuit arrangement illustrating a preferred embodiment of the invention as applied to a link circuit interconnecting a calling and a called subscriber's station;

Fig. 2 shows an undesirable characteristic of the output voltage of certain arrangements of the prior art which are overcome by a feature of the present invention; and

Fig. 3 shows the voltage characteristic of the modulated wave produced by the arrangement of Fig. 1.

In Fig. 1 a calling subscriber A is connected by means of a link circuit C to a called subscriber's station represented by ringer R which is connected across the subscriber's line L in series with a condenser C in the well-known manner. 1 is a source of low frequency alternating current (of the order of 20 cycles) suitable for ringing, which source is connected in series with filter F, having a low impedance to current of said fundamental frequency, over leads 9 to the normally open front contact of the ringing relay 10, the operating circuit for which is not shown as such arrangements are well known in the art. Operation of relay 10 disconnects the calling from the called line and connects the source 1 to the called line L to actuate the ringer R of the called station.

Connected across the output of the source 1 is a circuit comprising a non-linear inductance 3, an impedance 4, and a condenser 5. The inductance 3 has a ferromagnetic core of suitable structure fully described in my United States Patent 2,117,752, issued May 17, 1938. The average reactance of core 3 is smaller than the value of impedances 4 and 5, thus keeping the fundamental frequency of the current through the coil relatively sinusoidal.

Connected across the core 3 by means of conductor 2 is a circuit including filter F and condenser 6, which condenser is alternately charged and discharged by inductance 3, thus producing harmonics of the fundamental frequency generated by the source 1, as fully explained in the before-mentioned patent. The filter F may be of any convenient form, as, for example, a condenser 7 and an inductance 8, in parallel, which filter is proportioned so that its impedance to a certain harmonic (420 cycles) is high, and the impedance to harmonics adjacent thereto progressively decreases as the harmonic order increases and decreases relative to the certain harmonic (420 cycles), i. e., the impedance to the 19th and 23rd harmonics will be less than the impedance offered to the 21st (i. e., 420 cycles)

and the impedance offered to the 17th and 25th harmonics will be less than the impedance offered to the 19th and 23rd, etc. Therefore, the harmonic frequencies generated by the coil 3 and condenser 6 which lie outside the above narrow band of frequencies (i. e., the 17th, 19th, 21st, 23rd and 25th harmonics) will be suppressed in the circuit, coil 3, condenser 6 and filter F, and only the fundamental frequency (20 cycles) and the desired group of harmonics will appear in the output circuit represented by the conductors 9, the net effect of which in the output circuit is a wave of the fundamental frequency on which is superimposed said harmonic components modulated twice for each cycle of the fundamental. This results in a characteristic tone which has come to be well known to a calling subscriber as an indication that the called subscriber is being rung.

The usual manner in which this modulated frequency tone is transmitted to a calling subscriber is well konwn, it being sufficient to mention that condensers 11 and 12 are of such low capacity as to be of high impedance to the fundamental or ringing frequency but of relatively low impedance to the high frequency component. These condensers are connected in shunt to the back contacts of relay 10 whereby the modulated high frequency component of the ringing current is transmitted back to the calling subscriber during the period the relay 10 is operated and ringing current is connected to the called subscriber's line.

Further, in arrangements of the prior art, when harmonics are combined with a fundamental to provide a characteristic tone, such harmonics are combined with the fundamental in such a manner as to substantially increase the peak voltage of the fundamental, as shown in Fig. 2, which may, under certain conditions, be undesirable and, therefore, the second feature of the present invention consists in so choosing the value of condenser 5 that the phase of the harmoics generated by the coil 3 are shifted with reference to the phase of the fundamental by such an amount that the largest deviation from the fundamental wave occurs near the zero axis, as shown in Fig. 3, and the peak voltage of the modulated wave is not higher at any instant than the voltage of the fundamental wave alone.

What is claimed is:

1. In a telephone signaling system, a source of fundamental low frequency ringing current, means for generating therefrom a plurality of harmonic frequencies thereof, suppressing all but a desired group of said harmonics and combining said unsuppressed harmonic frequencies with said fundamental frequency, said means comprising a wave distorting device including a ferro-magnetic non-linear induction coil, input and output circuits for said device, said input circuit being supplied from said fundamental source, impedance means in the output circuit of said device which offers a substantially zero impedance to said fundamental frequency, a substantially infinite impedance to a particular one of said harmonics, and progressively lower impedance to the adjacent harmonics as this harmonic order increases and decreases relative to said particular harmonic, and a load circuit serially including said impedance means and said fundamental source.

2. In a telephone signaling system, a source of fundamental low frequency ringing current, means for generating therefrom a plurality of harmonic frequencies thereof, suppressing all but a desired group of said harmonics and combining said unsuppressed harmonic frequencies with said fundamental frequency, said means comprising a wave distorting device including a ferro-magnetic non-linear induction coil, input and output circuits for said device, said input circuit being supplied to said fundamental source, impedance means in the output circuit of said device which offers a substantially zero impedance to said fundamental frequency, a substantially infinite impedance to a particular one of said harmonics, and progressively lower impedance to the adjacent harmonics as their harmonic order increases and decreases relative to said particular harmonic, a load circuit serially including said impedance means and said fundamental source, and other means associated with said distorting device for shifting the phase relationship of said produced harmonic frequencies with respect to said fundamental wave by such an amount that the peak voltage of the combined wave in the load circuit is not higher than the peak voltage of the fundamental wave alone.

3. In the tone generator, a source of alternating current of a fundamental frequency, an output circuit therefor, means including a saturable magnetic core inductance coil supplied by said source for producing harmonics of said fundamental frequency, and other means including a circuit having a high impedance to a desired group of said harmonic frequencies and a decreasing impedance to all other frequencies, and substantially no impedance to said fundamental frequency, for combining said desired harmonic frequencies, to the exclusion of the other harmonics with said fundamental frequency in the output circuit.

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