

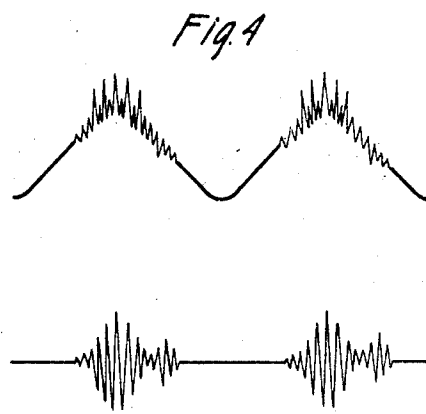
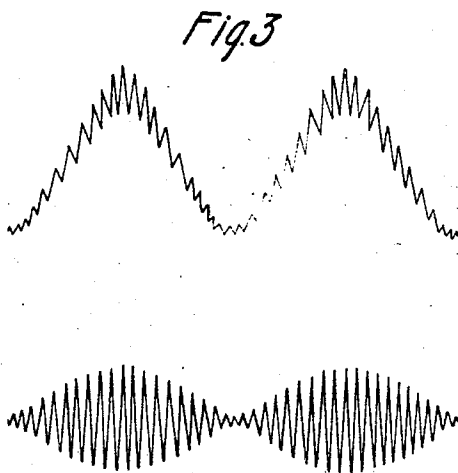
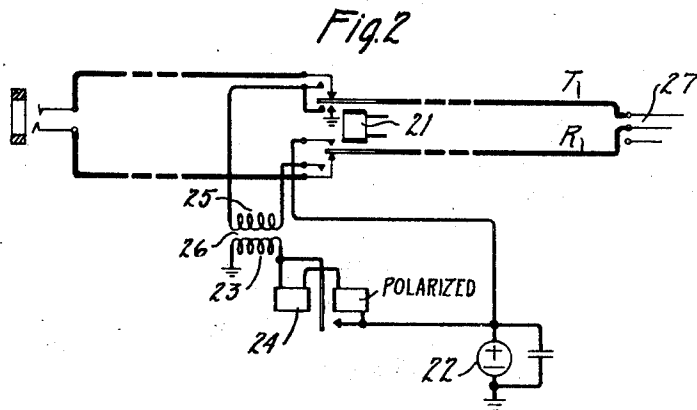
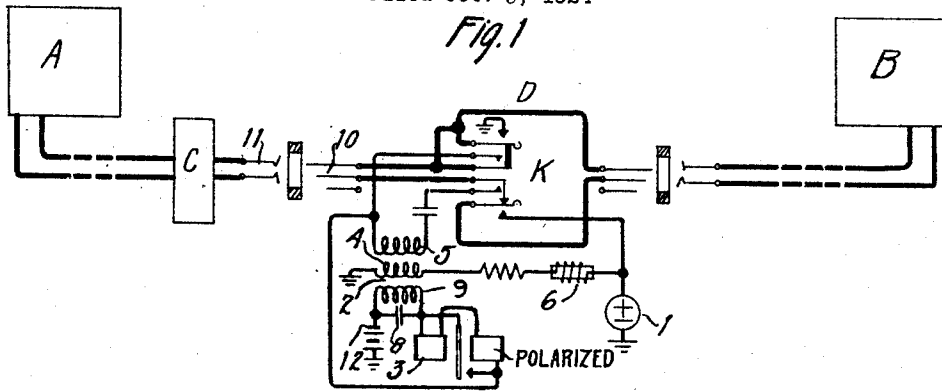
Nov. 30, 1926.

1,608,520

H. W. O'NEILL

SIGNALING SYSTEM

Filed Oct. 3, 1924



Inventor:
Henry W. O'Neill
by E. W. Adams Atty.

UNITED STATES PATENT OFFICE.

HENRY W. O'NEILL, OF ELMHURST, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SIGNALING SYSTEM.

Application filed October 3, 1924. Serial No. 741,319.

This invention relates to signaling systems and more particularly to a method of and apparatus for producing and applying signaling currents to inform a calling subscriber or operator that ringing operations are under way on a telephone connection.

As well understood in the art, current for operating a signal or bell at a called telephone station is usually of low frequency such as 16 or 20 cycles per second. In the handling of local connections various arrangements have, in the past, been employed for automatically deflecting a suitable amount of such low frequency current into the line of a calling party to produce a tone usually referred to as an audible ringing signal or a ring back signal, in the receiver during the periods such signaling current is applied to the called line. While various degrees of success have been had with such arrangements in local service work, they are not adapted to, nor adequate for, use in connection with toll and long distance systems. For example, on lines provided with equipment for simultaneous telephony and telegraphy low frequency signaling current, of sufficient magnitude to operate the usual signals or bells employed, cannot be used due to its adverse effect on the telegraph equipment. Further, such low frequency ring back signals are not suitable for transmission over circuits which may be relatively non-conductive or opaque to currents of such low frequencies. This may be due to coils and equipment, particularly in the form of telephone repeaters which are adapted to afford a maximum transmission efficiency for the higher frequency currents in the voice range, but which effectively obstruct passage of the low frequency ringing currents. The control of call signals over such circuits is ordinarily accomplished by the use of composite ringers, whereby the low frequency ringing current controls relay equipment to connect current of the order of 135 cycles for transmission over the line, which in turn controls other relay equipment at the distant or receiving end to connect the usual 16 or 20 cycle current to actuate the receiving device.

In local exchange systems wherein the before mentioned audible ringing signals are employed, such signals are usually manifested in the calling subscriber's receiver in the form of a well defined tone corresponding to

the successive half waves of the ringing current employed. Usually the arrangements employed for deflecting this current towards the calling end of a connection result in non-uniformity of the volume or intensity of the signals in the telephone receiver, the character and length of the called line having substantially as marked an effect in this regard as the character and length of the calling line.

The character of the audible signal employed as mentioned in connection with the handling of local service traffic appears to have now become a well understood form of signal both to telephone users and the telephone operating force. Therefore, a universal or common ring back signal for all classes of telephone service, may, therefore, be best and most readily realized by providing such a signal current of a character which will be substantially unchanged regardless of the line to which it is applied.

The principal feature of this invention therefore, resides in a system for providing a ring back signal wherein means are employed for producing alternating current of a frequency suitable and adequate for transmission over substantially any form of telephone circuit and wherein other means are employed for modulating said current by current of a second frequency and for applying such modulated current to the calling line.

Another feature of the invention resides in providing means whereby when signaling current of one frequency is connected to one section of a line, current of a different frequency varied or modulated by said first mentioned frequency is connected with another section of said line and whereby said sections of the line are rendered independent of each other as regards the current respectively present therein.

Another feature resides in a method of producing an alternating current wave of one frequency varied or modulated in accordance with a second frequency which consists in generating an alternating current of a relatively low frequency and applying it to the primary side of a transformer, in periodically varying a source of direct current at a higher rate than said alternating current frequency by means of a short-circuiting vibrator in series with said direct current source and in applying said varied

direct current to the primary side of said transformer whereby said low frequency alternating current affects the operation of said vibrator to produce in the secondary
 5 of said transformer an alternating current wave of the frequency of said vibrator varied in amplitude in accordance with the frequency of said low frequency alternating current.

10 Still another feature resides in a method of producing an alternating current modulated wave, which consists in generating an alternating current of a relatively low frequency and passing it through the primary
 15 winding of a transformer and the windings of a short-circuiting vibrator to cause said vibrator to operate, thus varying the amplitude of the alternating current flowing in the primary winding of the transformer to produce a modulated wave in the secondary
 20 winding thereof.

Other features of the invention will appear from the following description and appended claims in connection with the accompanying drawings in which Figs. 1 and
 25 2 illustrate alternate arrangements for practicing the features of the invention, and Figs. 3 and 4 are curves illustrating the modulated currents produced by the respective arrangements shown in Figs. 1 and 2.

Referring to Fig. 1 of the drawing, let it be assumed that a call, originating in a first toll area at point A for a station at point B in a second toll area, is routed by
 35 way of an originating operator's position at point C to an operator's position which commands the link circuit D which may serve for completing the connection between the two remote points. The operation of
 40 key K in the link circuit D applies ringing current over an obvious path from a source 1, for calling the station B. The key K also connects the winding 5 of transformer 2 to the calling line extending to point A,
 45 it being assumed that the answering plug 10 of the link circuit D is inserted in jack 11.

Assume that a direct current source 12 of approximately constant voltage be connected in series with winding 9. A substantially constant direct current will flow in its circuit, the magnitude of the current being determined by the resistance of the circuit and the E. M. F. of the source. If, as
 55 illustrated in Fig. 1, there be also included in the circuit a vibrator 3 which, in short-circuiting its energizing windings varies the resistance of the direct current circuit, the current through winding 9 will be caused to rise and fall. The difference between the maximum and minimum values of this direct current will depend both upon the magnitude of the resistance which is short-circuited and upon the E. M. F. of the source
 60 12. A larger E. M. F. will give a larger

change in current, other conditions remaining the same and a smaller E. M. F. a smaller change in current. If the vibrator operates to close its armature contact 425
 times per second, the unidirectional current
 70 in winding 9 will increase and decrease 425 times per second and in consequence there will be induced in winding 5, which is inductively related to winding 9, an E. M. F. of 425 cycles frequency. This alternating
 75 current has a substantially constant magnitude which depends upon the E. M. F. of source 12. Assume further that current source 1 produces alternating current of twenty cycles frequency and that the inductance 6 permits current of this frequency
 80 to pass through winding 4 to ground. In consequence of the inductive relation between windings 4 and 9 an alternating E. M. F. of twenty cycles frequency will be
 85 induced in winding 9. Accordingly, the E. M. F. of the direct current flowing from the source 12 through the winding 9 will be alternately aided and opposed by the E. M. F. of the twenty cycle current superimposed
 90 thereon. Bearing in mind that the magnitude of the 425 cycle current induced in winding 5 depends upon the unidirectional E. M. F. in the circuit of winding 9 it will be apparent that when the twenty cycle
 95 E. M. F. aids source 12 thus increasing the unidirectional current through winding 9, the 425 cycle E. M. F. induced in winding 5 will be increased and that when the 20 cycle E. M. F. opposes that of source 12,
 100 the 425 cycle E. M. F. in winding 5 will be diminished. From another view-point the effect of the twenty cycle E. M. F. is merely to increase or diminish the effect of source 12. Since the 425 cycle E. M. F. induced in
 105 winding 5 increases and decreases twenty times per second, the 425 cycle current may be said to be modulated at the lower frequency.

The upper curve of Fig. 3 represents the
 110 direct current flowing in the primary winding 9 of transformer 2 as varied by the 20 cycle current. It will be observed that when the upper half of the 20-cycle wave is at its maximum, the amplitude of the direct current pulsations are at a maximum and that they gradually diminish in amplitude until the lower half of the 20-cycle wave reaches its maximum.

The lower curve of Fig. 3 represents the
 120 modulated 425-cycle alternating current wave present in the secondary winding 5 of transformer 2 caused by the current in the primary windings as shown in the upper curve. It will be understood, therefore,
 125 that the 425 cycle current serves as a carrier wave in transmitting the low frequency 20 cycle current over the calling circuit to any operator that may be listening in on the circuit at point C and also to the calling
 130

subscriber at A. This modulated current will be heard in any receiver connected to the circuit as an easily recognized fluctuating tone.

As it is carried by the 425 cycle current, the low frequency current will not interfere with telegraph equipment (not shown) which may be assumed as present in the circuit at point C. Such carrier current, however, will readily pass through any high frequency coils and repeater equipment commonly present on toll and long distant circuits.

The inductance 6 may, as before mentioned, be understood as forming a path of relatively high impedance to the direct current pulsations set up by vibrator 3. A condenser 8 serves to favorably affect the tone quality of the output current and also overcomes any tendency relative to sparking at the contact of the vibrator.

In the handling of toll traffic, called subscriber's stations are usually reached by way of trunk lines extending from the toll board to the local switchboard. Such trunks may be arranged either for control on a manual or an automatic basis. In such systems, it is common practice to provide relays which respond at the moment a connection is extended to the line called for the purpose of applying ringing current thereto which application may be continued until automatically disconnected by the response of the called station. A variation of this procedure provides that a toll operator may start the ringing current which thereafter continues until discontinued, due to the response of the called subscriber.

In the arrangement of Fig. 2, a relay 21 may be considered as in association with a trunk circuit as before described and controlled in a well known manner, not shown, to connect ringing current from a source 22 to the tip and ring conductors T and R terminating in a plug 27 which may be assumed to be inserted in the jack of a called line. It will be noted that relay 21 in operating also disconnects the conductors of the trunk to the left thereby preventing the ringing current from flowing back over the calling end and at the same time connects the terminals of transformer winding 25 across this portion of the trunk.

Fig. 2 differs further from the arrangement of Fig. 1 in that the 20-cycle source 22 is connected in series with a polarized vibrator 24 and the primary winding 23 of transformer 26.

With relay 21 energized, a circuit also extends from the 20-cycle source 22 through the winding of polarized vibrator 24 and primary winding 23 of transformer 26 to ground, thereby causing the vibrator windings to be energized.

Depending upon the connection of the vi-

brator in the circuit, its armature will be attracted against its contacts, thereby causing it to vibrate during part of one-half wave of each cycle, but due to the opposite direction of the current during the other half wave, the windings will be energized in an opposite direction to repel the armature away from its contact, thereby causing it to remain at rest during such half wave.

Fig. 4 represents diagrammatically the character of the current flowing in the primary and secondary windings of the transformer. The upper curve representing the 20-cycle current in the primary as varied during each positive half wave by the action of the vibrator, and the lower curve of the figure shows the modulated wave present in the secondary of the transformer. It will be observed that due to the non-vibration of the armature of vibrator 24 during $\frac{1}{2}$ of each of the 20-cycle periods, there will be a corresponding interruption of the tone applied to the left-hand portion of the trunk circuit.

What is claimed is:

1. In a modulating system, a source of direct current, a vibrator adapted to short-circuit itself when energized and operated by said direct current and a source of alternating current superimposed on said direct current to vary the direct current energizing said vibrator in accordance with the wave form of said alternating current.

2. In a modulating system a circuit including a coupling device, a polarized self-short-circuiting vibrator and a source of direct current for operating said vibrator at a predetermined rate, a source of alternating current and means for applying said alternating current to said vibrator to alternately increase and decrease the effective voltage of said direct current.

3. In a modulating system a transformer, a source of direct current and a source of low frequency alternating current, a short circuiting vibrator having a tuned armature therefor, said armature operating in response to said direct current for producing, in conjunction with said transformer, alternating current of a relatively high frequency and means for superimposing said low frequency current on said direct current to cause the amplitude of said direct current to vary in accordance with said low frequency whereby said high frequency current is modulated in accordance with said low frequency.

4. In a system for converting direct current into alternating current, sources of direct current and low frequency alternating current, a vibrator of the short-circuiting type having a tuned armature responsive to said direct current for producing relatively high frequency alternating current, and means to apply said low frequency alternat-

ing current to the path of said direct current to modulate the high frequency alternating current produced thereby.

5. In a system of signaling by means of alternating current, a transformer, sources of pulsating direct and low frequency alternating current included in circuit with said transformer whereby said source of pulsating current is varied by said low frequency alternating current to produce a modulated alternating current in a secondary winding of said transformer, a first signaling circuit and means for connecting it with said low frequency current source and a second signaling circuit joined to said secondary winding of said transformer under control of said means.

6. In a signaling system, a source of high frequency carrier current comprising a source of direct current, a vibrator and a transformer winding, a source of low frequency current, a first line conductive to said low frequency current, and means for connecting said low frequency thereto, a second line circuit substantially non-conductive to said low frequency current, a secondary winding on said transformer connected to said second line circuit under control of said means and a path for applying said low frequency current to said first mentioned transformer winding to modulate said high frequency carrier current in accordance with said low frequency.

7. In a signaling system, a first and a second line section, a source of high fre-

quency current to said first mentioned comprising a short circuiting vibrator, a source of direct current and a primary winding for a transformer, a source of low frequency current for said second line section, a control means for energizing said second line section from the source of low frequency current, means for modulating said high frequency current by said low frequency current and means affected by said control means for energizing said first line section from said modulated high frequency current.

8. In a signaling system, a transformer, current sources to provide energy at a first and a second frequency for energizing windings of said transformer and effecting modulation of said first frequency by said second frequency, selective paths to effect separation of said frequencies relative to the respective sources, and means for employing said modulated current and current at said secondary frequency in signaling.

9. In a signaling system, sources of high and low frequency current, a transformer energized by said currents for effecting modulation of said high frequency current by said low frequency current, a plurality of selective paths for isolating current of one source from the sources of the other frequencies, and means for applying said modulated current and unmodulated currents in signaling.

In witness whereof, I hereunto subscribe my name this 1st day of October, A. D. 1924.

HENRY W. O'NEILL.