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SELECTIVE SIGNALING SYSTEM

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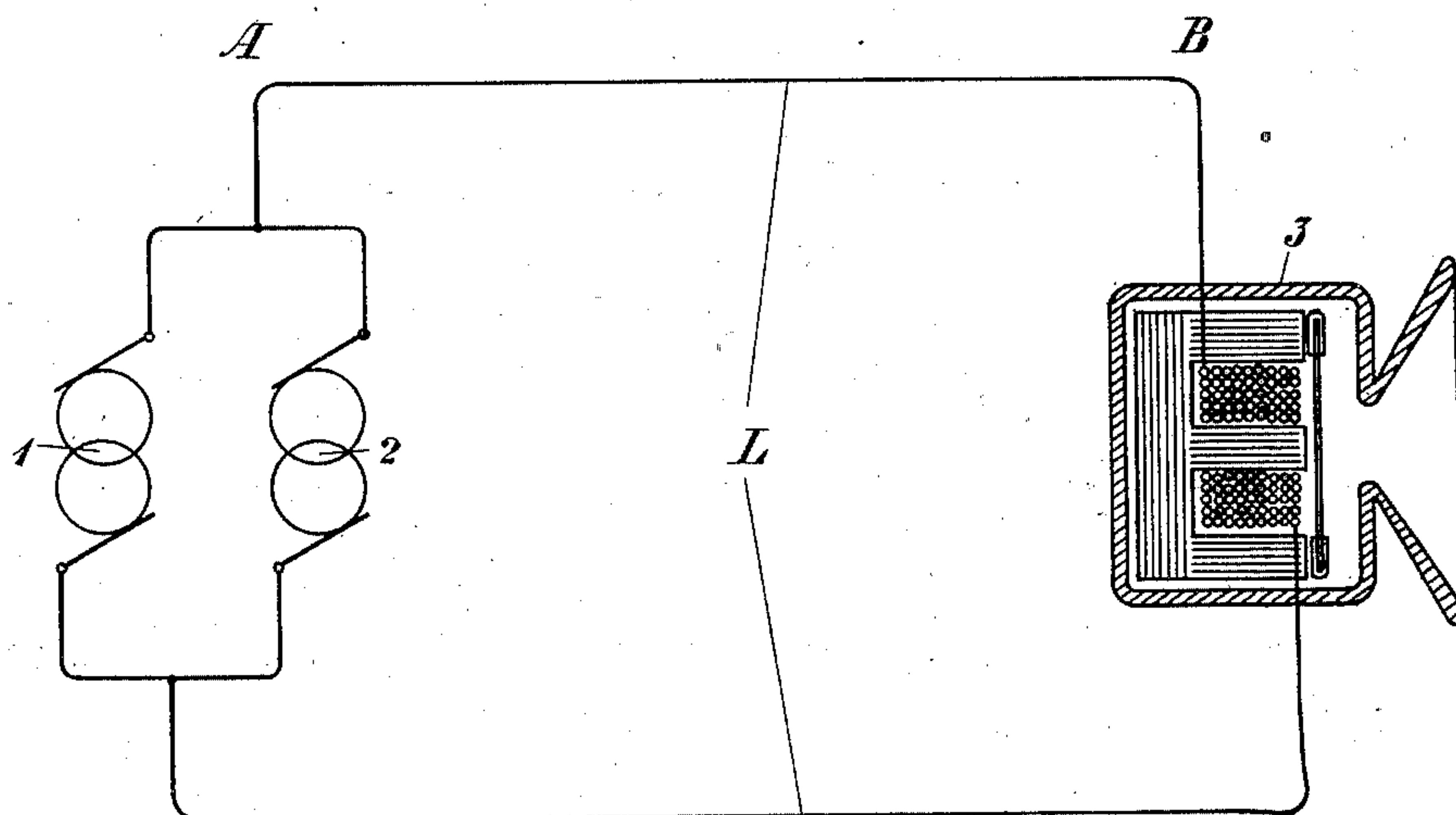


Fig. 1

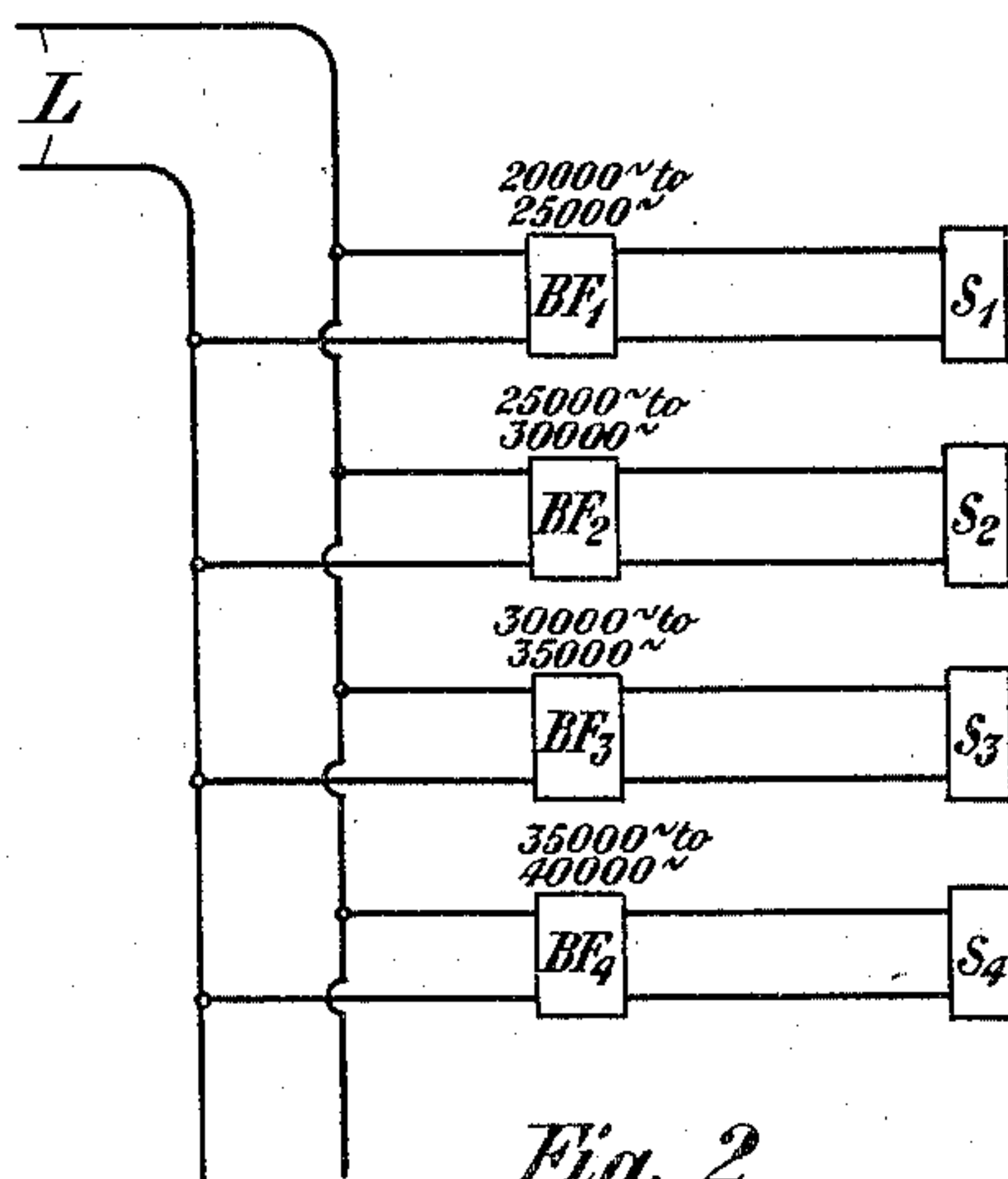


Fig. 2

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SELECTIVE SIGNALING SYSTEM

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This invention relates to selective signaling systems and more particularly to systems of the character which are adapted for use in connection with multi-station telephone lines.

It is an object of this invention to provide means for selectively signaling any one of the subscribers on a multi-party line without disturbing the others.

Another object is to provide means for signaling at carrier frequencies over either a voice or carrier frequency telephone system. These objects of the invention and certain other features thereof set forth below are attained as described in the following specification which has reference to certain specific embodiments of the invention illustrated in the accompanying diagram, in which Figure 1 is a diagrammatic view of one form and arrangement embodying the invention and Fig. 2 is a diagrammatic view of an application of the embodiment of the invention to selective ringing on multi-party lines.

Referring to Fig. 1, the reference character L designates a telephone line having associated therewith at one end two sources of current supply 1 and 2, and bridged across the line at the other end a signaling device 3.

Two currents having frequencies above the audible range, such as 30,000 and 31,000 cycles, and differing in frequency by a value well within the audible range, such as 1,000 cycles, are applied at station A to the conductors of the telephone line L. At B, a subscriber's station, there is located a signaling device consisting of a coil or an electromagnet having a non-magnetized or slightly magnetized iron core actuating either an armature of a bell or a diaphragm, such as is employed in telephone receivers and loud speakers, which armature or diaphragm is tuned to vibrate freely at about 1,000 cycles.

The signaling device is essentially an electromagnet and armature upon which a magnetic field acts due to the current in the helix wound about part or all of the core of the

electromagnet. If at any instant the current in the helix is I, then the force pulling the diaphragm or armature toward the electromagnet is

$$P = KI^2 \quad (1)$$

where K is a constant depending upon the physical structure.

The transmission of signals in accordance with this invention is characterized by such complex physical processes that an analysis of the phenomena involved seems best adapted to the elucidation of the invention. For simplicity, this analysis will be limited to the case of transmission of two high frequencies $\frac{p}{2\pi}$ and $\frac{q}{2\pi}$. The two currents may then be conveniently represented by the mathematical expressions $I_1 \sin pt$ and $I_2 \sin qt$. If the expressions of the values of the currents in line L be substituted in Equation (1) it will be found that

$$P = K(I_1 \sin pt + I_2 \sin qt)^2 \quad (2)$$

Expanding this expression it will result that

$$P = K(I_1^2 \sin^2 pt + 2I_1 I_2 \sin pt \sin qt + I_2^2 \sin^2 qt) \quad (3)$$

By a well known trigonometrical transformation equation (3) may be written in the following form:

$$P = \frac{KI_1^2}{2} - \frac{KI_1^2}{2} \cos 2pt + 2KI_1 I_2 \sin pt \sin qt + \frac{KI_2^2}{2} - \frac{KI_2^2}{2} \cos 2qt \quad (4)$$

And by another trigonometrical transformation equation (4) may be written in the following form:

$$P = \frac{KI_1^2}{2} - \frac{KI_1^2}{2} \cos 2pt - KI_1 I_2 \cos (p+q)t + KI_1 I_2 \cos (p-q)t + \frac{KI_2^2}{2} - \frac{KI_2^2}{2} \cos 2qt \quad (5)$$

The total pull is thus seen to be the sum of six components. The first and fifth terms of this expression (5), $KI_1^2/2$ and $KI_2^2/2$, since they involve only constant quantities, evidently only result in a steady pull on a diaphragm and therefore may be neglected for the purposes of this analysis. The second and last terms of this expression are of a double frequency and if $\frac{p}{2\pi}$ and $\frac{q}{2\pi}$ are inaudible frequencies, then these are also inaudible. The third term is of a frequency which is equal to the sum of the frequencies of the transmitted currents and obviously is also inaudible. The fourth term $KI_1I_2 \cos(p-q)t$ is of a frequency which is equal to the difference between the frequencies of the currents in line L and is the one on which the operation of this arrangement depends, representing the useful energy. Except for the matter of phase, the fact that this expression is a cosine rather than a sine has no significance.

Thus, two currents having frequencies above the audible range and differing in frequency by a value within the audible range are applied to the line L to produce at the signaling device, employed as a demodulator, two forces which, in combination, move its diaphragm at a frequency equal to the difference in the frequencies of the high frequency currents. By properly choosing the frequencies of the signaling currents it is possible to produce a signal of suitable low frequency without applying to the line any frequency within the audible range.

Fig. 2 represents an embodiment of this invention as applied to selective ringing on multi-party lines. By properly selecting the oscillator frequencies at the central office and by employing suitable band filters at the subscribers' stations it is possible to signal any one of a plurality of subscribers without disturbing the others. For example, a station having interposed between the line and signaling device a band filter which passes only frequencies between 20,000 and 25,000 cycles may be signaled by currents having frequencies of 22,000 and 23,000 cycles without affecting any other subscriber, if no other subscriber on the line has a filter of the same limits. Other subscribers may be signaled by using frequencies within the limits of their band filters.

It will be understood that the frequencies hereinbefore described are merely illustrative and may be varied in practice as conditions may require.

It will also be understood that the details of the arrangements herein set forth may be varied and the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. The method of high frequency telephonic signaling over a telephone line which consists in generating a plurality of pairs of high frequency oscillations, all of which are sinusoidal waves, impressing all of said oscillations on said telephone line, and effecting mechanical vibrations corresponding to each pair of said high frequency oscillations after transmission over said telephone line to produce signals of frequencies equal to the differences between the corresponding pairs of high frequency oscillations, said signals being of frequencies within the limits of audibility.
2. In a high frequency signaling system, the combination of sources of energy generating a pair of continuous, high frequency, undamped carrier waves, an untuned transmission circuit upon which said high frequency waves are superposed, and electromagnetic means for receiving said high frequency waves to produce mechanical vibrations of a frequency within the audible range, said generated high frequency carrier waves differing from each other by a frequency within the limits of said receiving means.
3. In combination, means for generating a pair of unmodulated carrier waves, an untuned circuit for transmitting said carrier waves, and a receiver of the electromagnetic type for translating said carrier waves into audible signals.
4. In combination, means for generating two unmodulated high frequency waves differing in frequency by an amount within the limits of audibility, an untuned medium for transmitting said waves, a filter for suppressing undesired waves and for freely transmitting said unmodulated high frequency waves, and electromagnetic means for converting the signals represented by said high frequency waves into audible mechanical vibrations.
5. In a signaling system, in combination, a plurality of carrier currents, a plurality of signaling devices, means for transmitting said carrier currents to said signaling devices, and a plurality of band filters, each band filter selecting a pair of said carrier currents within its limits to the exclusion of all other carrier currents, each pair of said carrier currents being employed to operate a signaling device.
6. A multiplex signaling system comprising a common transmission line, means for transmitting sinusoidal waves of different high frequencies thereover, an individual circuit for each pair of said high frequency sinusoidal waves, separate selective means connecting each of said circuits to said line, said selective means comprising filters connected effectively in parallel to each other with respect to said line, each of said selective means passing only one pair of said high frequency sinusoidal waves and effectively

suppressing all other currents, and electromagnetic means associated with each filter of the selective means for obtaining a magnetic pull of a frequency equal to the difference of the frequencies of each pair of sinusoidal waves.

7. In a multiplex signaling system, in combination, a line, means to impress a plurality of sinusoidal currents of different frequencies upon said line, said sinusoidal currents being grouped into pairs, each pair differing in frequency by a predetermined amount, selective means consisting of band filters connected in parallel to each other with respect to said line, and means of the electromagnetic type operatively associated with each pair of said sinusoidal currents impressed upon said line.

8. In a carrier current signaling system, a high frequency line, a plurality of electromagnetic devices connected thereto, means for impressing on said high frequency line a plurality of high frequency sinusoidal currents, and individual band filters connecting each electromagnetic device to said high frequency line, each band filter passing only two of said high frequency sinusoidal currents to the exclusion of the others, the two high frequency sinusoidal currents being related so as to operate said electromagnetic devices.

9. In a multiplex signaling system, a line adapted for carrying a plurality of high frequency currents, means for producing a plurality of high frequency sinusoidal waves for transmission over said line, a plurality of electromagnetic receivers, each electromagnetic receiver being employed for receiving signals transmitted by each pair of said high frequency sinusoidal waves, and a plurality of band filters each selectively passing the high frequency sinusoidal waves employed in the transmission of a different signal to each electromagnetic receiver.

10. A multiplex signaling system comprising a common transmission line, means for transmitting a plurality of currents of high frequencies thereover, each pair of said currents differing in frequency by an amount within the limits of audibility, an individual circuit for each pair of said high frequency currents, separate selective means connecting each of said circuits to said line, said selective means comprising filters connected effectively in parallel to each other with respect to said line, each of said selective means passing one pair of said high frequency currents to the exclusion of all other currents, and electromagnetic demodulating means responsive to each pair of said currents, each pair of said currents producing a magnetic pull which has a frequency equal to the difference between the frequencies of the currents of said pair and which operates the corresponding electromagnetic demodulating means.

11. A multiplex signaling system comprising

ing a common line, means for supplying thereto a plurality of different carrier frequency currents, each pair of said carrier currents differing in frequency by a predetermined amount, selective means for each pair of said carrier currents connected to said line, and a plurality of receivers acting as demodulators, one of said receivers being provided for each pair of carrier currents, each pair of said carrier currents producing a magnetic pull of a frequency equal to the difference between the frequencies of the carrier currents of said pair and sufficient to operate the corresponding receiver.

12. In a signaling system, a pair of intercommunicating stations, a plurality of signaling channels at one station, a plurality of corresponding signaling channels at the other station, an electromagnetic device in each of said second-mentioned channels, and means whereby pairs of high frequency signaling currents may be transmitted from each of said first-mentioned channels to the distant station and applied to the corresponding electromagnetic device, one pair of said high frequency currents being impressed upon each electromagnetic device and producing a magnetic pull in the corresponding electromagnetic device of a frequency equal to the difference between the frequencies of the impressed currents and sufficient to operate said device.

In testimony whereof, I have signed my name to this specification this 5th day of March 1925.

GEORGE K. THOMPSON.