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F. E. D'HUMY ET AL

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TELEGRAPH SYSTEM

Original Filed June 18, 1935

2 Sheets-Sheet 1

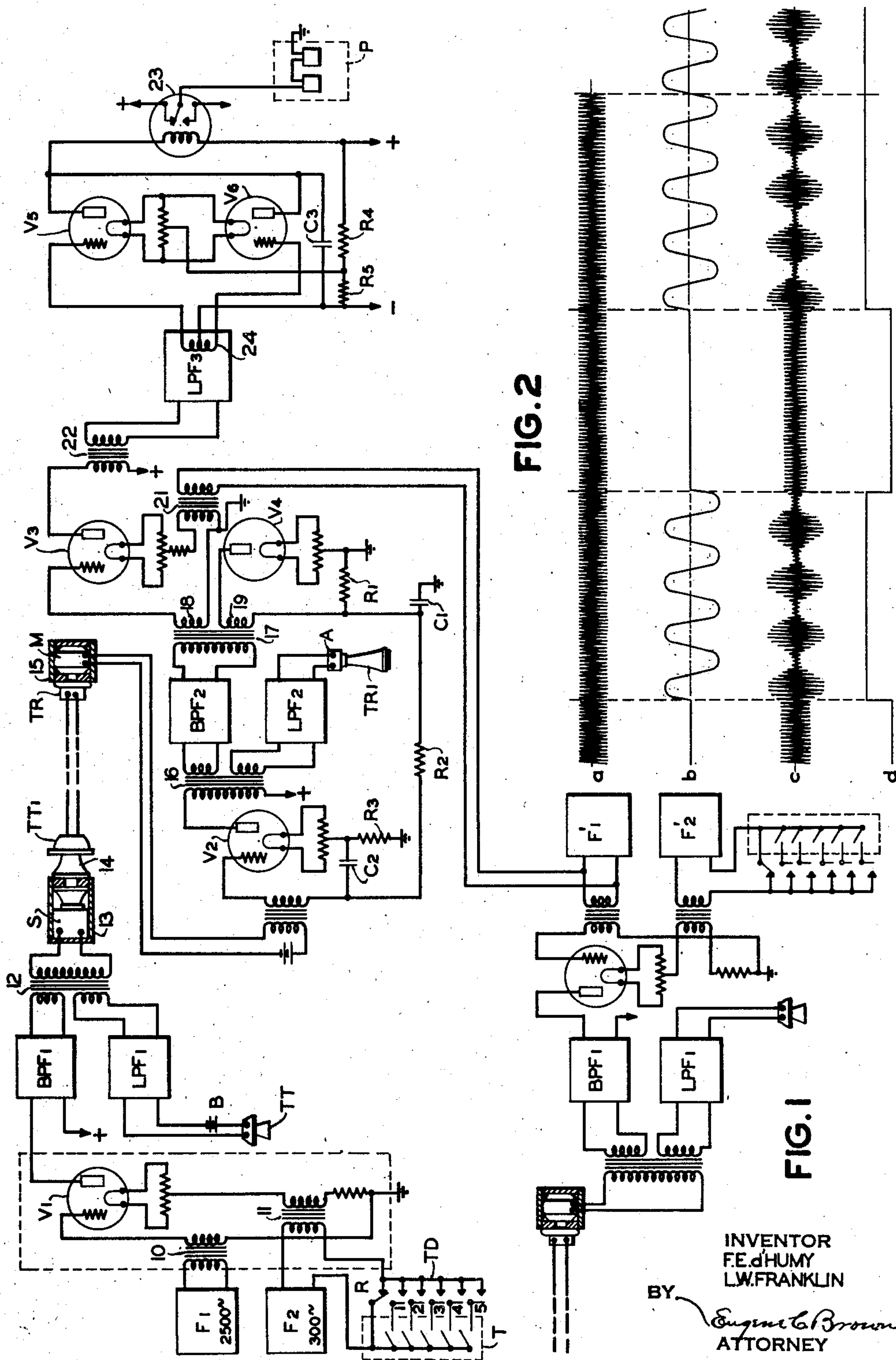


FIG. 2

Fig. 1

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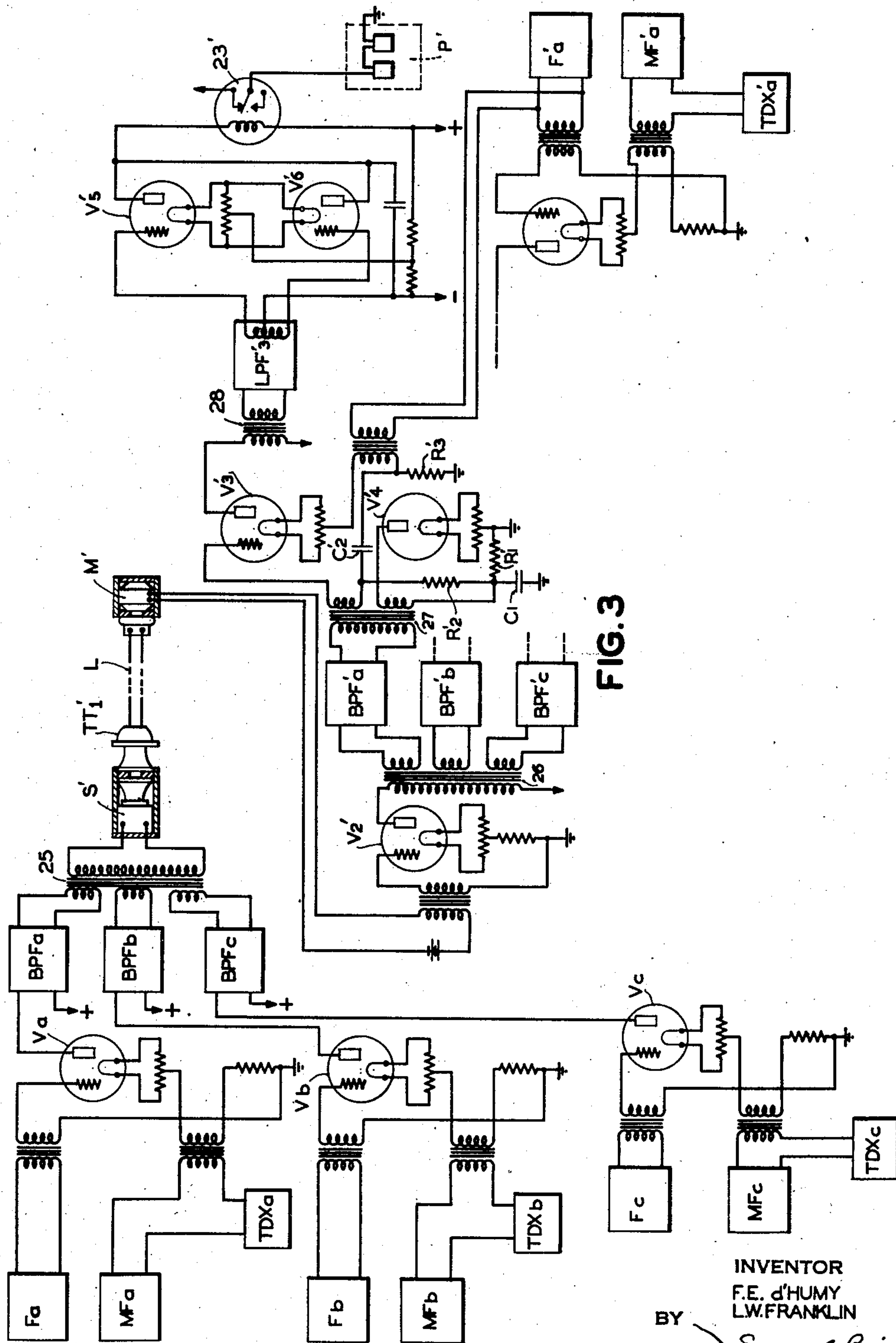


FIG. 3

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TELEGRAPH SYSTEM

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30 Claims. (Cl. 179—4)

This invention relates to telegraph systems and more particularly to the transmission of telegraph signals over standard telephone circuits.

In a copending application of F. E. d'Humy and L. W. Franklin, Serial No. 17,842, filed April 23, 1935, there is disclosed a system for carrying on telegraph correspondence over a standard telephone circuit by tone or audible signals. Briefly the invention of said application comprises producing oscillation of a frequency within the audible range, keying such oscillations in accordance with a telegraph code and applying said keyed oscillations to a tone producing device acoustically shielded and coupled to a standard telephone transmitter, to produce electrical variations or trains of oscillations in the telephone circuit. At the receiving end of the telephone circuit, the received signals are rectified and filtered so as to enable a standard telegraph receiver to respond thereto.

The present invention is an improvement on the invention of the aforesaid application, one of the objects thereof being to permit simultaneous transmission of voice signals and telegraph signals over a standard telephone circuit without any changes in the telephone circuit or equipment.

Another object is to enable a plurality of telegraph channels to be operated over a telephone system in a simple, convenient and efficient manner.

Another object is to provide an improved plural channel communication system.

Other objects and advantages of the invention will hereinafter appear.

The invention will be more fully understood by reference to the accompanying drawings in which

Fig. 1 is a circuit diagram of a telegraphic-telephone transmitting and receiving system embodying certain features of the present invention;

Fig. 2 is a diagram of the signals as they appear in various parts of the system; and

Fig. 3 is a circuit diagram of a modified form of the system employing a plurality of channels of telegraph communication.

Referring first to Fig. 1, there is shown a system for the simultaneous transmission of telegraph and voice signals, thereby permitting telegraph communication to be maintained over a standard telephone system without interfering with ordinary telephone conversation thereover. Two sources of electrical oscillations, F1 and F2, are provided. They may be vacuum tube oscillators, small alternators of the Alexanderson type, a microphone howler, a tuning fork con-

trolled means or other well known form of oscillator of the proper frequency. Source F1 is labeled 2500 cycles per second and source F2 is marked 300 cycles per second. These values are arbitrary, however, and other frequencies within reasonably wide limits may be employed. The source F1 is left unkeyed while the source F2 is keyed by a standard telegraph transmitter which may be either a keyboard transmitter or a storage transmitter such as a tape controlled transmitting distributor. A start-stop transmitter of the latter type is disclosed in Patent No. 1,805,324 of Roth-ermel, granted May 12, 1931. In transmitting distributors of this type, the rest contact R of the transmitting distributor TD is closed when the transmitter is idle, so as to apply a marking condition to the outgoing line and upon transmission of a character the rest contact is opened to transmit a spacing condition to the line. This is followed by successive closing of the code contacts 1 to 5 to complete circuits through the selectively closed contacts of the tape transmitter T. The rest contact R again closes following transmission of the fifth code impulse.

The oscillations from the source F1 are continuously applied through the transformer 10 to the grid of the vacuum tube V1. The oscillations from the source F2 are applied in accordance with a telegraph code to the cathode return circuit of tube V1 through the transformer 11. The frequency F1 is thus modulated by the keyed oscillations from source F2. This modulation, of course, may be obtained by other well known methods such as those in common use in radio receivers of the superheterodyne type. The output of tube V1 is applied to a band pass filter BPF1 adapted to pass frequencies between 2150 and 2850 cycles and to highly attenuate signals of other frequencies.

In Fig. 2, curve (a) illustrates the steady carrier frequency F1 as it is applied to the mixer tube V1. Curve (b) shows the frequency source F2 as keyed by the tape transmitter T. Curve (c) indicates the form of the signals after they have passed through the band pass filter BPF1. Curve (d) shows a standard square topped printer signal for purpose of comparison with the curves (b) and (c).

The band pass filter BPF1 may be of any of the well known types now in common use. This filter need not necessarily be of the sharp cut off type since its chief function is to eliminate the fundamental frequency and low harmonics of the low frequency source F2. The frequencies which will be impressed upon this filter are F1, F2,

$F1-F2$, and $F1+F2$ as well as certain of their harmonics which may be of appreciable amplitude. In addition due to the keying of the frequency source $F2$ at ordinary telegraph frequencies of about 25 cycles per second, there will be some 25 cycle modulation of certain of these frequencies. Consequently if a frequency band of from 2150 cycles to 2850 cycles is allowed to pass through the filter $BPF1$, this range of frequency may be employed for telegraph communication over a standard telephone circuit and the frequencies below about 2000 cycles down to about 200 cycles may be used for regular telephone conversation.

A separate telephone transmitter TT in circuit with a battery B is provided for telephone conversation over the telephone system. The voice frequencies picked up by the transmitter TT are passed through a low pass filter $LPF1$, designed to highly attenuate all frequencies above about 2000 cycles. The output from the filters $BPF1$ and $LPF1$ are passed through a coupling transformer 12 and from the secondary thereof applied either directly or through an amplifier (not shown) to a sound producing device S .

The sound producing device S is enclosed in a sound insulating container 13, the open end of which may be placed in contact with the mouthpiece 14 of a standard telephone transmitter $TT1$ so that the composite telegraph tone signals and voice signals will be impressed on the diaphragm of the telephone transmitter and hence reproduced in the telephone receiver TR at the distant end of the telephone circuit.

The telephone and telegraph receiving apparatus comprises a demodulating system. The tone signals produced by the telephone receiver are picked up by a microphone M preferably enclosed in a sound insulating container 15 having its open end disposed in contact with the telephone receiver TR . The signals produced in the microphone are amplified by amplifier tube $V2$ of conventional design and are applied through the output transformer 16 to a band pass filter $BPF2$ and a low pass filter $LPF2$, in tandem. The low pass filter $LPF2$ is designed to pass frequencies below 2000 cycles and to highly attenuate higher frequencies. A telephone receiver $TR1$ is connected in the output circuit of the low pass filter and serves to reproduce the voice frequencies introduced into the telephone transmitter TT at the sending station. An amplifier A may be inserted between the low pass filter $LPF2$ and the telephone receiver $TR1$, if desired.

The band pass filter $BPF2$ is designed to pass the frequency band between 2150 and 2850 cycles, the telegraph signals carried by this range of frequency being transmitted through a transformer 17 to a demodulator system having automatic gain control means associated therewith. The secondary winding 18 of the transformer 17 is connected in the grid circuit of a three element vacuum tube $V3$ and the winding 19 is connected in the plate circuit of the two electrode vacuum tube $V4$. Since the 2500 cycle carrier frequency is being transmitted from the source $F1$ whether the 300 cycle frequency is imposed thereon or not, the voltage across the diode tube $V4$ may be used to generate the negative voltage applied to the grid of the tube $V2$, to reduce the gain of the tube $V3$ when strong signals are being received. It will be noted that the portion of the signal energy which is applied to the rectifier tube $V4$ is received and produces a pulsating direct current voltage across the resistance $R1$. This voltage is

smoothed or filtered by the combined action of resistance $R1$ and condenser $C1$ and resistance $R2$ and condenser $C2$ and produces an added negative voltage, in addition to that produced by the plate current drop through the resistance $R3$. This added negative voltage is applied to the grid of tube $V2$, and thus acts to reduce the amplification of amplifier tube $V2$. This added voltage is proportional, or nearly so, to the received 2500 cycle component so that its action is to level out the amplitude of the signals, as applied through the filters $BPF2$ and $LPF2$.

The signals from the filter $BPF2$ are applied as stated to the demodulator or frequency converter tube $V3$. In addition a local source of 2500 cycle frequency is applied to the tube $V3$. This local source may be the frequency generator $F1$ used for transmission in the opposite direction or it may be a separate source of oscillations. This local source of oscillations is applied through the transformer 21, the secondary winding of which is connected in the cathode return circuit of tube $V3$. It might equally well be applied to tube $V3$ by any of the means common to frequency converters, such as used in superheterodyne radio receiving circuits. The mixing of the local 2500 cycle frequency with the frequencies passed by the filter $BPF2$ will result in a strong 300 cycle frequency in the output circuit of tube $V3$. The output circuit of tube $V3$ is coupled through the transformer 22 to a low pass filter $LPF3$ designed to suppress the frequencies substantially above 300 cycles. A band pass filter designed to pass 300 cycle oscillations might equally well be used. The output of the filter $LPF3$ is applied in push-pull to the grids of tubes $V5$ and $V6$. The function of the tubes $V5$ and $V6$ is to rectify the full wave trains of 300 cycle telegraph signals, and amplify the same so that they will be adaptable to the operation of a standard start-stop telegraph printer P . The operation of tubes $V5$ and $V6$ is as follows:

A bleeder circuit is provided from positive battery through the resistances $R4$ and $R5$, to negative battery. The plate electrodes of tubes $V5$ and $V6$ are connected to positive battery through the winding of the printer relay 23. The filament return is made to the junction of resistance $R4$ and $R5$. The grid return from the center tap of the output winding 24 of filter $LPF3$ is made to the negative end of the bleeder circuit. Therefore, the negative bias on tubes $V5$ and $V6$ is the voltage drop across resistance $R5$ and the plate voltage is the voltage drop across resistance $R4$. A filter condenser $C3$ tends to even the flow of current through the winding of relay 23. The current in the relay winding is substantially as shown in curve (d) of Fig. 2. The tongue of relay 23 is connected to the selecting magnet of the printer P .

In the use of the system a call between telephone subscribers is made in the usual way using the transmitter $TT1$ after which the calling subscriber couples his sound producing device S to the telephone transmitter and the called subscriber couples his receiving microphone M to the telephone receiver. Thereupon simultaneous telephone and telegraph communication may be conducted over the telephone circuit.

It will be understood, of course, that for full two way operation there will be one transmitting and one receiving means at each station, the transmitting sounder producing device S and receiving microphone M at each station being coupled to the transmitting mouthpiece and re-

ceiving earpiece respectively, of the same telephone instrument.

In long telephone lines it is sometimes the practice to use vodas relays or other voice operated devices to restrict conversation to one direction at a time. The purpose of such devices is to reduce singing and echo effects. In such systems it is obvious that two way telegraph communication cannot be conducted but is necessary to operate one way at a time or to employ a separate telephone system for telegraph communication in each direction. Telephone conversation may, of course, at the same time be carried on over both of such telephone systems in the same direction as the printer signals.

It will be noted that the 300 cycle carrier frequency is first modulated in accordance with the telegraph code signals and the 2500 cycle carrier, in turn modulated by the modulated 300 cycle frequency. In Fig. 3 this carrier-on-carrier system is shown in connection with the application of a number of telegraph channels to a single standard telephone system. In the modification of Fig. 3 the telephone channel is eliminated and in its place several additional carrier-on-carrier channels similar to the telegraph channel of Fig. 1 are operated.

In Fig. 3, three carrier-on-carrier channels are shown although many more may be provided within the range of efficient telephone line transmission. Each channel has its own main carrier frequency generator F_a , F_b , F_c , etc., and also its own modulator frequency source MF_a , MF_b , MF_c , etc. Each modulator frequency is keyed by a telegraph transmitting distributor TDX_a , TDX_b , etc. and applied to a modulating tube V_a , V_b , V_c , etc., to which the frequency sources F_a , F_b , F_c , etc., are coupled, respectively. The output of the tubes V_a , V_b , V_c , etc., are passed through individual band pass filters BPF_a , BPF_b , BPF_c , etc., and the outputs of the several filters are combined through a transformer 25 and impressed upon a tone producing device S' which is disposed in sound transferring relation to the transmitter TT' of the telephone circuit.

The oscillators F_a , F_b and F_c may operate respectively, at frequencies of 2800 cycles, 2450 cycles and 2100 cycles and the filters BPF_a , BPF_b and BPF_c may pass frequencies between the ranges 2950 to 2650, 2600 to 2300, and 2250 to 1950 respectively. The modulator frequency sources MF_a , MF_b and MF_c may be of the order of 150 cycles per second. It is to be understood, however, that these frequencies are arbitrary and may be varied.

The signals received over the telephone line L are picked up by the microphone M , amplified by the tube V_2' and applied through transformer 26 to the band pass filters $BPF'a$, $BPF'b$, $BPF'c$, etc. These filters pass respectively the same frequencies as filters BPF_a , BPF_b , BPF_c , etc., at the transmitting station. The apparatus associated with the output of each of the filters $BPF'a$, $BPF'b$, etc., is the same and therefore only that associated with filter $BPF'a$ will be described.

The signals passed by the filter $BPF'a$ are applied through transformer 27 to a three element tube $V'3$ and a two element rectifier tube $V'4$. The function of tube $V'4$ is similar to that of tube V_4 of Fig. 1 except that it is used to control the amplification of the frequency converter tube $V'3$ instead of that of the amplifier tube V_2 . For this purpose the grid of tube $V'3$ is connected through resistances $R'2$ and $R'1$ to the cathode

of the rectifier tube to thereby apply an added negative voltage to the grid of tube $V'3$ in proportion to the magnitude of the 2500 cycle signals received over the channel. A local source of oscillations $F'a$ is also applied to tube $V'3$ and the output of the tube is applied through transformer 28 to a low pass filter $LPF'3$. In the output circuit of the filter $LPF'3$ are rectifier tubes $V'5$ and $V'6$ in push-pull arrangement, as shown in Fig. 1. The output of these tubes operates a relay 23' to control the printer P' .

As is well known, the ordinary telephone does not respond equally well to all frequencies over the audio range. By having an individual automatic gain control tube $V'4$ associated with each channel, this variation may be compensated for by the individual channel receiving means. This allows a wider frequency spectrum to be utilized with correspondingly more channels. While a modulating frequency of 150 cycles per second is shown in Fig. 3, the exact frequency used as the modulating frequency as well as the channel spacing used will depend to a large extent on the number of channels desired and the economies involved, that is, whether the additional expense involved in the use of extremely efficient filters is justified by the extra channels obtained by their use.

Since the filters BPF_a , BPF_b , BPF_c , etc., are exactly the same in characteristics as filters $BPF'a$, $BPF'b$, $BPF'c$, etc., it is obvious that when one way transmission at a time is used, the same filters may, by appropriate switching means, be used both for receiving and sending.

It will be noted, that in both modifications shown herein there have been no changes in the telephone circuit. The telephone may, therefore, be used for either telephone or telegraph communication or for both. It is obvious that the invention is not limited to the particular form or values indicated but numerous changes may be made therein, within the scope of the invention.

What is claimed is:

1. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a higher frequency, modulating said latter oscillations in accordance with said keyed oscillations, utilizing said modulated oscillations to produce tone signals and impressing said tone signals on the transmitter of the telephone system.

2. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a higher frequency not exceeding 3000 cycles per second, modulating said latter oscillations in accordance with said keyed oscillations, filtering said modulated oscillations to eliminate the first mentioned lower frequency oscillations, and impressing signaling currents corresponding to said filtered oscillations upon the telephone system.

3. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a higher frequency, modulating said latter oscillations in accordance with said keyed

oscillations, filtering said modulated oscillations to attenuate frequencies substantially above and below the frequency of said second mentioned oscillations, utilizing said filtered oscillations to produce tone signals and impressing said tone signals on the transmitter of the telephone system.

4. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a frequency above about 2000 cycles per second, modulating said latter oscillations in accordance with said keyed oscillations, filtering said modulated oscillations to attenuate frequencies below about 2000 cycles per second, utilizing said filtered oscillations to produce tone signals and impressing said tone signals on the transmitter of the telephone system.

5. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a frequency near the upper range of efficient telephone transmission, modulating said latter oscillations in accordance with said keyed oscillations, utilizing said modulated oscillations to produce tone signals and impressing said tone signals on the telephone system.

6. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a frequency near the upper range of efficient telephone transmission, modulating said latter oscillations in accordance with said keyed oscillations, filtering said modulated oscillations to attenuate frequencies substantially below the frequency of said second mentioned oscillations, impressing said filtered oscillations on the telephone system and utilizing oscillations of a frequency below said filtered oscillations for additional channels of communication over said telephone system.

7. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a frequency near the upper range of efficient telephone transmission, modulating said latter oscillations in accordance with said keyed oscillations, filtering said modulated oscillations to attenuate frequencies substantially below the frequency of said second mentioned oscillations, impressing said filtered oscillations on the telephone system and utilizing oscillations of a frequency below said filtered oscillations for telephone communication over said telephone system.

8. The method of communication over a telephone system which comprises producing telegraphically modulated oscillations of a frequency band near the upper range of efficient telephone transmission and voice frequency signals having the frequencies within said band suppressed, utilizing said telegraphically modulated oscillations to produce tone signals and concurrently impressing said tone signals and voice frequency signals on the transmitter of a telephone system.

9. The method of communication over a telephone system which comprises producing tele-

graphically modulated oscillations of a frequency band near the upper range of efficient telephone transmission and voice frequency signals having the frequencies within said band suppressed, utilizing said telegraphically modulated oscillations and said voice frequency signals to produce audible signals and impressing said audible signals on the transmitter of a telephone system.

10. The method of telegraph communication over a telephone system comprises producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillation of a higher frequency, modulating said latter oscillations in accordance with said keyed oscillations, utilizing said modulated oscillations to produce tone signals, transmitting said tone signals over a telephone system, converting the received tone signals into electrical oscillations, translating said oscillations into telegraph code impulses and operating a telegraph receiver in accordance with said impulses.

11. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a higher frequency, modulating said latter oscillations in accordance with said keyed oscillations, filtering the higher frequency components of said oscillations, rectifying the lower frequency components thereof to produce telegraph code impulses and operating a telegraph receiver in accordance with said impulses.

12. The method of telegraph communication over a telephone system comprising producing electrical oscillations of a predetermined frequency, keying said oscillations in accordance with a telegraph code, producing electrical oscillations of a higher frequency, modulating said latter oscillations in accordance with said keyed oscillations, utilizing said modulated oscillations to produce tone signals, transmitting said tone signals over a telephone system, converting the received tone signals into electrical oscillations, regulating the amplitude of said received oscillations in accordance with a characteristic of the telephone circuit and controlling the operation of a telegraph receiver in accordance with said received oscillations.

13. The method of telegraph communication which comprises producing a plurality of oscillations of different predetermined frequencies, independently modulating the oscillations of each frequency in accordance with a telegraph code, concurrently impressing said modulated oscillations on a tone producing device, transmitting the tone signals so produced over a telephone circuit, converting the received tone signals into electrical oscillations, filtering out the oscillations of each of said original frequencies, regulating the amplitude of the oscillations of each of said frequencies independently in accordance with the transmission characteristics of the telephone circuit at each of said frequencies, and utilizing the oscillations of each frequency to control the operation of an individual telegraph receiver.

14. In combination with a telephone system, a first source of oscillations, means for keying said oscillations in accordance with a telegraph code to produce trains of oscillations, a second source of oscillations, means for modulating said second oscillations by said keyed oscillations, means responsive to said modulated oscillations to pro-

duce tone signals, and a telephone transmitter connected to the telephone system and disposed in sound receiving relation to said tone producing means.

15. In combination with a telephone system, a first source of oscillations, means for keying said oscillations in accordance with a telegraph code to produce trains of oscillations, a second source of oscillations, means for modulating said second oscillations by said keyed oscillations, means responsive to said modulated oscillations to produce tone signals, a telephone transmitter for said telephone system disposed in sound receiving relation to said tone producing means, a sound responsive device disposed in sound receiving relation to the distant receiver of said telephone system for producing oscillations in accordance with received tone signals, and means for demodulating said latter oscillations to produce telegraphic code impulses.

16. In combination with a telephone system, a first source of oscillations, means for keying said oscillations in accordance with a telegraph code, a second source of oscillations of a frequency near the upper range of efficient telephone transmission, means for modulating said second oscillations by said keyed oscillations, a first filter for suppressing oscillations of frequencies substantially below the frequency of said second source of oscillations, a voice responsive device for producing voice frequency currents, a second filter associated therewith for suppressing voice frequency currents in the range efficiently passed by said first filter, a sound producing device, means for impressing said filtered telegraphically modulated oscillations and said filtered voice frequency currents on said sound producing device, and a telephone transmitter forming part of said telephone system, disposed in sound receiving relation to said sound producing device.

17. In combination with a telephone system, a first source of oscillations, means for keying said oscillations in accordance with a telegraph code, a second source of oscillations of a frequency near the upper range of efficient telephone transmission, means for modulating said second oscillations by said keyed oscillations, a first filter for suppressing oscillations of frequencies substantially below the frequency of said second source of oscillations, a voice responsive device for producing voice frequency currents, a second filter associated therewith for suppressing voice frequency currents in the range efficiently passed by said first filter, sound producing means responsive to said filtered telegraphically modulated oscillations and said filtered voice frequency currents, a telephone transmitter forming part of said telephone system, disposed in sound receiving relation to said sound producing means, a sound responsive device disposed in sound receiving relation to the distant receiver of said telephone system for producing oscillations in accordance with received tone signals, a third filter for suppressing oscillations of a frequency substantially below the frequency of said second source of oscillations, a fourth filter for suppressing frequencies in the range efficiently passed by said third filter, means for impressing said received oscillations on said third and fourth filters, means in the output of said third filter for demodulating the oscillations passed thereby to produce telegraph code impulses and means in the output of said fourth filter for converting the signals passed thereby into audible tones.

18. In combination with a telephone system,

means for producing tone signals in accordance with a telegraph code, means for impressing said tone signals on the transmitter of said telephone system concurrently with voice signals and means associated with the distant receiver of said telephone system for separating said tone signals and said voice signals whereby simultaneous telegraph and telephone communication may be conducted over the telephone system.

19. In combination with a telephone system adapted for ordinary telephone conversation, means for impressing voice currents thereon, means for concurrently transmitting audible telegraph signals thereover, with said telephone signals, and means restricting the frequency components of the voice currents to a portion of the audible band below the frequency of the telegraph signalling current for preventing interference of said telephone and telegraph signals with each other.

20. In combination with a telephone system, plural-channel means for concurrently transmitting a plurality of audible telegraph signals over said system, means for preventing interference between said signals in separate channels and means for regulating the amplitude of each received telegraph signal in accordance with the characteristics of the telephone system.

21. The method of communication over a telephone system which comprises generating electrical oscillations of two different frequencies, producing therewith permutation code telegraph signals having frequency components in the range efficiently transmitted by the telephone system, said last-mentioned step including the step of modulating the oscillations of one frequency by the other, transmitting said signals over the telephone system and controlling a telegraph receiver in accordance with said signals.

22. The method of communication over a telephone system which comprises generating electrical oscillations of two different frequencies, producing therewith permutation code telegraph signals having frequency components in the range efficiently transmitted by the telephone system, said last-mentioned step including the step of modulating the oscillations of one frequency by the other, transmitting said signals over the telephone system and filtering, rectifying and detecting said signals.

23. The method of communication over a telephone channel which comprises producing telegraphically modulated oscillations of frequency near the upper range of efficient telephone transmission and voice currents having frequencies approximating that of said oscillations suppressed, concurrently impressing said oscillations and voice currents on the telephone channel and filtering the received oscillations from the received voice currents.

24. In a combined telephone-telegraph system, a circuit, means for concurrently transmitting audible-tone telegraph signals and voice currents over said circuit, the frequency components of said telegraph signals and voice currents being limited to less than 3000 cycles per second and means for preventing interference of said telegraph signals and voice currents with each other.

25. In a combined telegraph-telephone system, a telephone circuit, means for producing electrical oscillations of a predetermined frequency, means for keying said oscillations in accordance with a telegraph code, means for producing electrical oscillations of a higher frequency, not exceeding 3000 cycles per second, means for modulating said

- higher frequency oscillations in accordance with said keyed oscillations, means for filtering said modulated oscillations to eliminate the first mentioned lower frequency oscillations, and means electrically independent of the telephone equipment for impressing signalling currents corresponding to said filtered oscillations upon said telephone circuit.
26. In a combined telephone-telegraph system, a telephone transmitter, means for producing telegraphically modulated oscillations of a frequency band near the upper range of efficient telephone transmission, means for producing voice frequency signals having the frequencies within said band suppressed and means, including said telephone transmitter, for impressing said telegraphically modulated oscillations and said voice frequency signals on the telephone system.
27. In a combined telephone-telegraph system, a telephone circuit, means for producing telegraphically modulated oscillations of a frequency band near the upper range of efficient telephone transmission, means for producing voice frequency signals having the frequencies within said band suppressed, and means electrically independent of the telephone system for impressing said telegraphically modulated oscillations and said voice frequency signals on said telephone circuit.
28. In a combined telephone-telegraph system, a telephone sub-station, means at said sub-station for producing telegraphically modulated oscillations of a frequency band near the upper range of efficient telephone transmission, means

at said sub-station for producing voice currents having the frequencies within said band suppressed, means for impressing said telegraphically modulated oscillations and voice currents on the telephone system, means at a remote point in the system for separating the received voice currents and telegraphically modulated signals, a sound reproducer responsive to said voice currents, a recorder, and means for operating said recorder in accordance with the received telegraphically modulated signals.

29. In combination with a telephone system, a telephone sub-station, a first source of oscillations, means for keying said oscillations in accordance with a telegraph code to produce trains of oscillations, a second source of oscillations at said sub-station, means for modulating said second source by said keyed oscillations, means responsive to said modulated oscillations to produce tone signals, a telephone transmitter at said sub-station connected to the telephone system and arranged in sound receiving relation to said tone signal producing means and means at a remote point in the telephone system for effecting a record of said signals.

30. In a combined telephone-telegraph system, a telephone circuit, means for impressing voice currents thereon of predetermined frequency spread, means for concurrently impressing a non-interfering audible frequency carrier on said circuit and means for keying said carrier in accordance with telegraph signals.

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